Developing Realized Niche Space Probability Distribution Functions for the Everglades Landscape Vegetation Succession Model

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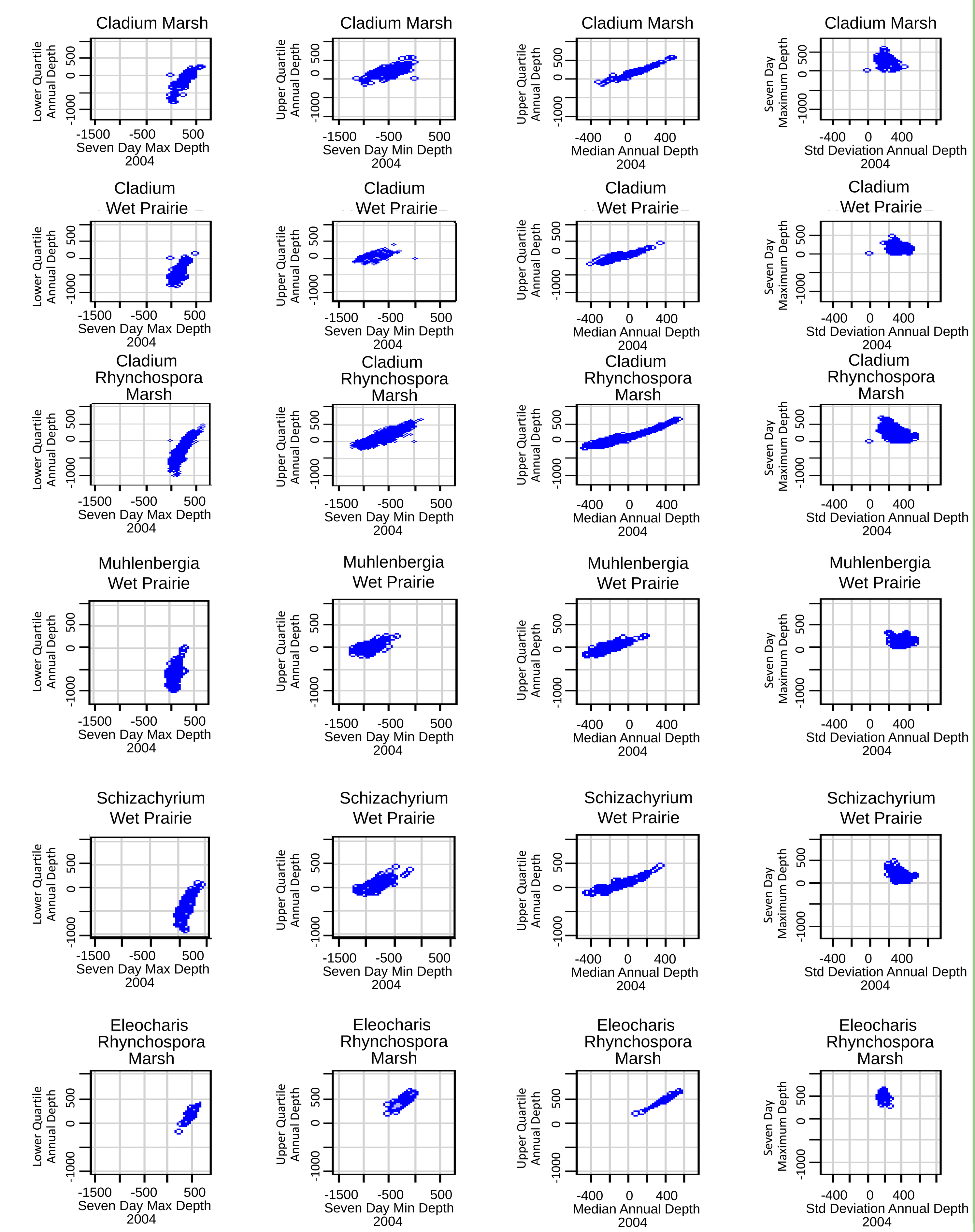
Introduction

The Everglades Landscape Vegetation Succession Model (ELVeS) Version 1.0 was parameterized using a composite remotely sensed vegetation map developed by combining aerial photographic maps and satellite imagery. Source data for each of these components were derived from data representing four different acquisition dates between 1993 and 2004. High resolution color infrared aerial photography (South Florida Water Management District) was used for each of the Everglades Water Conservation Areas. Everglades National Park was not included in the area covered by aerial photography, so the Florida GAP classified Thematic Mapper image from 1993 was used for this geographic area. Four hydrologic metrics (mean annual water depth in the wet period, 17 day water depth minimum and maximum and the standard deviation of annual water depth) derived from the Everglades Depth Estimation Network (EDEN) data archive were used to develop probability functions describing the distribution patterns of freshwater marsh communities. The vegetation map accuracy strongly influences the accuracy of the derived relationships for modeling.

Vegetation succession processes are partly based on time sensitive relationships between the dynamic hydrologic drivers which were not adequately addressed previously. Differences between the acquisition dates for the vegetation map and the EDEN hydrologic metrics were not considered in ELVeS 1.0. Temporal differences between these data sources incorporates un-quantified errors describing vegetation community and hydrologic drivers. To address this issue field vegetation surveys that could be linked with specific dates and hydrologic conditions were considered as an enhanced approach to developing parameters for ELVeS.

Figure 2. Scatter plot ellipsoids for communities illustrating distributions given combinations of hydrometric parameters.



All units are millimeters

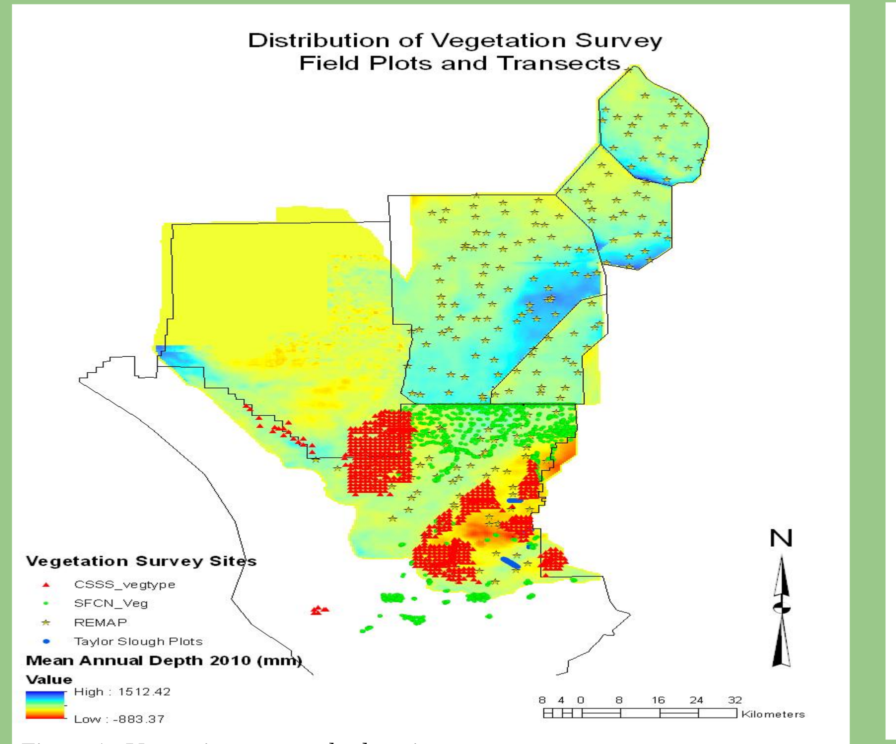


Figure 1. Vegetation survey plot locations.

The map above the shows the distribution of the four vegetation surveys evaluated to enhance the distribution functions. The mean annual depth surface is one of 49 hydrologic metrics considered in the evaluation. The 2D plots compare drivers for five marl prairie vegetation types. The 3D plot illustrates how well the realized niche separate communities along specific hydrologic gradients.

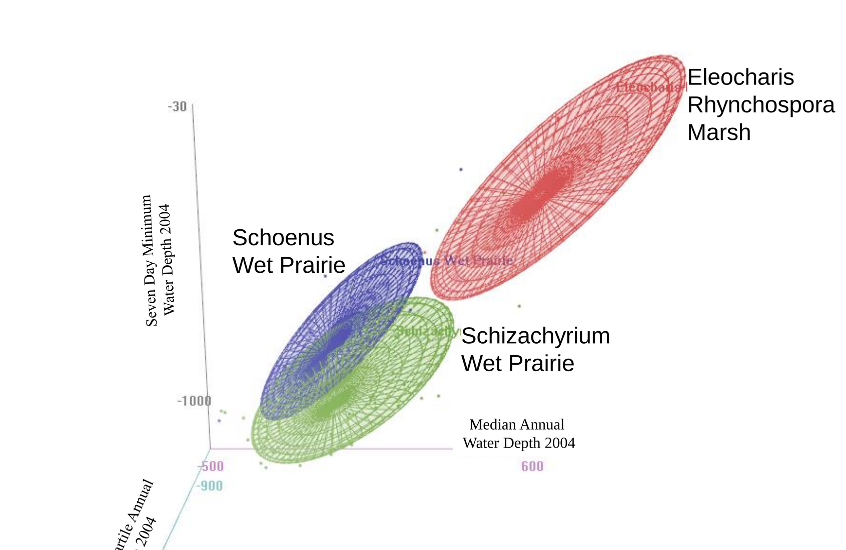


Figure 3. Distribution ellipses illustrating partial overlapping and complete separation of the niche space for three Cape Sable seaside sparrow habitat communities and three drivers.

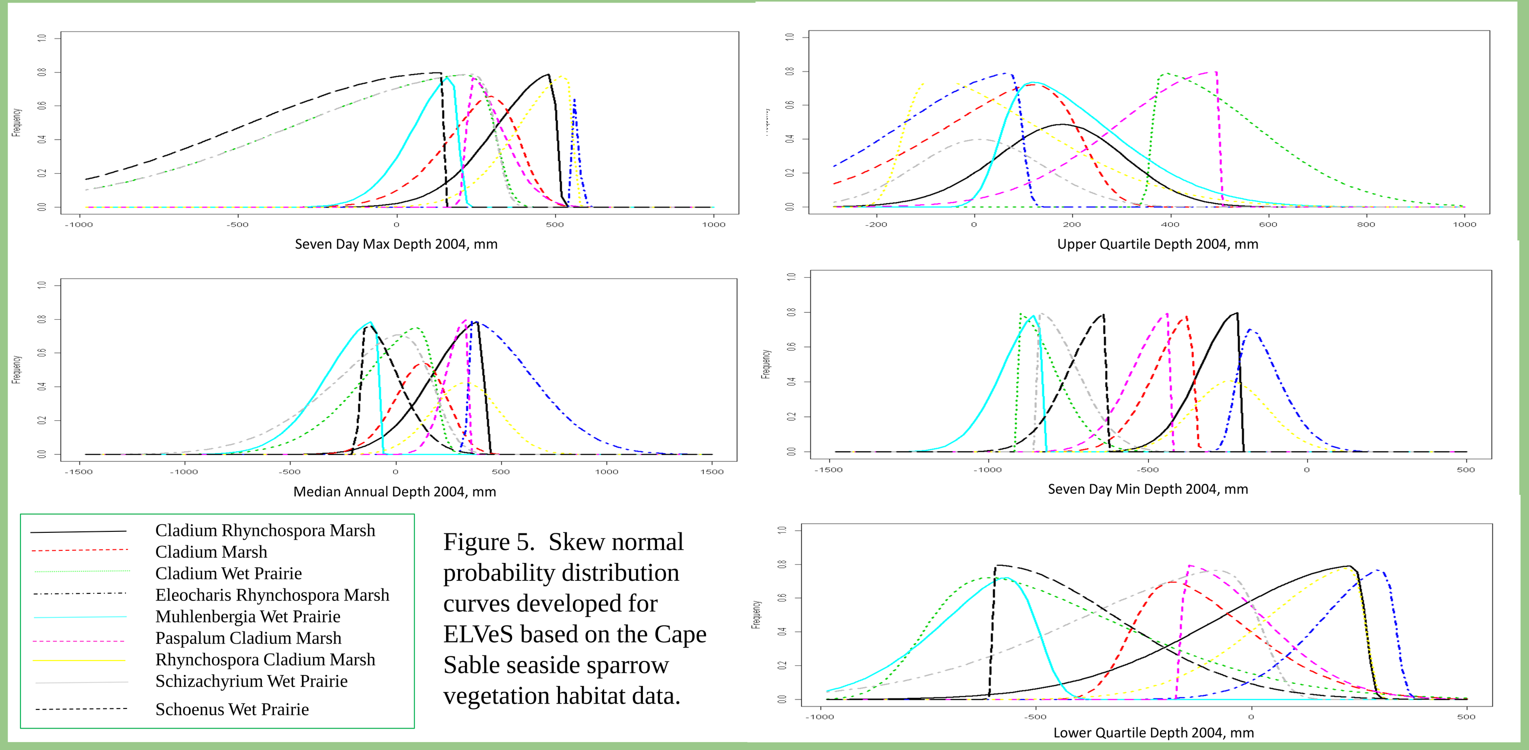


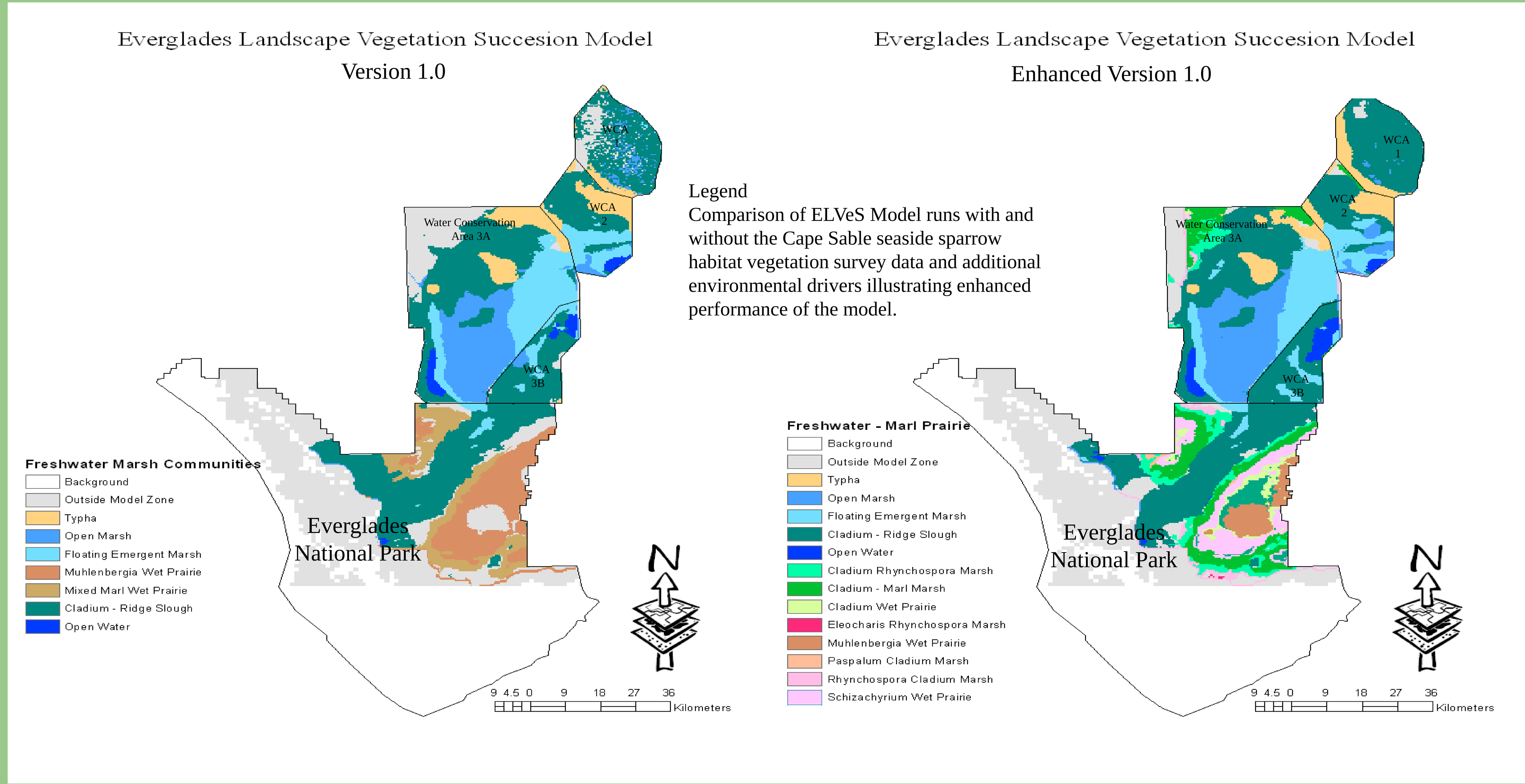
Figure 5. Skew normal probability distribution curves developed for ELVeS based on the Cape Sable seaside sparrow vegetation habitat data.

Methods

Vegetation surveys conducted by the Environmental Protection Agency for the R-EMAP program, the South Florida Caribbean Office of the National Park Service, Taylor Slough vegetation surveys by Everglades National Park Service and the Cape Sable seaside sparrow habitat vegetation survey conducted by Mike Ross (2004) were substituted for the vegetation map, to enhance linking vegetation survey periods directly with temporal coinciding hydrologic conditions.

In addition to the hydrologic drivers, vegetation community distribution patterns based on soil loss on ignition and soil total phosphorus were developed using the same approach. Data for these drivers were provided by the University of Florida and the South Florida Water Management District. We hypothesize that using field vegetation community records would provided an enhanced basis for developing realized niche space representations for freshwater marsh and marl prairie vegetation communities. Everglades Depth Estimation Network (EDEN) hydrologic conditions were used as the input hydrologic model. Six additional hydrologic metrics; standard deviation of annual water depths, seven day minimum and seven day maximum water depth, lower quartile and upper quartile annual water depths, and the median annual water depth were added to the parameterization of the model.

Here we focus attention on the Cape Sable seaside sparrow habitat vegetation survey to illustrate the enhanced performance of ELVeS. Survey plot and transect locations were overlaid on 49 hydrologic metrics in ARCGIS to establish community distribution patterns with each of the hydrologic drivers. Summary statistics and 2D and 3D dimensional scatter plot visualizations were developed to characterize community realized niche space separability (Figures 2, 3 and 4).



Legend
Comparison of ELVeS Model runs with and without the Cape Sable seaside sparrow habitat vegetation survey data and additional environmental drivers illustrating enhanced performance of the model.

Community frequency patterns for each of the hydrologic and soil metrics were used to quantify distribution patterns illustrated as skew normal curves. ELVeS was parameterized using skew normal and logistic probability coefficients for freshwater and marl prairie vegetation communities.

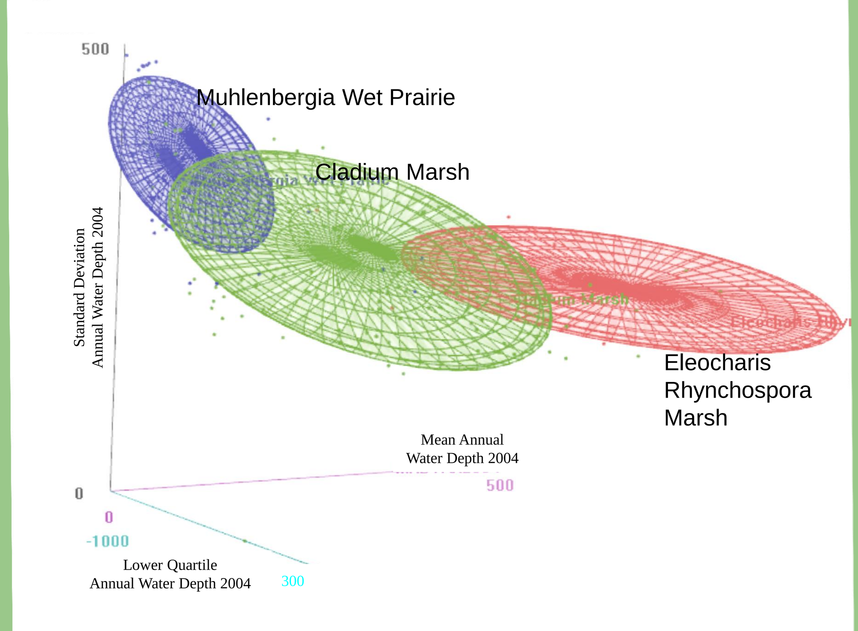


Figure 4. Distribution ellipses illustrating partially overlapping niche space of three Cape Sable seaside sparrow habitat communities.

RESULTS

Inclusion of the Cape Sable seaside sparrow habitat vegetation survey data improved the performance of the ELVeS model. Primary enhancement are seen in the delineation of marl prairie communities critical for the Cape Sable seaside sparrow. Initial runs of the model that did not include these data were able to differentiate only two marl prairie communities. Simple data reduction methods such as 2D and 3D visualization provided substantial information value enabling enhanced parameterization of this model.

Refining the parameterization of ELVeS will continue enhancing the overall performance of the model.

References

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Ross et al. 2004. Effects of Hydrologic Restoration on the Habitat of the Cape Sable Seaside Sparrow Annual Report of 2003 – 2004. Southeast Environmental Research Center, Florida International University, Miami, Florida.

simGlades Open Source EcoModeling: www.cloudacus.com/simglades/ELVeS.php