Appendix 6.D. Hotspot Predictive Model Profiles

6.D.1. Overview

This appendix presents detailed model profiles for the abundance, species richness, and Shannon diversity index hotspot analyses described in this chapter. The format is similar to Appendix 6.C. Annual and seasonal maps are presented, along with cross-validation observed vs. predicted plots and cross-validation relative uncertainty calibration plots. Annual cross-validation analyses were conducted in 20x20 cell (~18x18 km) bins. The larger bin size was necessary to include enough cross-validation data for all species simultaneously. Each figure in this appendix is explained in the associated caption; for detailed methods, see Appendix 6.A.

Annual hotspot relative uncertainty map

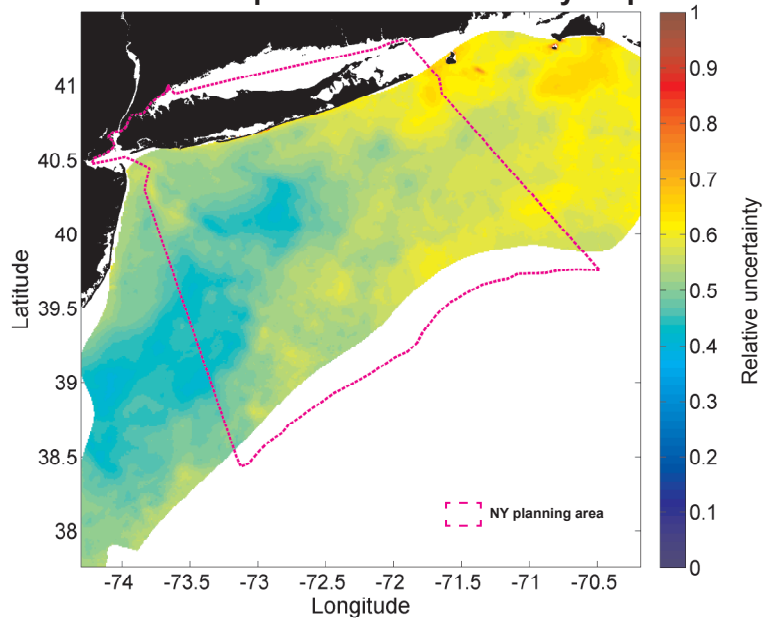

Figure 6.D.1. Annual hotspot relative uncertainty map. The relative uncertainty value is a dimensionless number scaled between 0 and 1, where values closer to 0 indicate greater certainty. The relative uncertainty value at each location is the same for all hotspot quantities (abundance, richness, and diversity index), because it is a function of the underlying trend and spatial model uncertainty for each species/group, but the relationship of the relative uncertainty value to actual prediction error varies for each of the quantities analyzed. That relationship can be seen in the uncertainty calibration plots for each predicted quantity: Figure 6.D.4 (Abundance), Figure 6.D.8 (Richness), and Figure 6.D.12 (Shannon Diversity Index).

Seasonal hotspot relative uncertainty maps

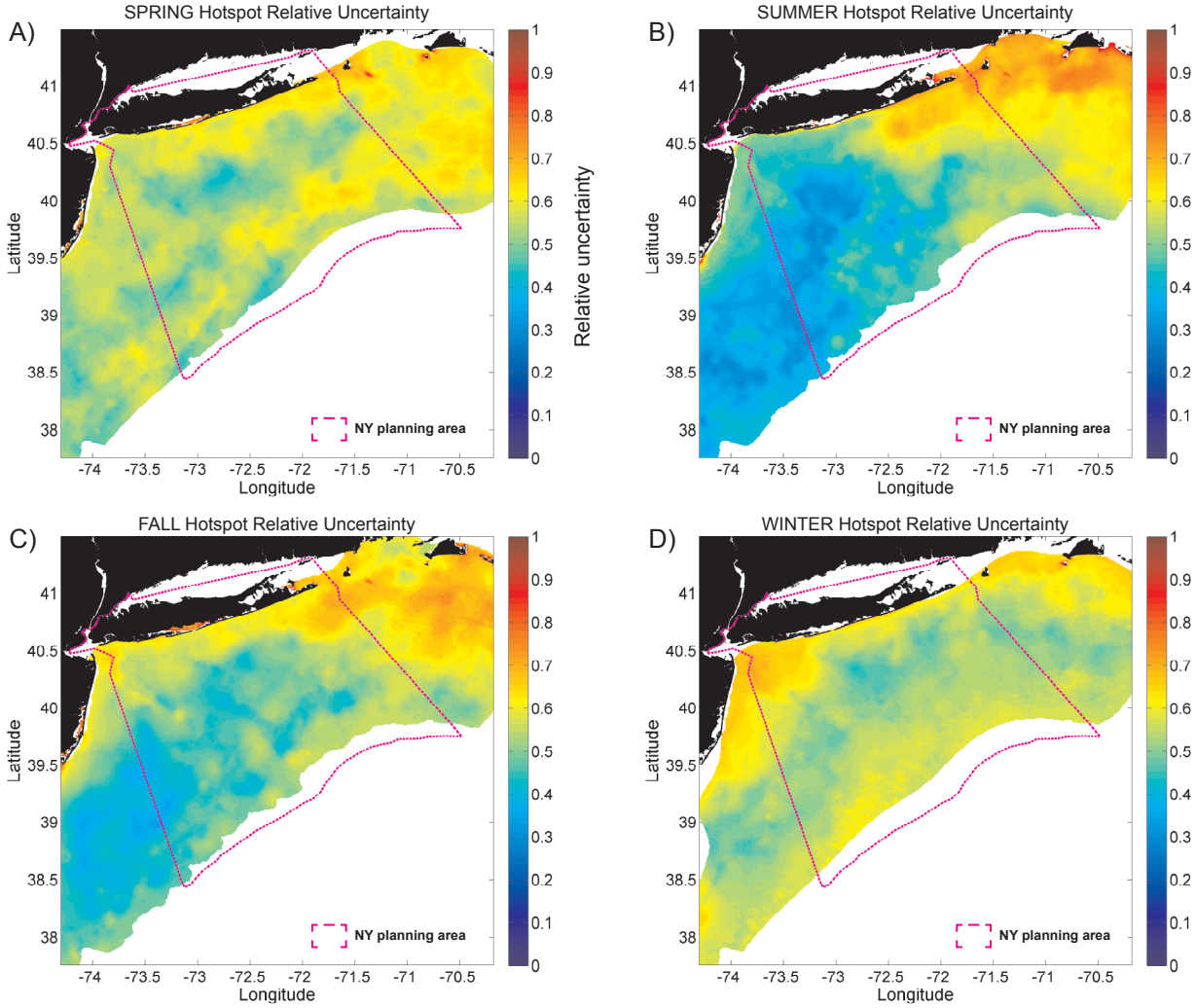

Figure 6.D.2. Seasonal hotspot relative uncertainty maps for (A)Spring, (B)Summer, (C)Fall, and (D)Winter. Explanation of relative uncertainty values is as in Figure 6.D.1.

ABUNDANCE HOTSPOTS

Annual abundance hotspot map

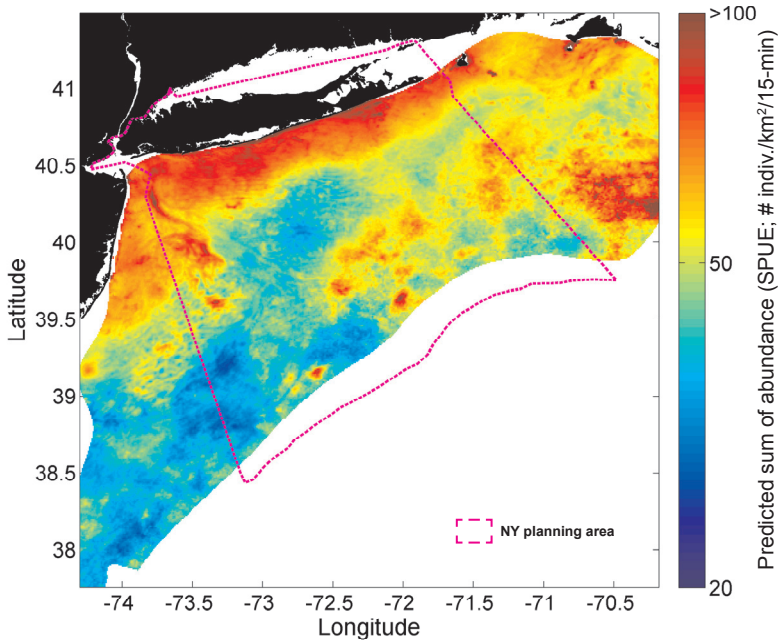

Figure 6.D.3. Annual predicted seabird relative abundance hotspot map. Shading represents the sum of the predicted relative abundance (SPUE) for all modeled species and groups over all seasons in which they were modeled (# indiv/km²/15-min). Abundance was treated as zero for all seasons in which a species or group was not modeled. Note that this method may overestimate the abundance seen in any given 15-minute survey due to unaccounted-for correlations among species (a correction factor could be derived from the cross-validation results in Figure 6.D.5).

Annual Abundance Hotspots Cross-Val. Uncertainty Calibration Plot

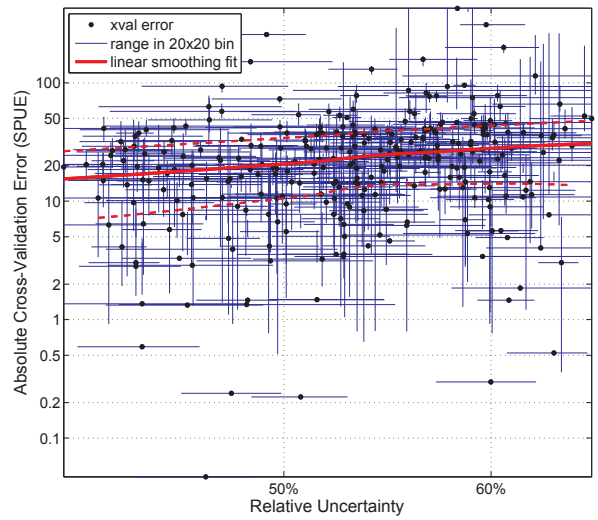

Figure 6.D.4. Cross-validation: relative uncertainty calibration plot for annual abundance hotspot map. The mean absolute cross-validation error calculated in 20x20 cell bins is plotted vs. the mean relative uncertainty value in the same bins; dashed lines show range of values in each bin. Red line is a robust linear loess smoothing fit (+/- 1 standard deviation; dashed red lines). Although the pattern is noisy, mean absolute cross validation error, measured in units of SPUE (# indiv./km²/15-min) can be seen to decrease smoothly as relative uncertainty decreases. Note log scale on both axes.

Seasonal abundance hotspot maps

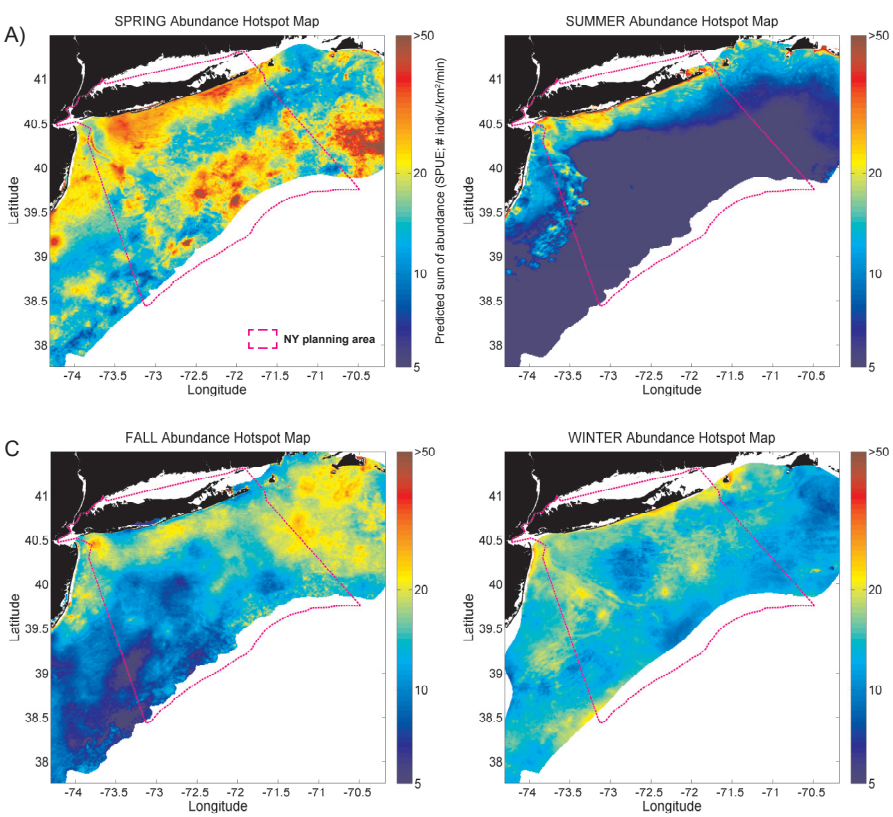

Figure 6.D.6. Seasonal predicted relative abundance hotspot maps for (A)Spring, (B)Summer, (C)Fall, and (D)Winter. Hotspots were calculated by summing predicted abundances of all modeled species and groups in the indicated season.

Annual Cross-Val. Observed vs. Predicted Abundance

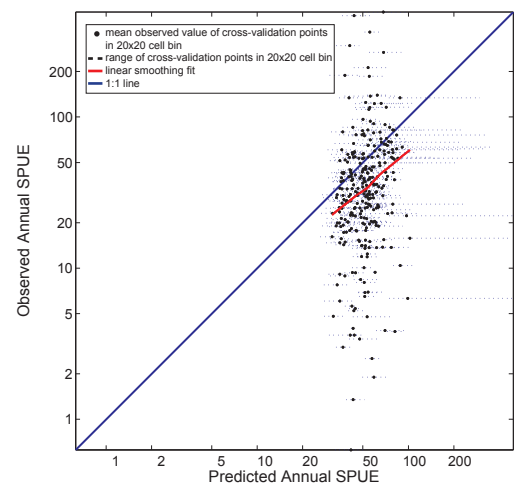

Figure 6.D.5. Cross-validation: observed vs. predicted values for the annual abundance hotspot map. Observations not included in the model training set were averaged in 20x20 cell bins and are plotted vs. the mean prediction value in the same bins. The 1:1 line (blue line) and a robust linear loess smoothing fit (red line) are plotted. Dashed horizontal lines show range of predictions in each bin. The x-axis is compressed compared to the y-axis for two reasons: first, the model predicts the average value expected over a long time at any given location, and individual observations vary around this average; second, many more predictions than observations are averaged to create each bin value (many of the 20x20 cell bins contain only one observation, but they contain up to 400 predictions). The loess smoothing fit suggests that predicted total abundance correlates well with observed total abundance, but that observed total abundance is systematically lower than the prediction by a factor of approximately 1.5 to 2. Note log scale on both axes.

SPECIES RICHNESS HOTSPOTS

Annual species richness hotspot map

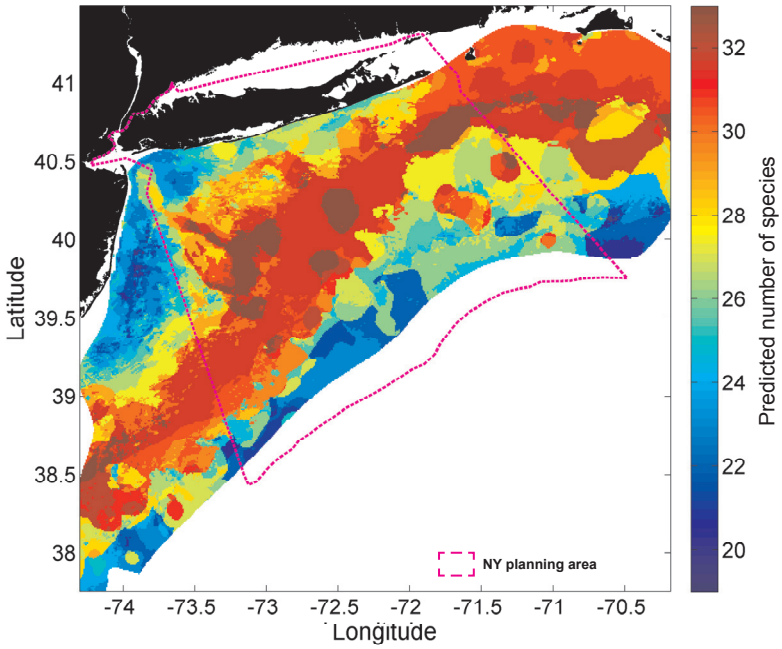

Figure 6.D.7. Annual predicted seabird species richness hotspot map. Shading represents the median of upper and lower bounds on predicted species richness at each location, obtained by summing minimum and maximum number of species that could have been present over all species and groups, treating each species or group as present if its predicted relative abundance was above a threshold. See Section 6.8.8.2 for methods. Species and groups that were not modeled in any season did not contribute to richness. Note that this estimate of richness overestimates the actual number of species that would be seen in any given 15-minute survey, both because it is unlikely that half of the species in each group will always be present, and because of unaccounted-for correlations among species (a correction factor could be derived from the cross-validation results in Figure 6.D.9).

Annual Species Richness Hotspots Cross-Val. Uncertainty Calibration Plot

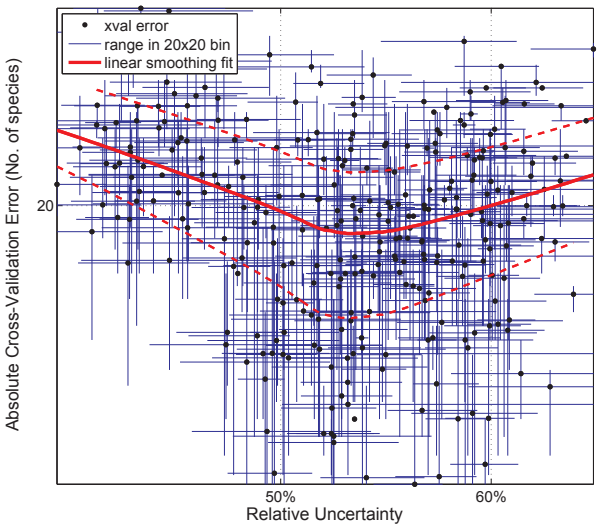

Figure 6.D.8. Cross-validation: relative uncertainty calibration plot for annual richness hotspot map. The mean absolute cross-validation error calculated in 20x20 cell bins is plotted vs. the mean relative uncertainty value in the same bins; dashed lines show range of values in each bin. Red line is a robust linear loess smoothing fit (+/- 1 standard deviation; dashed red lines). Results indicate a very noisy and non-linear relationship between relative uncertainty and the actual observed cross-validation error in species richness; relative uncertainty values between approximately 50% and 60% correspond to the best relationship between predicted and observed values at the 20x20 cell bin scale. It is recommended that the relative uncertainty of the richness hotspot maps be interpreted with caution. Areas where relative uncertainty <40% appear particularly unreliable. Some of this may be an artifact of the large bin size (20x20 cells) required for this cross-validation exercise. Note log scale on both axes.

Seasonal species richness hotspot maps

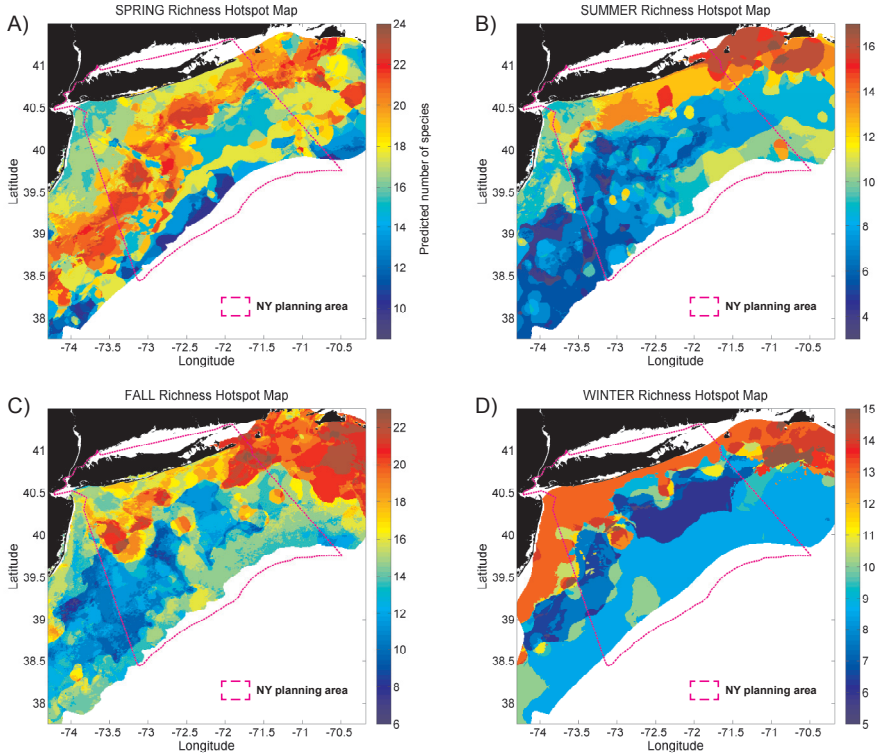

Figure 6.D.10. Seasonal predicted species richness hotspot maps for (A)Spring, (B)Summer, (C) Fall, and (D)Winter. Richness hotspots were calculated as described in Section 6.8.8.2. Species and groups not modeled in a given season did not contribute to richness for that season.

Annual Cross-Val. Observed vs. Predicted Species Richness

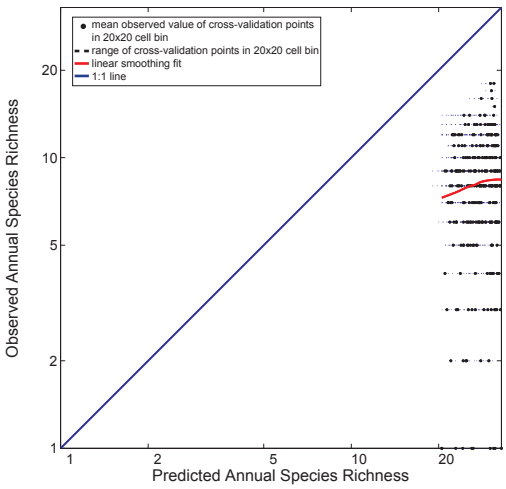

Figure 6.D.9. Cross-validation: observed vs. predicted values for the annual species richness hotspot map. Observed richness at locations not included in the model training set were averaged in 20x20 cell bins and are plotted vs. the mean predicted richness in the same bins. The 1:1 line (blue line) and a robust linear loess smoothing fit (red line) are plotted. Dashed horizontal lines show range of predictions in each bin. The x-axis is compressed compared to the y-axis for the same reasons as noted in Figure 6.D.5. The loess smoothing fit suggests that predicted species richness correlates well with observed species richness, but that observed richness is systematically lower than the prediction by a factor of approximately 3 to 4. Note log scale on both axes.

SHANNON DIVERSITY INDEX HOTSPOTS

Annual diversity index hotspot map

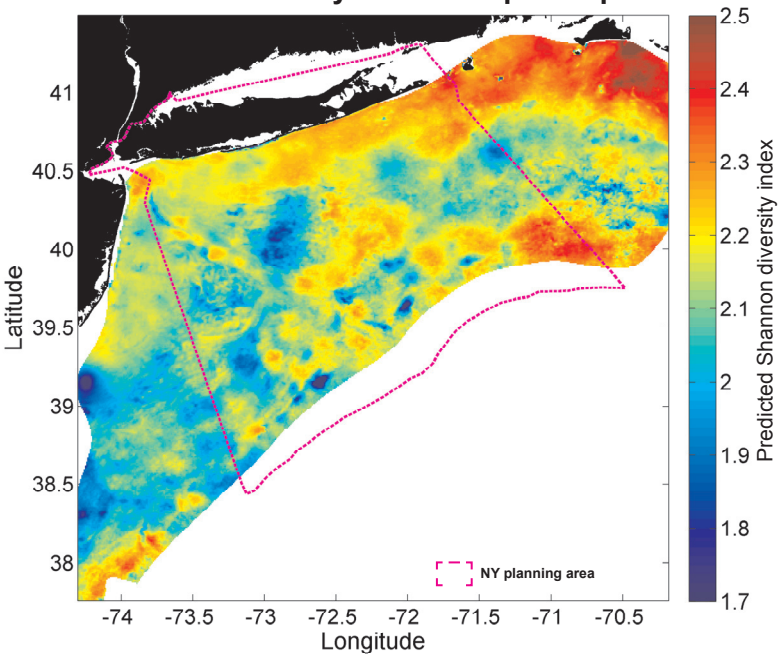

Figure 6.D.11. Annual predicted seabird Shannon diversity index. The Shannon index incorporates both presence and relative abundance. See section 6.8.8.3 for methods. Species and groups that were not modeled in any season did not contribute to index calculation. Note that this estimate of diversity overestimates the actual value of diversity index calculated in any given 15-minute survey for the reasons noted in captions for Figures 6.D.3 and 6.D.7 (a correction factor could be derived from the cross-validation results in Figure 6.D.13).

Annual Diversity Index Hotspots Cross-Val. Uncertainty Calibration Plot

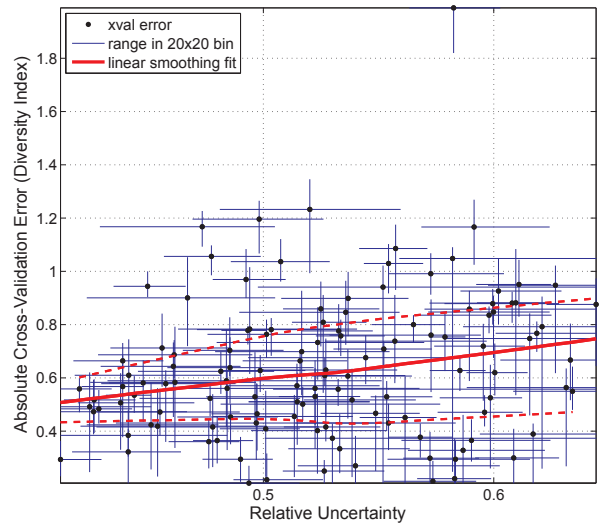

Figure 6.D.12. Cross-validation: relative uncertainty calibration plot for annual diversity index map. The mean absolute cross-validation error calculated in 20x20 cell bins is plotted vs. the mean relative uncertainty value in the same bins; dashed lines show range of values in each bin. Red line is a robust linear loess smoothing fit (+/- 1 standard deviation; dashed red lines). Although the pattern is noisy, mean absolute cross validation error, measured in units of the Shannon diversity index, can be seen to decrease smoothly as relative uncertainty decreases. Note that y-axis is linearly scaled and x-axis is log scaled.

Seasonal diversity index hotspot maps

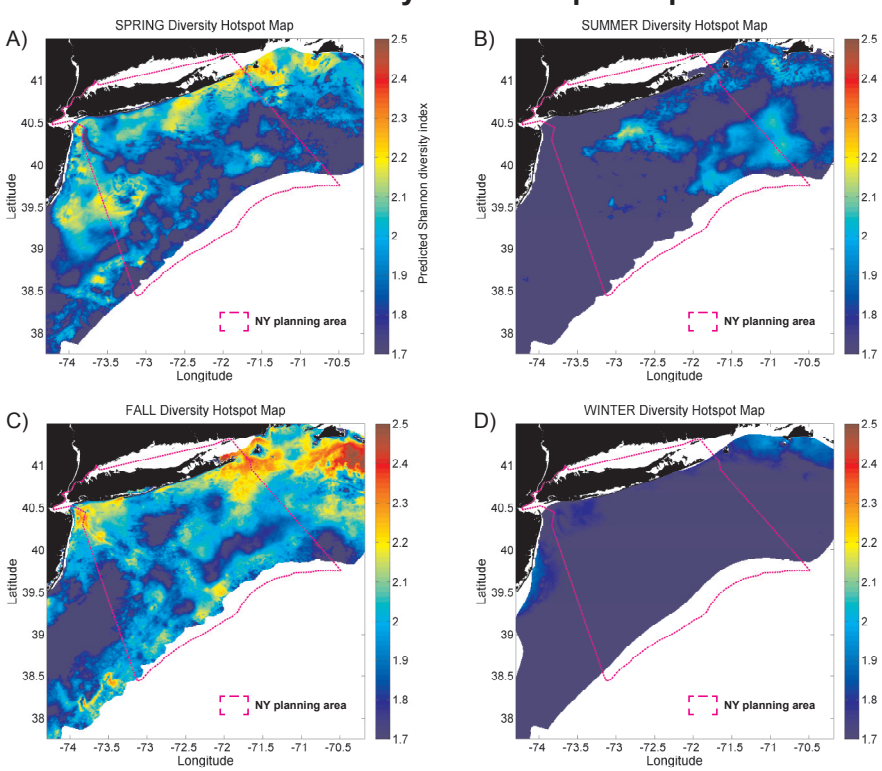

Figure 6.D.14. Seasonal predicted Shannon diversity index maps for (A)Spring, (B)Summer, (C)Fall, and (D)Winter. Diversity index values were calculated as described in Section 6.8.8.2. Species and groups not modeled in a given season did not contribute to diversity calculations for that season.

Annual Cross-Val. Observed vs. Predicted Diversity Index

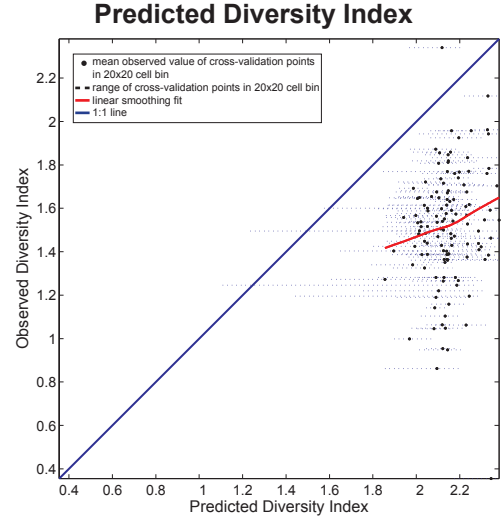

Figure 6.D.13. Cross-validation: observed vs. predicted values for the annual Shannon diversity index map. Observed Shannon diversity index at locations not included in the model training set was averaged in 20x20 cell bins and is plotted vs. the mean predicted Shannon diversity index in the same bins. The 1:1 line (blue line) and a robust linear loess smoothing fit (red line) are plotted. Dashed horizontal lines show range of predictions in each bin. The x-axis is compressed compared to the y-axis for the same reasons as noted in Figure 6.D.5. The loess smoothing fit suggests that the predicted Shannon diversity index correlates well with the observed value of the index in 20x20 cell bins, but that observed diversity is systematically lower than the prediction by a factor of approximately 1.2 to 1.4. Note that both axes are linearly scaled.