U. S. Fish & Wildlife Service

Wetland Conservation Prioritization Model for Northwest Florida

Draft Technical Report

WETLAND CONSERVATION PRIORITIZATION MODEL

for Northwest Florida

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EXECUTIVE SUMMARY

This report presents the technical details associated with the wetland conservation prioritization model (WCP Model) for the Florida panhandle developed in the U. S. Fish and Wildlife Service (Service) Panama City Field Office (PCFO). The WCP model was developed as a tool to provide strategic guidance for the implementation of wetland related conservation activities within the PCFO. It is a forward thinking effort to inform conservation activities like petitioned species, species recovery plans, prioritization needs for conservation agreements (safe harbors, conservation credits, Habitat Conservation Plans, land acquisition, etc.) and steer them, where appropriate, to areas with the highest perceived ecological value based on the model results.

The WCP model is a two tiered, spatially explicit prioritization model in which we used existing statewide, landscape conservation planning data layers to focus our prioritization at the landscape and then at the local level. We first defined landscape level focus areas, called Wetland Conservation Areas (WCA). These were large contiguous blocks of land that exhibited relatively high ecological value based on the model analysis. Within these WCAs we then prioritized mapped wetlands using factors that attempt to capture ecological parameters that were deemed to make a wetland more important or "value," things like proximity to managed lands, wetland size, species richness, etc.

The landscape level model development, which defined the WCA, was based on a series of landscape conservation planning data layers that were used to address three ecological functions: species conservation, water protection/function, and natural community conservation. Through a surface density approach, data within each ecological function was distributed across the landscape. Areas of high value (high density) were then isolated using thresholds that achieved a balance between connectivity and isolation for each layer. Through the union of these layers we defined the areal extent of the WCA which made up almost 6.5 million acres (just over 2.5 million ha). By using big picture parameters we then developed a suite of 16 metrics (GIS layers) that established the basis for assigning priority values to the wetlands that were mapped within the WCA. A total of 81,808 wetlands, making up 1,750,901.12 acres (684,672.20 ha), were analyzed. Their values ranged from a low of 20 to a high of 130 out of a potential maximum value of 159.

Our model did not take a weighted overlay approach to the prioritization of wetlands. Since this was a general ecological model we chose a simple additive overlay approach because no one metric was deemed more important. However, because the model was intentionally designed as a hierarchical model, future runs of the model can easily apply a weighted overlay approach. Furthermore, individual layers can be looked at separately to determine the priority distribution of the wetlands for that criterion. We feel this makes it a more robust model.

Whether used to help inform regulatory decisions, to help prioritize where we spend our time and resources, or as a tool for technical assistance to our partners concerning landscape management as well as avoidance and minimization; this model provides a means by which we can strategically approach wetland related conservation. This model is not intended to be the answer to all things wetland nor is it believed to be "the" model. This is a model, just one approach to try to get at prioritizing wetlands. It is our hope that we will be able to continue to develop this model with continued input from our partners.

ACKNOWLEDGEMENT

Undertaking an effort like this takes a lot of support at various levels. This project would not have been possible without the support of the following individuals or groups. The Panama City Field Office's Pinelands/Wetlands Eco-Team sat down as a group and provided us with their input and guidance on what factors they felt made a wetland important. These factors became the foundation from which we prioritized wetlands within the analysis area. Jason Drake, GIS Coordinator for the U.S. Forest Service's National Forests in Florida and Mark Endries, GIS Analyst, for the Service in Asheville, NC provided me with a sounding board for questions I had about approaches to analyses and or tools to capture the desired analysis. Dr. Don Imm, project leader, for the Panama City Field Office and Dr. Jon Hemming provided invaluable support in data analysis and data interpretation and general availability in bouncing ideas off them.

I would be remiss if I did not also thank all the great GIS analysts, specialist and conservation planners that have been doing tremendous natural resources related geospatial work here in Florida. If it was not for the wealth of information and spatial data that we have here in this state we would not have been able to do this work. So special thanks goes out to the GIS Analysts, Specialists and Conservation Planners for: Florida Department of Environmental Protection, Florida Fish and Wildlife Conservation Commission, Florida Natural Areas Inventory, and all the others that worked with these agencies/groups to make the data we used possible.

Finally, I want to thank Ted Martin, Service biologist with the Panama City Field Office, who is the primary person, from the wetland side of things, which I corresponded with regarding this project. Ted organized the initial meeting of our office's wetland ecosystem team to flesh out those factors that were believed to make a wetland important. The information he synthesized from this meeting became the road map for which the analyses were developed. Throughout the model development process, Ted was very helpful in clarifying questions I had about these factors and providing insight into our wetland conservation program which lent applicability to the model analyses. Here is your horse.

INTRODUCTION

> ***"Wetlands provide many ecological, economic, and social benefits, such as habitat for fish, wildlife, and a variety of plants. They serve as nurseries for saltwater and freshwater fishes and shellfish of commercial and recreational importance… We should all be concerned about the substantial loss of this diminishing resource, which helps ensure good water quality for local communities and provides vital habitat for a diversity of important wildlife species.***
>
> ***Wetlands are at a tipping point. While we have made great strides in conserving and restoring wetlands since the 1950s when we were losing an area equal to half the size of Rhode Island each year, we remain on a downward trend that is alarming."***
>
> ***Ken Salazar-Secretary of the Interior***

Wetlands are an important habitat type for which many fish, wildlife and plants depend. A high percentage of federally listed species depend on wetlands to some degree for their survival (NRCS 2012, Flynn 1996, Mitsch and Gosselink 1993,

Niering 1988); therefore, they are a priority habitat for the Service (USFWS 1996). Furthermore, late in the 1950's and then in the 1970's legislation (Endangered Species Act of 1973, Clean Water Act of 1972, Fish and Wildlife Coordination Act of 1958, Migratory Bird Treaty Act, etc.) was passed that gave the Service authority to be involved in wetland related issues (Smalley 2004). It is from these that programs like the Coastal Program, the Environmental Contaminants Program, the Endangered Species Program, etc., work with a variety of partners to protect and restore wetlands.

In 2005 the Florida Fish and Wildlife Conservation Commission (FWCC) introduced Florida's Comprehensive Wildlife Conservation Strategy. The Strategy was a broad level, habitat based strategy in which they identify Freshwater Marsh and Wet Prairies as one of the eight terrestrial priority habitats due to threats to the habitat. Natural Pinelands was also among the eight priority habitats; although not specifically a wetland type, this habitat included wet flatwoods and had various wetland types interspersed within it. Other freshwater wetland habitats, while not among the eight priority habitats, received high threat status based on their analysis. These included bay swamps, cypress swamps, and hardwood swamp/mixed wetland forest. It is in keeping with the Commission's premise of "sustaining the health and integrity of the habitat category [type], the broad array of wildlife that lives within each will be conserved and maintained" (FWCC 2005) that we approach this model. Furthermore by protecting and conserving these habitats, in this case wetlands, the many ecosystem services they provide (i.e., water quality, wildlife habitat, flood control, etc.) (Moore and Hunt 2011, Ramsar 2011, Groot, R de et al. 2006) will also be conserved and maintained which will lead to a healthier ecosystem.

During this time the Service, at a national level, was developing a habitat management based, conservation framework. This framework, called Strategic Habitat Conservation or SHC for short, was accepted and published in 2006 (USGS & USFWS 2006). This report presented a paradigm shift from the more traditional, opportunistic, conservation approach of the Service to a strategic framework that allowed for the "efficient conservation of wildlife populations through habitat management, which we define as protection of existing habitat, and habitat restoration or manipulation" (USFWS 2008). SHC continues to mature and grow and is the model by which we strive to do conservation. While we did not take a species-specific approach, setting population objectives as defined in the SHC Handbook, to our model; we apply the basic premise that efficient conservation requires a strategic approach. Through our modeling effort we hope to benefit or aid in our strategic approach to various areas. By creating this model we hope to increase work force efficiency by focusing our wetland conservation efforts in those places that are deemed to have the highest conservation value, while helping us to make informed decisions on what do we give up and what do we stand firm on.

This report describes the analyses and approach taken in developing the WCP model.

WETLAND CONSERVATION PRIORITIZATION MODEL DEVELOPMENT

The WCP model is a step down model comprised of two models: a landscape scale model (WCA model) and a local scale model (Wetland Prioritization model (WetPrior)). The landscape scale model defines broad, landscapes within the Panhandle of Florida that have high ecological value per our analysis. We refer to these landscapes as Wetland Conservation Areas (WCA). Within the WCAs, we used the local scale model to prioritize wetlands, on a wetland by wetland basis, based on a suite of factors.

All GIS work was conducted in ArcGIS (ESRI 2010a) within both the raster and vector format using pre-existing GIS layers as the source input. All analysis for the WCA boundary development was conducted within the panhandle of Florida. The resolution for all rasters was 30x30 m.

Wetland Conservation Area Model Development

Model Input Data Layers: To define the WCA, we identified three broad categories of ecological value that we sought to capture: 1) species conservation, 2) water protection/function, and 3) natural community conservation. For the species conservation category we selected landscape conservation planning layers that relate to the conservation of federally listed (LE and LT), state listed (S1 and S2), and globally ranked species (G1 & G2) species. For the water protection and function category we chose data layers that identified larger, higher quality areas that support water related parameters that affect species conservation: water quality, watershed integrity/health, stream protection, etc. Finally, for the natural community conservation category we selected layers that identified habitats that are unique, areas that are relatively intact and relatively non-impacted by development or urbanization. In all, seven landscape conservation planning layers were selected that represented the three ecological value categories (Table 1). These layers were selected because they are well accepted, landscape scale, conservation planning data sets that are arguably among the best data sets available for identifying and assessing the ecological value of Florida's natural resources.

Table 1. Landscape conservation planning data layers, by ecological value categories, used in the development of the WCA.

Ecological Value Category*/Data Layer*	*Source*	*Format*
Species Conservation		
Strategic Habitat Conservation Areas	FWCC	Raster
Rare Species Habitat Conservation Priority Areas	FNAI	Raster
Water Protection/Function		
Natural Floodplain	FNAI	Raster
Surface Waters	FNAI	Raster
Functional Wetlands	FNAI	Raster
Natural Community Conservation		
Potential Natural Areas	FNAI	Vector
Under Represented Natural Communities	FNAI	Raster

They were developed for the Florida Forever Needs Assessment project and as part of that project the features within the layers were assigned a priority rank based on their degree of importance. Since it was not readily apparent the criteria used to define the layer's priority values, the layer's metadata was used to get a better understanding of the data. Based on this information, each data set was subset to those areas that best captured our target ecological value objectives.

Below are the landscape conservation planning data sets used to generate the WCA, a brief description of the data and the priority classes retained for the analysis. To learn more about the data layers that went into this analysis refer to the Florida Forever Needs Assessment report.

Species Conservation

The following conservation planning data layers comprised the species conservation ecological value category. These are data layers that relate directly to listed and rare species conservation and address the species aspect of our ecological values.

Strategic Habitat Conservation Areas (SHCA**)**. *Strategic Habitat Conservation Areas identify unprotected habitat areas in Florida that are important for the long-term survival of 62 focal species (Endries et al. 2009a). In cooperation with Florida Natural Areas Inventory (FNAI) this layer was updated to include conservation lands and given priority rank values based on their state and global ranks (FNAI 2010).*

We selected priority classes 1 and 2 from SHCA (Figure 1). Within these two classes all the federally listed species modeled were represented. In addition we used this data set to focus on the species modeled that are of highest conservation concern (S1 and S2, or G1 and G2, or LE and LT) (FNAI 2010). In sub-setting this data, those species in which the Service has recovery responsibility are captured.

Figure 1. Priority classes 1 (black) and 2 (brown) used for Strategic Habitat Conservation Areas

Rare Species Habitat Conservation Priority Areas (Rare Spp.). *The Rare Species Habitat Conservation Priorities layer identifies areas throughout Florida that "protect both the greatest number of rare species and those species with the greatest conservation need." This occurrence-based habitat model models 248 species (invertebrates, plants, and vertebrates) with high conservation need. Priority values are based on species richness and the rarity of the species (FNAI 2010).*

We selected all priority classes for Rare Spp. (Figure 2). All the federally listed species modeled were represented in this data. We chose to include priority class 6 in our analysis because it represents the remaining habitats for those species FNAI modeled but were of conservation need even though they were of the lowest conservation need (FNAI 2010). Therefore, by including all mapped habitat areas we ensure that the areas that provide habitat for species of concern are being incorporated into our analysis.

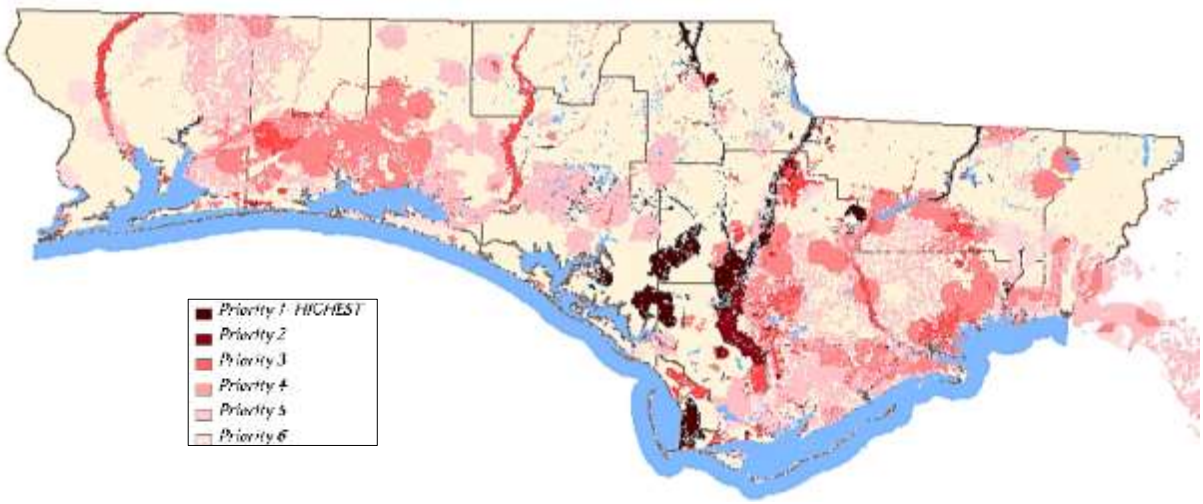


Figure 2. Priority classes used for Rare Species Habitat Conservation Areas

Water Protection/Function

The following conservation planning layers comprised the Water Protection and Function ecological value category. These layers relate directly to priority water resources/wetlands attempt to address the importance of water resources.

Natural Floodplains (Nat. Floodplain). *Natural floodplain represents the "naturalness" of the major river systems and their tributaries in FL. It was based primarily on FWC's 2003 land cover data set and some on the FLUCCS data. Priorities were set using Potential Natural Areas as an indicator of the naturalness of the floodplain (FNAI 2010).*

We selected all priority classes for Natural Floodplains because these represent the wetlands associated with major river systems (Figure 3). Whether associated with a relatively natural state (Priority Class 1 and 2) or not (Priority 3) (FNAI 2010) all of these areas are important to the protection and health of the river system and watershed. Therefore, we felt it was important to include all classes.

Figure 3. Priority classes used for Natural Floodplains

Surface Waters (Surf Waters). *Surface waters layer identifies surface waters throughout the state that are deemed of high quality (Outstanding Florida Waters, National Scenic Waters and National Estuaries, shellfish harvesting areas, seagrass beds, springs, water supply and waters important for imperiled fish). Waters were prioritized based on their "proximity to a water body, stream order, downstream length, basin size and other factors" (FNAI 2010).*

We selected only priority classes 1 through 3 from the Surface Water Protection layer (Figure 4). We chose these classes because we felt they captured resources that would support the greatest water related ecological value, considering the importance of the feature and its proximity to water.

Figure 4. Priority classes 1-3 used for Surface Waters

Functional Wetlands (Funct. Wetlands). *Functional wetlands layer depicts wetlands, defined by the FLUCCS data, considered to be in a more natural state. This state of naturalness was determined by the intersection of a Land Use Intensity index and FNAI's Potential Natural Areas (FNAI 2010).*

We chose to use priority classes 1, 2, and 3 from the Functional Wetlands layer (Figure 5). These priority classes were selected because we wanted to capture those wetlands that were considered of highest quality potentially (lowest degree of impact from human activities and/or high degree of naturalness). While some of the wetlands selected were not found in mapped natural areas, these wetlands had very high land use intensity index values (≥9), indicating very low land use intensity (FNAI 2010).

Figure 5. Priority classes used for Functional Wetlands

Natural Community Conservation

The following conservation planning data layers comprised the Natural Community Conservation ecological value criteria. These are data layers that relate directly to priority natural areas or community and attempt to capture the vegetative aspect of our ecological value criteria.

Potential Natural Areas (PNA). *Potential Natural Areas depicts large area throughout Florida that, through aerial photo interpretation, appear to be in a good quality, natural state. The Potential Natural Areas are priorities "based on size and perceived quality and type of natural community present" (FNAI 2007).*

All the priority classes, 1 through 5, were selected for Potential Natural Areas (Figure 6). Priority classes 1, 2, 3, and 4 were chosen because they represent the highest perceived quality natural areas in Florida. We also included Priority Class 5, because these areas were still considered to be ecologically viable (FNAI 2010).

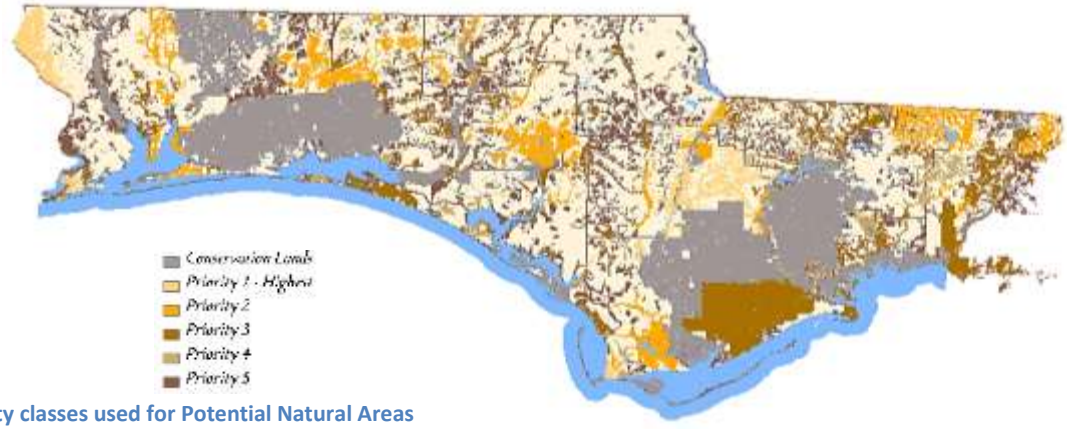


Figure 6. Priority classes used for Potential Natural Areas

Under Represented Natural Communities (Nat Comm). *Under Represented Natural Communities identifies those natural communities in which less than 15% of their original Florida extent exists on conservation lands. These natural communities were then prioritized by their global rank (FNAI 2010).*

We selected all the priority classes because they represented natural communities that are considered rare and/or are not well protected by conservation lands within Florida (Figure 7). Many of these habitat types contain unique or endemic species therefore they are of great ecological value (FNAI 2010).

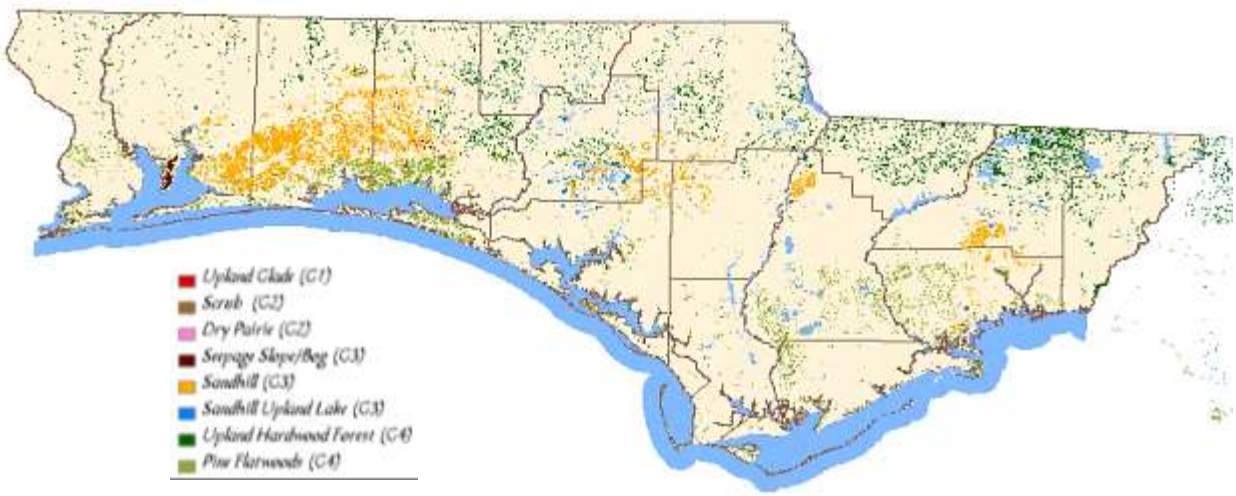


Figure 7. Classes used for Under Represented Natural Communities

Density Surface Analysis. Densities surfaces are used to analyze the distribution of mapped features by mapping the patterns of high concentration areas of your target geographic features (Mitchell 1999). Surface analysis allows the user "to clearly identify the distribution" of their target features, by revealing complex spatial patterns that may otherwise be difficult to see (Thurstain-Goodwin 2003). This is accomplished by taking the target features, in this case represented as points, and spreading these discrete features over an area (ESRI 2010b). To do this the density of features within a neighborhood around each cell center, defined by the search radius, is calculated and assigned to the cell (Mitchell 1999).

We generated density surfaces for all seven of the WCA model inputs in order to map the areas of high concentrations of each of the ecological inputs. Specifically this was accomplished by converting each of the rasters into a point layer so that for every cell containing a target ecological value, a point was generated (Figure 8). Several parameters go into defining the generation of density surfaces: population field, density type, search radius, area units, and output cell size. Because each input parameter affects the output of the density surface analysis, we controlled for these variables. For each of the density surfaces we set the following values to maintain consistency among all density surface analyses: 1) no population field value, 2) Kernel function for density type, 3) 10,000 m search radius, 4) area units to square meters, and 5) cell size to 30m.

Because the PNA layer is a polygon layer we converted it into a 30m raster and then created the point layer from the raster. By using this approach we avoided the polygon size bias that would result if we converted the polygon layer directly into a point layer based on the label point location.

The output values for each density surfaces were binned into 9 classes based on an Equal Interval classification scheme. Values within the lowest densities (areas that included zero density values) were assigned to the Class 0 bin; the next lowest densities were assigned Class 1 bin, and so on. The highest densities were assigned to the Class 8 bin (Figure 9).

Figure 8. Point layer generated for each landscape conservation planning layer based on the following input priority classes: A. SHCA Priority Classes 1 and 2; B. Rare Spp. Priority Classes 1-5; C. Nat. Floodplain Priority Classes 1, 2 and 3; D. Surf. Waters Priority Classes 1, 2 and 3; E. Funct. Wetlands Priority Classes 1, 2 and 3; F. PNA Priority Classes 1-5; G. Nat. Comm. Priority Classes 1-10..

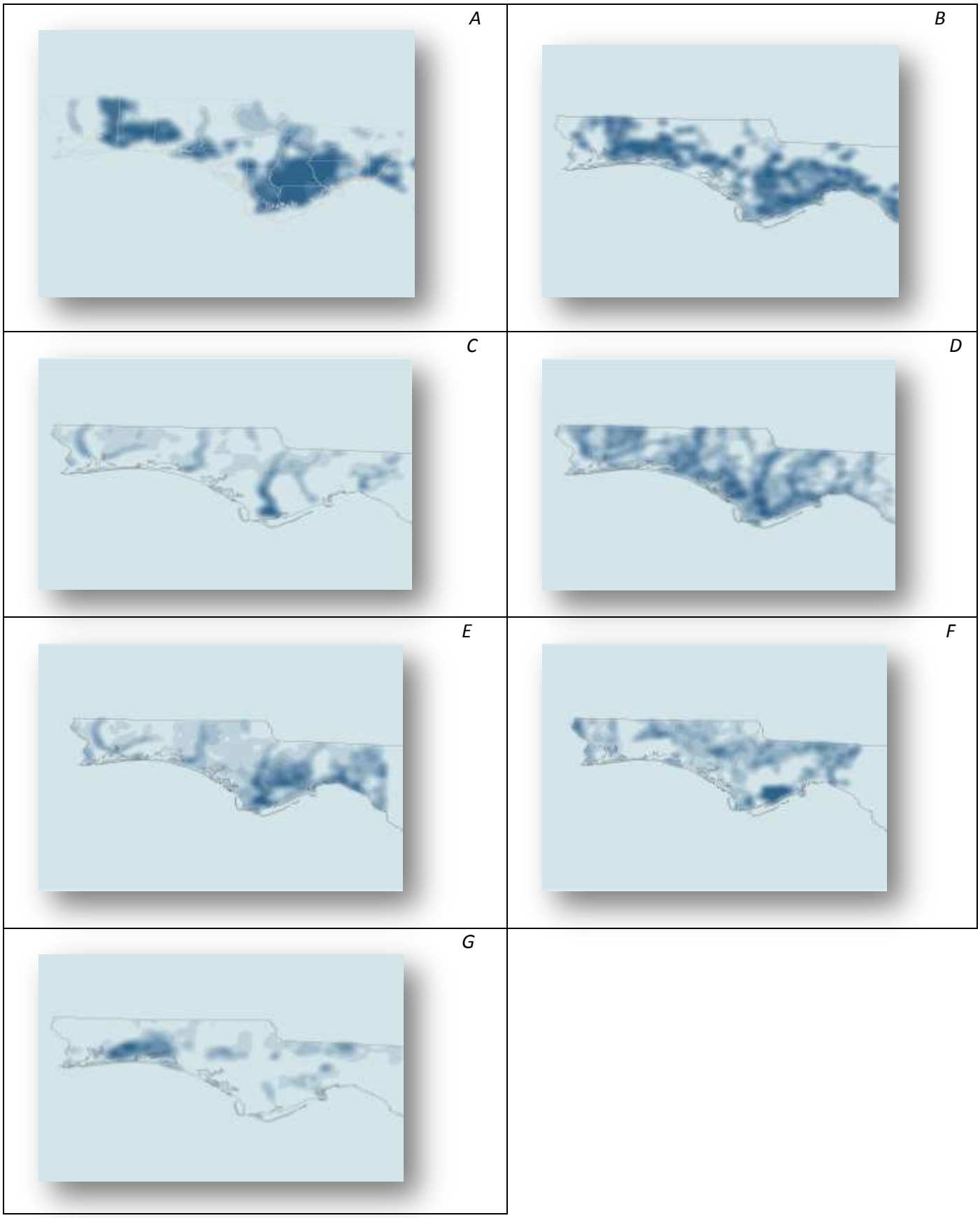


Figure 9. Density surfaces generated for each landscape conservation planning layer based on the following input priority classes: A. SHCA Priority Classes 1 and 2; B. Rare Spp. Priority Classes 1-5; C. Nat. Floodplain Priority Classes 1, 2 and 3; D. Surf. Waters Priority Classes 1, 2 and 3; E. Funct. Wetlands Priority Classes 1, 2 and 3; F. PNA Priority Classes 1-5; G. Nat. Comm. Priority Classes 1-10. Darker blue areas are areas with higher densities, while lighter blue areas are areas of lower densities..

Unity Sub-model

To generate the boundary to define the Wetland Conservation Areas we reclassified the original continuous values of each density surface into their corresponding categorical classes (0-8). Starting with the lowest density class (class 0), we removed one subsequently higher class at a time until we achieved the "desired" spatial pattern of the remaining density surface classes (Figure10). The classes were chosen to provide the pattern that balanced connectivity and isolation within the density surface classes. This varied with each of the input density surfaces.

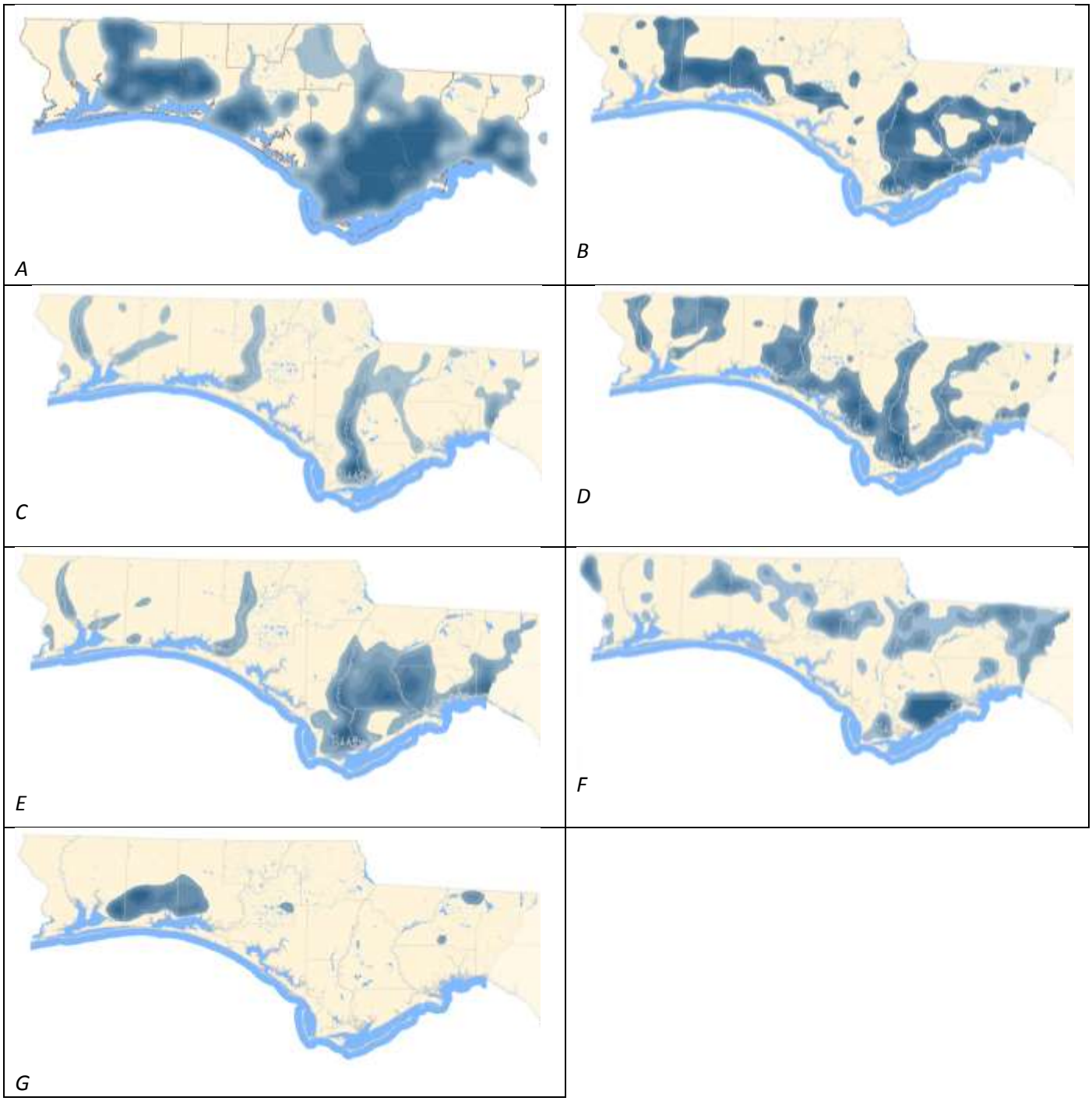


Figure 10. Reduced density surface classes (steel blue gradient areas) for each landscape conservation planning layers used to define the WCA boundary: A. SHCA Density Classes 2-8; B. Rare Spp. Density Classes 5-8; C. Nat. Floodplain Density Classes 2-8; D. *Surf. Waters Density Classes 4-8; E. Funct. Wetlands Density Classes 3-8; F. PNA Density Classes 3-8; G. Nat. Comm. Density Classes 4-8. Darker steel blue areas represent higher densities. Coastal waters (light blue) are not part of the density surfaces.*

After reducing the density surface classes for each layer down, we overlaid these surfaces. To create the WCA, we combined and reclassified each density surfaces to generate a single output layer with values of 1 = WCA and 0 = non-WCA (Figure 11) using the following expression:

WCA == (con([SHCA] ≥ 2, 1, 0) + con([Rare Spp] ≥ 5, 1, 0) + con([Nat Floodplain] ≥ 2, 1, 0) + con([Surf Waters] ≥ 4, 1, 0) + con([Funct Wetlands] ≥ 3, 1, 0) + con([PNA] ≥ 3, 1, 0) + con([Nat Comm] ≥ 4, 1, 0))

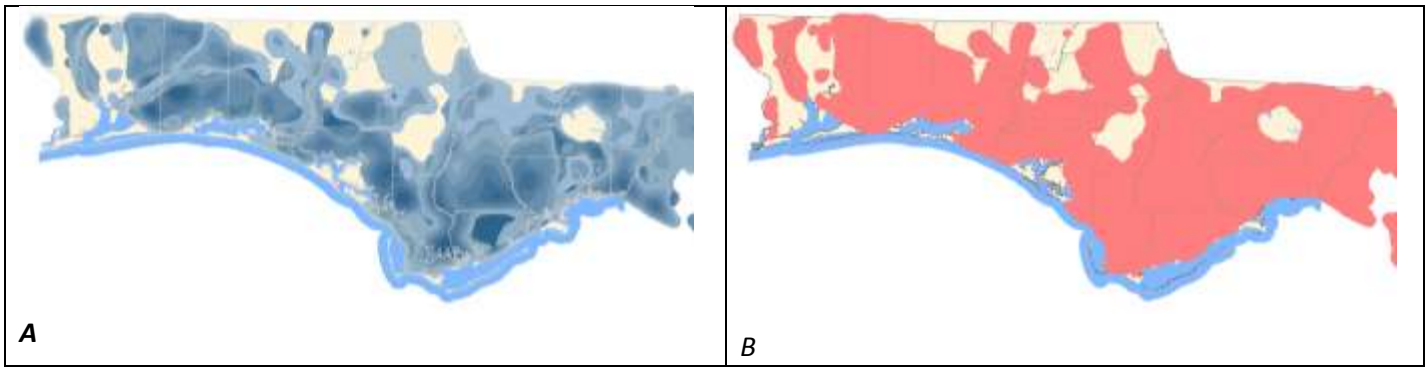


Figure 11. WCA Unity Model results. A. Virtual overlay of the reduced input density surfaces (steel blue color); B. WCA (salmon color) produced by reclassification of the reduced input density surfaces. Coastal waters (light blue) are not part of density *surfaces. Coastal waters (light blue) are not part of density surfaces.*

WCA Unity Model results. A. Virtual overlay of the reduced input density surfaces (steel blue color); B. WCA (salmon color) produced by reclassification of the reduced input density Since the above expression set all non-WCA cells equal to 0, we used SETNULL() to turn these non-WCA cells into NULL values in order to produce a vector layer of the WCA created by the Unity model (Figure 12).

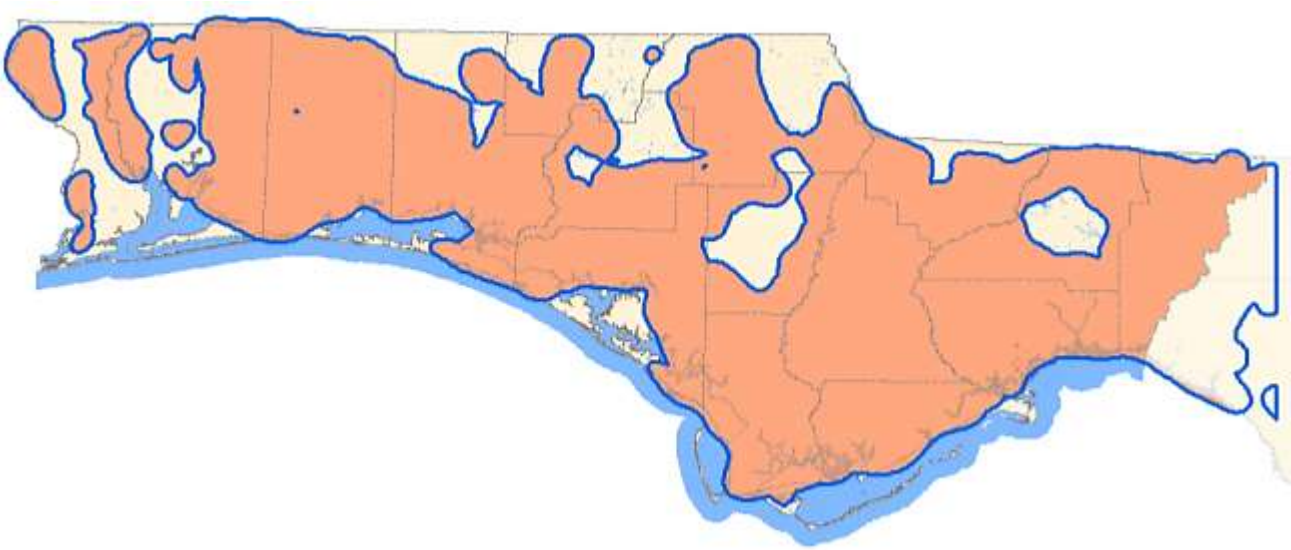


Figure 12. WCA vector model (blue line) produced by vectorizing the raster model of the WCA.

Additive Sub-model

Within the WCA, we developed an additive model to map the high, landscape-level, ecological value areas (hotspots). To do this we took each of the original density surfaces and did a simple unweighted linear additive model:

(SHCA + Rare Spp + Nat Floodplain + Surf Waters + Funct Wetlands + PNA + Nat Comm)

This generated an output surface made up of the sum of the density values at each cell location of the seven input density surfaces. This was then masked (spatially reduced) to only within the WCA (Figure 13).

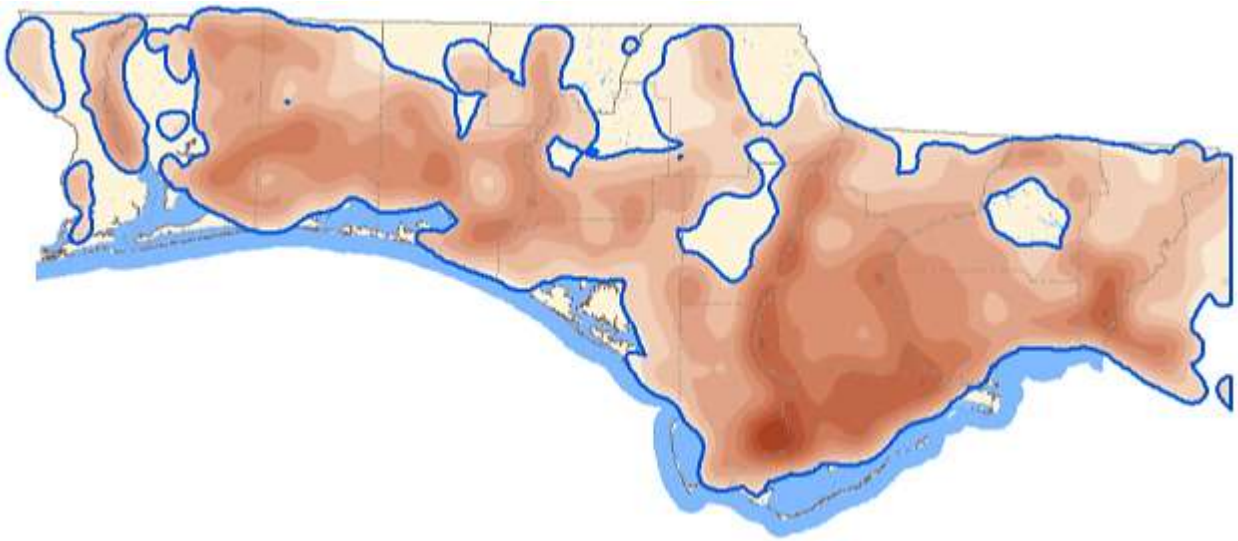


Figure 13. Additive model of the density surfaces within the WCA. Darker shaded areas represent landscape-level, ecological value hotspot areas.

WETLAND PRIORITIZATION MODEL

The second part of WCP model was to the development of the local scale model, WetPrior. As mentioned before, the local scale model focused on assigning priority values to each individual wetland based on an agreed upon suite of factors. Below we describe the model inputs, the analyses, and the development of the prioritization model for the wetlands within the WCA.

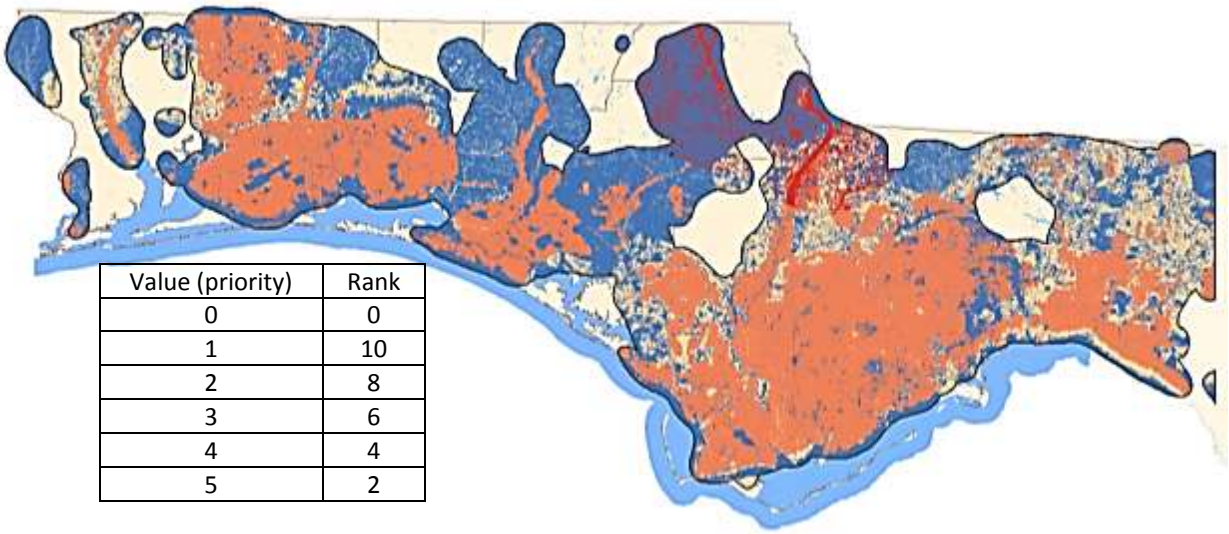
Wetland Prioritization Metric Development

To do this the Wetlands Ecosystem Team met and identified factors (prioritization metrics) they felt made a wetland(s) important. These metrics were grouped into common themes, called prioritization criteria. A total of 6 prioritization criteria were designated: 1) Listed Species Conservation, 2) Connectivity, 3) Type/Rarity, 4) Natural Habitat, 5) Wetland Functionality, and 6) Wetland Characteristics. Within each prioritization criteria there were between one to four prioritization metrics (hereafter, metrics). In all, 16 metrics were used to rank/prioritize the wetlands within the WCA. For each metric layer, we set the values to a 0 – 10 ranking class system (scale), where a value of 10 was assigned to the highest metric values and a 1 to the lowest metric values. A zero class rank was assigned to those values that had no value (NULL) or were background. For each metric we reviewed the literature to determine if there was any data to support defining the class breaks manually. If no supporting literature was found or the literature was not clear, we applied a built-in ArcGIS classification scheme to define the class breaks. The specific classification scheme used for each metric varied depending on the data. We have identified the classification scheme used within the corresponding write-up below for each metric along with a description of the process steps used to conduct the metric analysis.

***Listed Species Conservation Criteria*.** This prioritization criterion contains listed species related metrics. This suit of factors addresses areas that are important for the conservation of listed and/or rare species and areas that potentially contain high concentration of species.

Habitat Conservation Areas (SHCA). *Wetlands that are part of a Habitat Conservation Areas are more important than those that are not.*

The FWCC's Strategic Habitat Conservation Areas layer was used to capture this parameter. Because this layer had already been prioritized by FWCC for the Florida Forever Assessment (FNAI 2010) we simply limited it to the WCA and reclassified the existing priority values to a 0-10 scale (Figure 14).

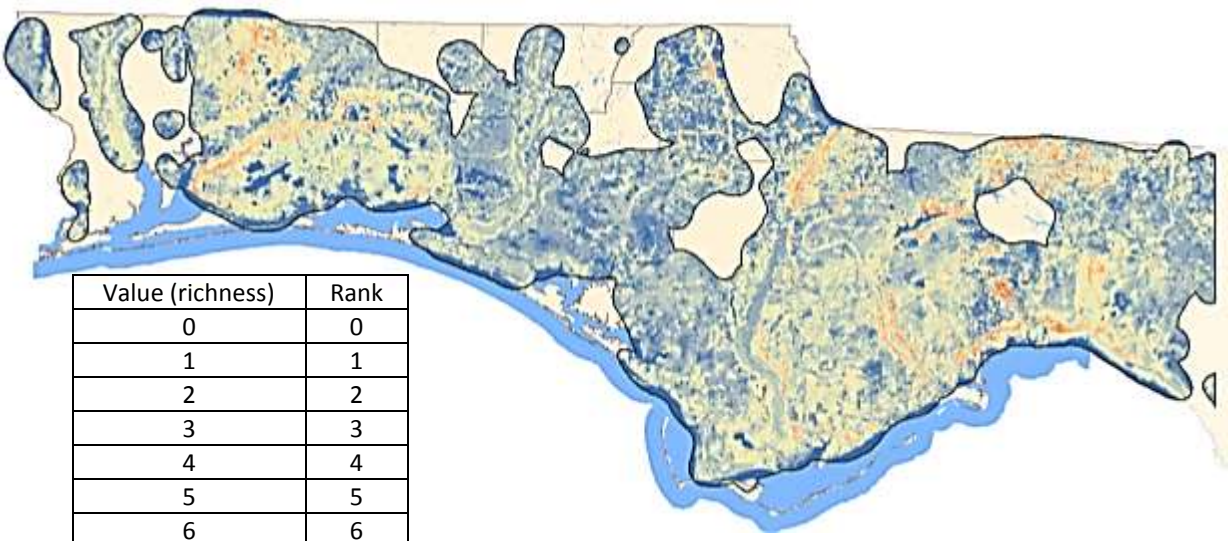


Value (priority)	Rank
0	0
1	10
2	8
3	6
4	4
5	2

Figure 14. Reclassification SHCA metric with reclassification table.

Species Richness (SppRich). *Wetlands that have higher species richness are more important than those that have lower species richness.*

We used the FWCC's Potential Habitat Richness layer (Endries et al. 2009b) to capture species richness. Because the values for this layer already reflected a ranked system, the number of species habitats that occurred, we simply clipped the layer to the WCA and maintained the existing richness ranking values (Figure 15).

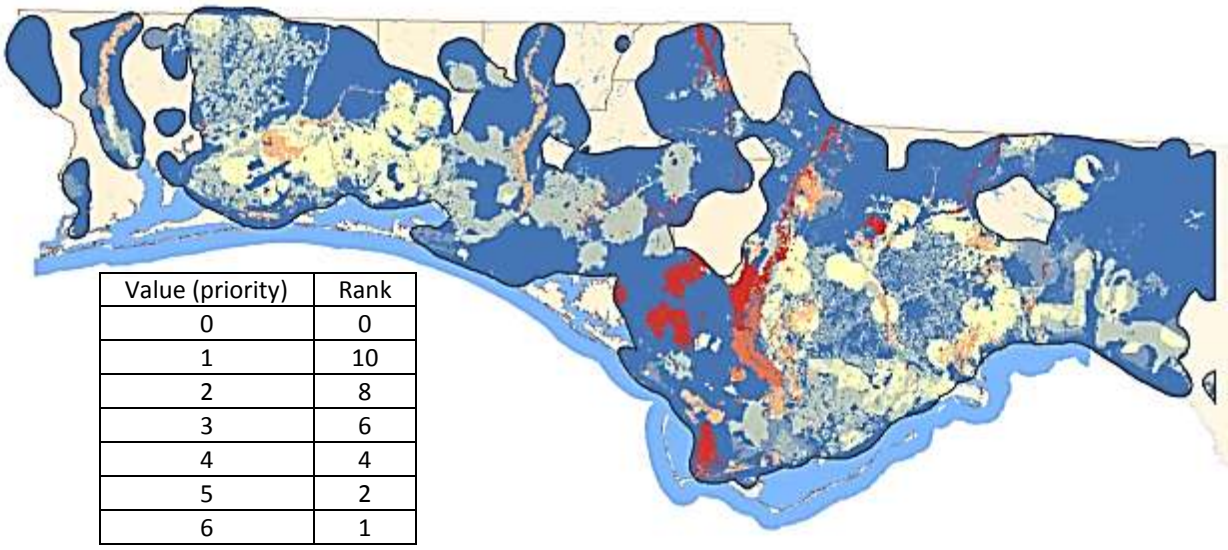


Value (richness)	Rank
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Figure 15. Reclassification Species Richness metric with reclassification table

Listed/Rare Species Priority Areas (RareSpp). *Wetlands that support priority habitat areas for listed and/or rare species are more important than those wetlands that do not support priority habitat areas.*

We used FNAI's Habitat Conservation Priorities layer developed for the Florida Forever Needs Assessment (FNAI 2010). As with the other layers used in the Florida Forever Needs Assessment this was already a prioritized layer. Therefore, we again clipped it down to the WCA and reclassified the priority values to a 0-10 scale (Figure 16).

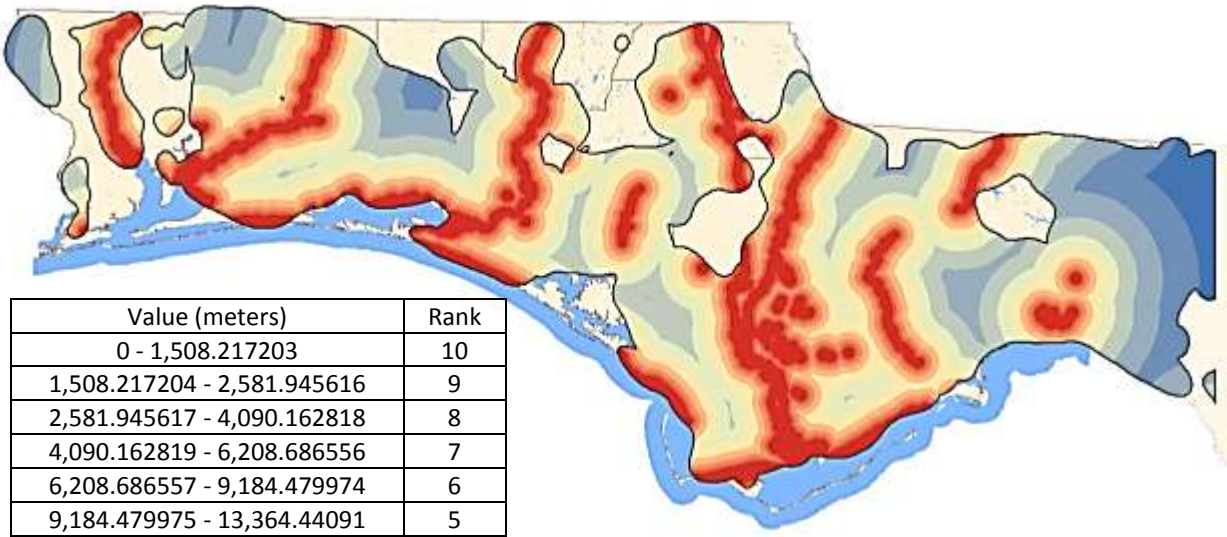


Value (priority)	Rank
0	0
1	10
2	8
3	6
4	4
5	2
6	1

Figure 16. Reclassification Listed/Rare Species Priority Areas metric with reclassification table.

Proximity to Critical Habitat (DistCritHab). *Wetlands that are within or near designated critical habitat are more important than those that are farther away from designated critical habitat areas.*

At the time of this analysis, the Service had designated critical habitat for 11 federally listed species. We used these designations to capture this parameter. Because these designations were both line and polygon layers we first converted them into rasters and combined them to create a critical habitat layer. We then ran a straight-line distance analysis on this layer. We applied a Geometrical Interval classification to the straight-line distance output in order to assign priority ranks (Figure 17).



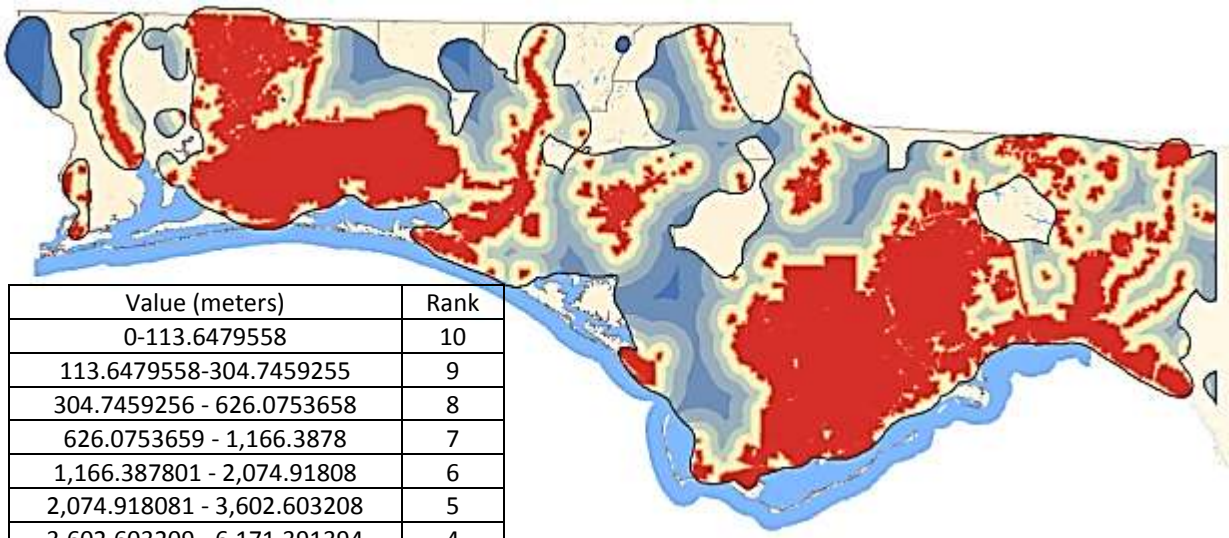
Value (meters)	Rank
0 - 1,508.217203	10
1,508.217204 - 2,581.945616	9
2,581.945617 - 4,090.162818	8
4,090.162819 - 6,208.686556	7
6,208.686557 - 9,184.479974	6
9,184.479975 - 13,364.44091	5
13,364.44092 - 19,235.8409	4
19,235.84091 - 27,483.12798	3
27,483.12799 - 39,067.71502	2
39,067.71503 - 55,340.05469	1

Figure 17. Reclassification Proximity to Critical Habitat metric with reclassification table.

Connectivity Criteria. This prioritization criterion contains metrics that are related to connectivity. This suit of factors addresses proximity to natural resources as well as to conservation areas which will provide greater potential for re-colonization. It also addresses the connectivity relationship of wetlands to one another which may decrease the potential of local extinction of species that rely on wetlands for their survival (Dramstad et al. 1996).

Near Managed Lands (DistMngdLands). *Wetlands that are near managed lands are more important than those farther away.*

We used the latest managed lands layer, maintained by FNAI. This layer maps lands that are managed for conservation (FNAI 2010). To address this parameter we ran a straight-line distance analysis on the managed lands layer and reclassified the output based on a ten class, geometrical interval classification scheme (Figure 18). Distances closer to managed lands were assigned higher priority ranks while distances farther away were assigned lower priority ranks.

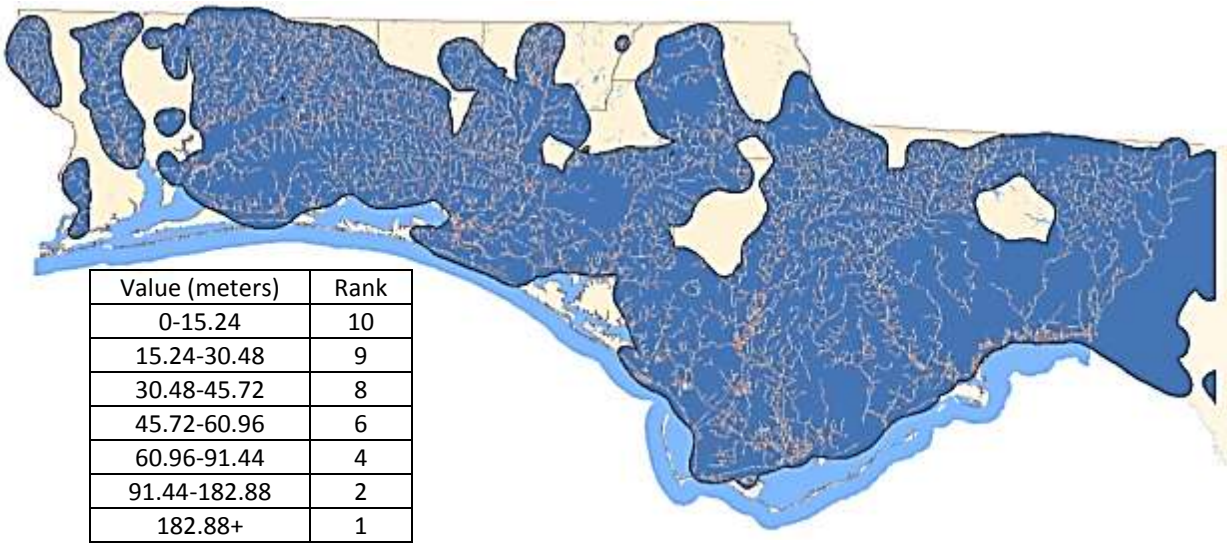


Value (meters)	Rank
0-113.6479558	10
113.6479558-304.7459255	9
304.7459256 - 626.0753658	8
626.0753659 - 1,166.3878	7
1,166.387801 - 2,074.91808	6
2,074.918081 - 3,602.603208	5
3,602.603209 - 6,171.391394	4
6,171.391395 - 10,490.78459	3
10,490.7846 - 17,753.80365	2
17,753.80366 - 29,966.50195	1

Figure 18. Reclassification Near Managed Lands metric with reclassification table.

Near Hydrology (DistHydro). Wetlands that are near river and streams are more important than those that are found farther away from rivers and streams.

We used US Geological Survey's National Hydrologic Dataset (NHD) 1:100k to address this metric. We converted the vector-based NHD data into a 30m raster and ran a straight-line distance analysis on the layer. We then applied a Manual classification scheme to reclassify the output. We based the priority class rank thresholds on water quality protection (Environmental Law Institute 2008) and requirements of species associated with water (Jones, Edmunds & Associates Inc. 2000, NatureServe 2011, FWCC 2005). We based the upper distance threshold of 200m on the Swainson's warbler (Limnothlypis swainsonii) (Bushman and Therres 1988). We chose the Swainson's warbler because its direct association to streams and its distance requirement captured the majority of other stream related species. Distances closer to hydrologic features were given higher priority ranks and distances farther away were assigned lower priority ranks (Figure 19).



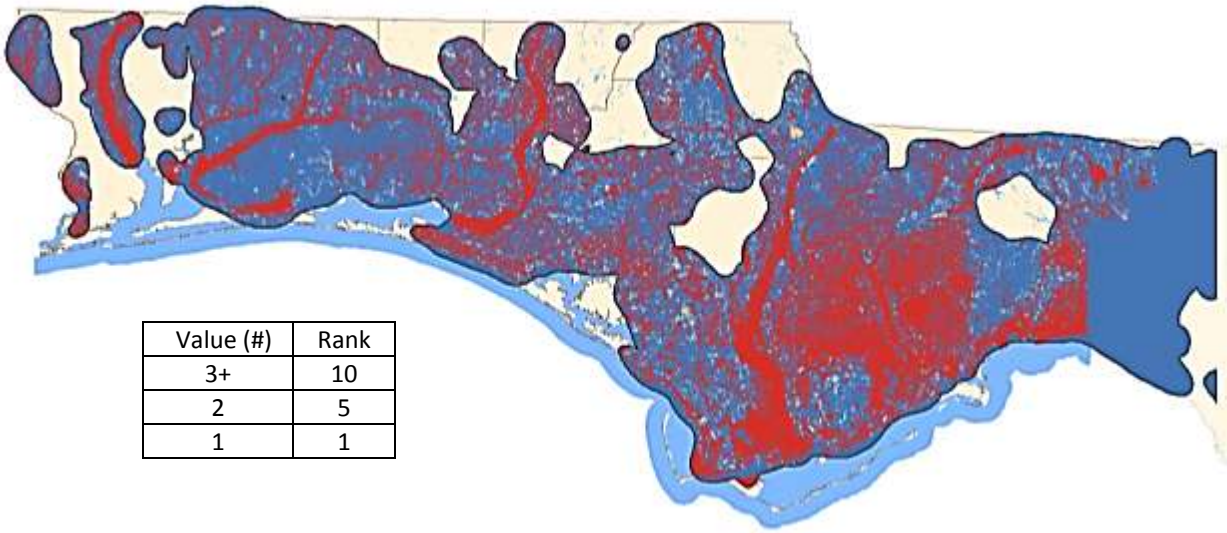
Value (meters)	Rank
0-15.24	10
15.24-30.48	9
30.48-45.72	8
45.72-60.96	6
60.96-91.44	4
91.44-182.88	2
182.88+	1

Figure 19. Reclassification Near Hydrology metric with reclassification table.

Connected Wetland/Wetland Complexes (WetComplx). *Wetlands that are connected to other wetlands or are part of a complex are more important than those that are not connected to other wetlands.*

We approached these factors as one metric. We used the Florida Department of Environmental Protection's 2006/2007 Landuse (hereafter referred to as landuse) layer for this analysis. We selected all 600 series (Wetlands) features. We buffered these wetlands by 100 ft. A one hundred foot buffer was chosen to capture effective water quality and provide aquatic habitat protection (USFWS 2001).

We defined a connected wetland as any wetland in which a connection was created by the buffering process. A wetland complex was then defined as three or more wetlands contained within a wetland buffer. Wetland complexes were assigned a priority rank of 10, buffers containing 2 wetlands received a priority rank of 5, and non-connected wetlands were still given a priority rank, but they were only assigned a value of 1 (Figure 20).



Value (#)	Rank
3+	10
2	5
1	1

Figure 20. Reclassification Connected Wetland/Wetland Complexes metric with reclassification table.

Wetland Type/Rarity Criteria. This prioritization criterion contains a metric that relates to the relative rarity of the wetland type. This factors attempts to address the relative importance of mapped wetland types that are relatively less abundant within the extent of the landuse data set (essentially the panhandle of Florida).

Relative Rarity of Wetland Type (WetTypeRarity). *Rarer wetland types are relatively of "greater" value than abundant wetland types.*

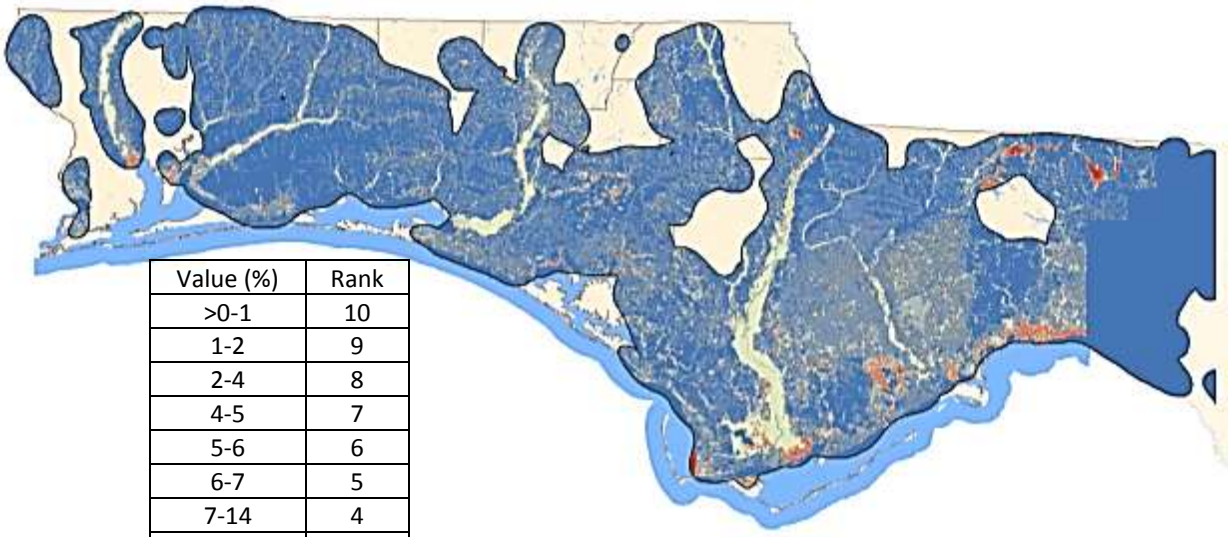
We defined rarity of wetland type as the relative abundance of each unique wetland type within the Florida Panhandle (Escambia Co. east through Jefferson County). To calculate this metric we selected all the 600 series wetlands from the landuse data and summed the total acres within the mapping area. We then calculated the total acres for each unique wetland type and calculated its percentage of occurrence:

$$Rarity = (SumWetlandTypeAcres/1{,}962{,}939.1159) * 100$$

To address potential bias due to individual wetland size, we developed a ranking factor that took into account the frequency and acres of the wetland types (Imm pers. comm., 2011). To do this, we calculated percent of occurrence and percent of total area of each wetland type. We then calculated the ranking factor by taking the average of these values.

$$(((WetlandTypeCount/TotalWetlandCount)*100) + (WetlandTypeAcres/ TotalWetlandAcres)*100)))/2$$

We assigned increasing priority ranking values to increasing rarity ranking factor (Figure 21).



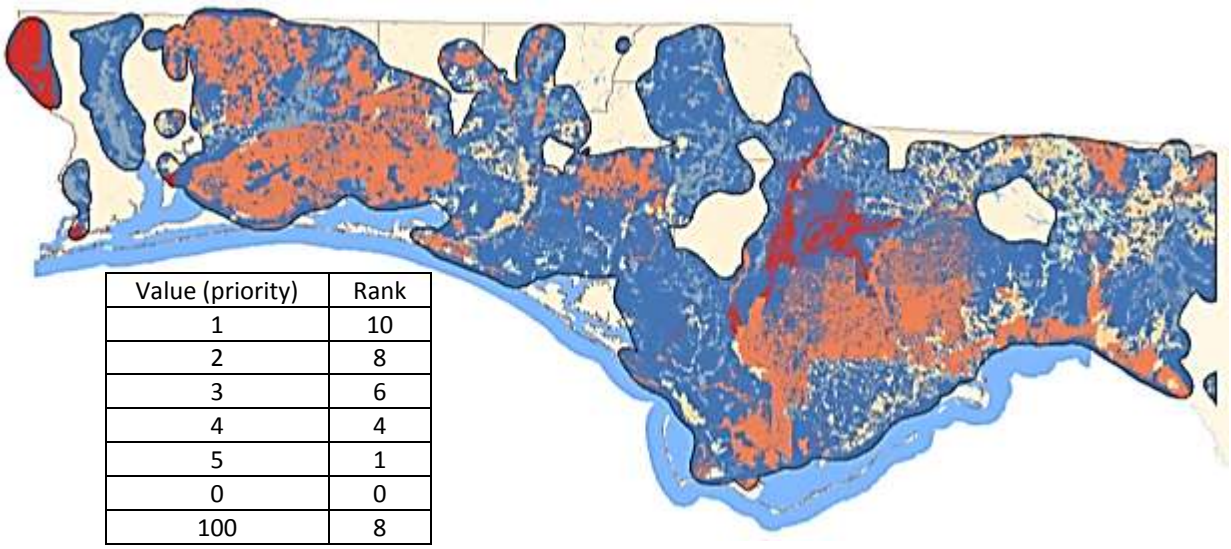
Value (%)	Rank
>0-1	10
1-2	9
2-4	8
4-5	7
5-6	6
6-7	5
7-14	4
14-19	3
19-30	2
30+	1

Figure 21. Reclassification Relative Rarity of Wetland Type metric with reclassification table.

Natural Habitat Criteria. This prioritization criterion contains metrics that relate to the naturalness of the area. These factors attempt to capture the relative importance of areas that are relatively natural and are not as impacted by the influences of development.

Presence of Natural Habitat (PNA). *Wetlands that contain native and/or natural habitat are of greater value than those that do not.*

To capture a metric for presence of native vegetation we used FNAI's PNA layer (FNAI 2007) as a surrogate. We clipped the layer down to the WCA and reclassified the existing priority values to our 1-10 priority rank scale (Figure 22). We assigned high priority PNAs high priority ranks and we assigned non-PNAs a priority rank of 0. Featured with the value of 100 (managed lands) were assigned a value of 8.

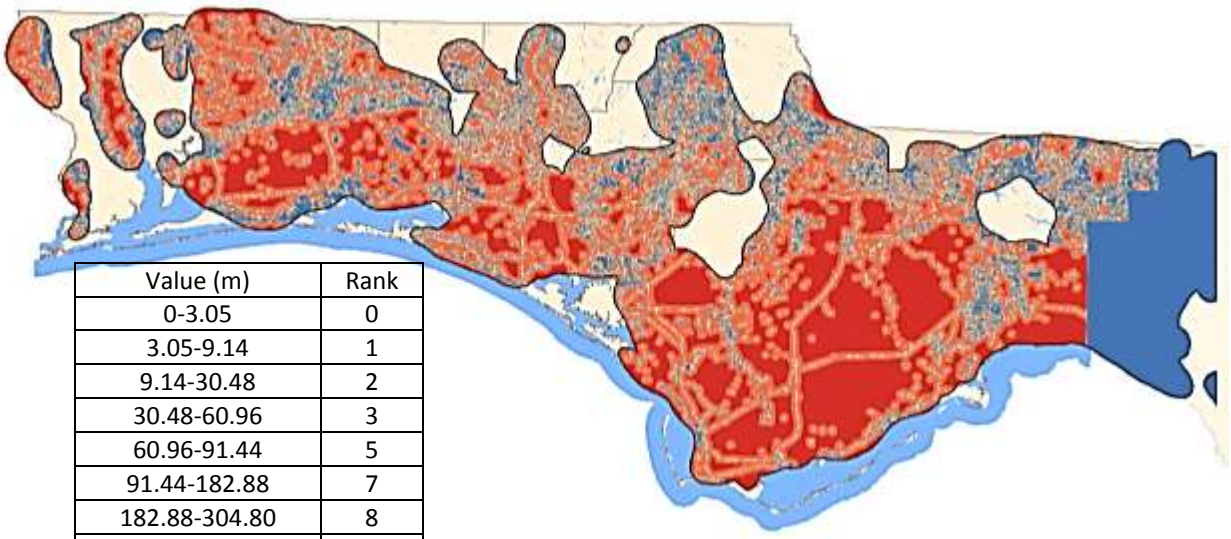


Value (priority)	Rank
1	10
2	8
3	6
4	4
5	1
0	0
100	8

Figure 22. Reclassification Presence of Natural Habitat metric with reclassification table.

Away from Development (DistDevelop). *Wetlands that are away from developed areas are more valuable than those that are close to development.*

We used the landuse layer to develop this prioritization metric. We selected for all 1000 series (urban & built-up); 2000 series (agriculture) except for 2120 (unimproved pastures); 7000 series (barren lands) except for 7100, 7200, 7300, and 7310 (beaches, sand, rock, rock with marsh, respectively); and 8000 series (transportation, communication and utilities). We ran a straight-line distance analysis on this layer. We then "clipped" the output raster down to the WCA and applied a manual classification scheme to define the priority class ranking breaks (Figure 23). The class breaks were gleaned from literature on the benefit of buffers for water quality, wildlife and other ecosystem services (Environmental Law Institute 2008; Jones, Edmunds & Associates, Inc. 2000).

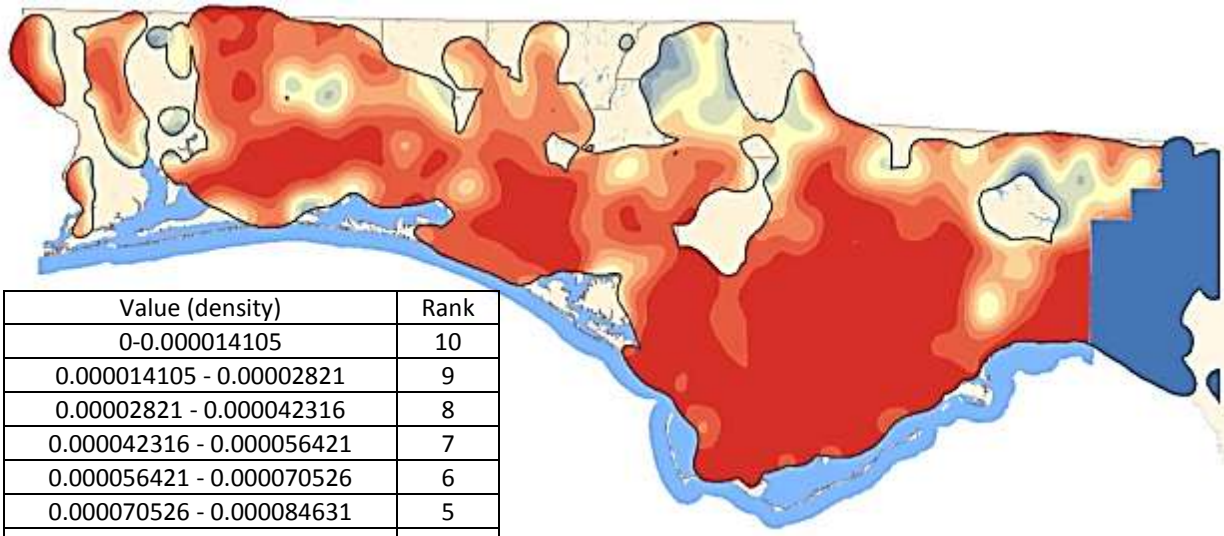


Value (m)	Rank
0-3.05	0
3.05-9.14	1
9.14-30.48	2
30.48-60.96	3
60.96-91.44	5
91.44-182.88	7
182.88-304.80	8
304.80-1524.0	9
1524.0+	10

Figure 23. Reclassification Away from Development metric with reclassification table.

Low Density Development (DevlopDensity). *Wetlands found in lower density developed areas are more valuable than those found in high density urban areas.*

We ran a density surface analysis on the developed layer used in the distance from developed metric. We set the search radius to 10,000m and acres as the population field. We applied an equal interval classification scheme to the output to set the class breaks for our priority ranking classes (Figure 24).

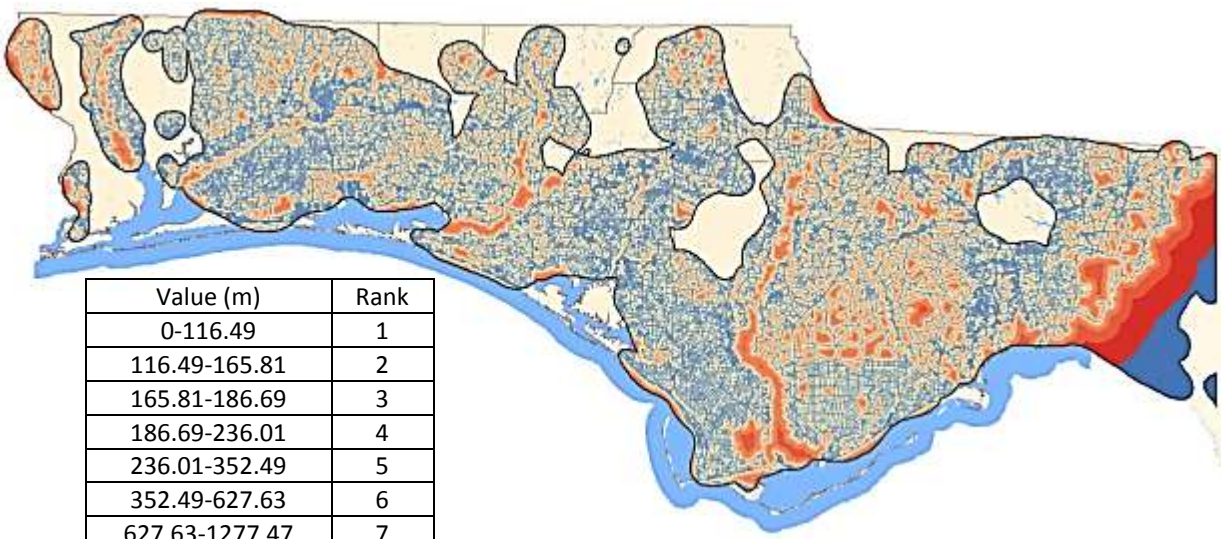


Value (density)	Rank
0-0.000014105	10
0.000014105 - 0.00002821	9
0.00002821 - 0.000042316	8
0.000042316 - 0.000056421	7
0.000056421 - 0.000070526	6
0.000070526 - 0.000084631	5
0.000084631 - 0.000098736	4
0.000098736 - 0.000112841	3
0.000112841 - 0.000126947	2
0.000126947 - 0.000141052	1

Figure 24. Reclassification Low Density Development metric with reclassification table.

Away from Roads (DistRoads). *Wetlands further away from roads are more valuable than those close to roads.*

We used the TIGER 2008 roads layer to develop this wetland prioritization ranking metric. We selected for major roads (field MTFCC = S1100 or S1200). We ran a straight-line distance on these roads. We then "clipped" the output down to the WCA and applied a geometrical interval classification scheme to define the priority class ranking breaks (Figure 25).



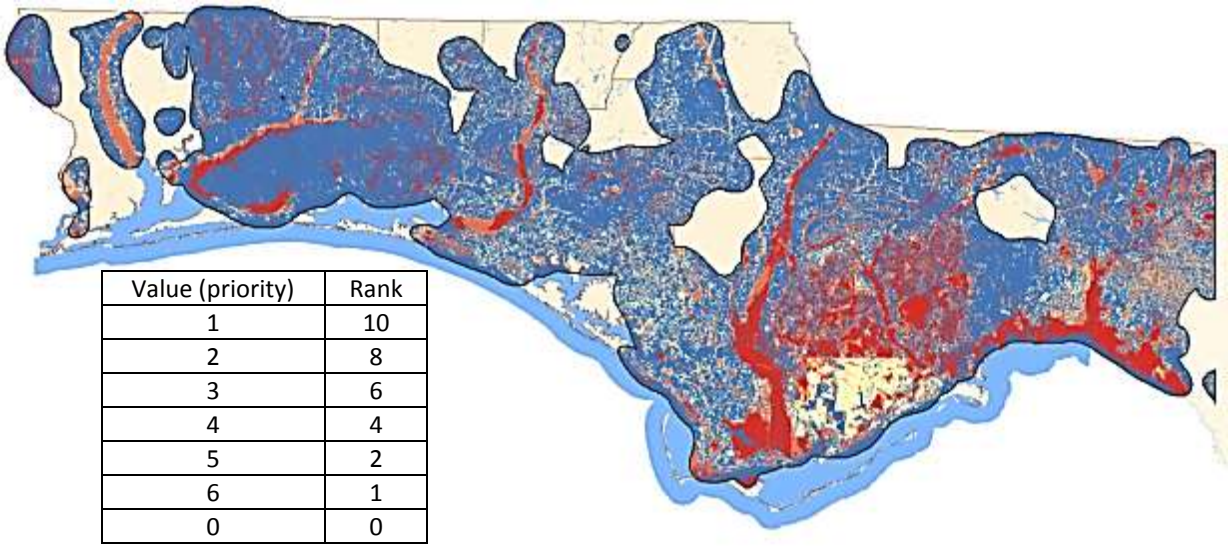
Value (m)	Rank
0-116.49	1
116.49-165.81	2
165.81-186.69	3
186.69-236.01	4
236.01-352.49	5
352.49-627.63	6
627.63-1277.47	7
1277.47-2812.33	8
2812.33-6437.55	9
6437.55-15000	10

Figure 25. Reclassification Away from Roads metric with reclassification table.

Wetland Functionality Criteria. This prioritization criterion contains metrics that relate to functionality. These factors attempt to capture the relative importance of wetlands that are "healthy" and provide important water quality and recharge services for the public.

Part of a Functional Wetland (FunctWet). *Functional wetlands are more valuable than non-functional wetlands.*

We used FNAI's Functional Wetlands dataset (FNAI 2010) to capture this wetland ranking parameter. We clipped the layer down to the WCA and reclassified the existing priority class values to place on our priority ranking scale (Figure 26).

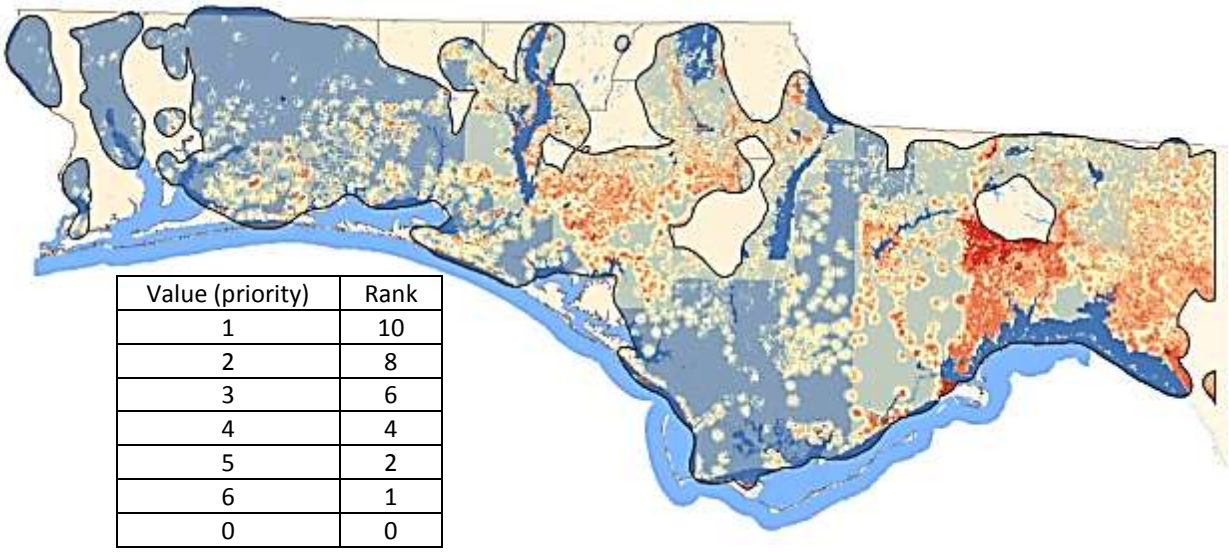


Value (priority)	Rank
1	10
2	8
3	6
4	4
5	2
6	1
0	0

Figure 26. Reclassification Part of a Functional Wetland metric with reclassification table.

Support Water Recharge (WaterRechrg). *Wetlands that provide aquifer/water recharge benefit are more valuable than those that do not support recharge.*

As with the functional wetland parameter we used an existing data set that prioritized lands that protect surface waters in Florida (FNAI 2010). We clipped the layer down to the WCA and reclassified the existing priority class values to place on our priority ranking scale (Figure 27).



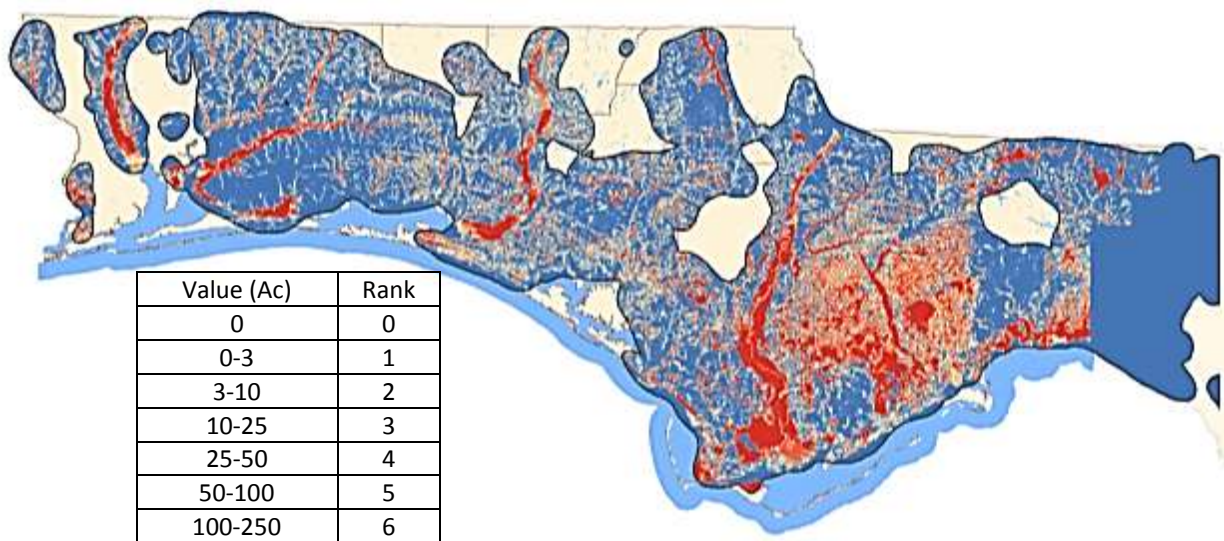
Value (priority)	Rank
1	10
2	8
3	6
4	4
5	2
6	1
0	0

Figure 27. Reclassification Support Water Recharge metric with reclassification table.

Wetland Characteristics Criteria. This prioritization criterion contains metrics that relate to physical characteristics of the wetland. These factors attempt to capture the relative importance of some common landscape ecological principles related to patch characteristics: larger patches tend to support greater number of species, generally have larger populations of species and lower local extinction rates, patches with greater interior habitat support greater populations and number of interior species which tend to have greater conservation importance (Dramstad et al. 1996).

Wetland Size (WetSze). *Larger wetlands are better than smaller wetlands.*

We selected all wetlands within the landuse layer (FLUCCS code = 600) and ran a dissolve based on the Level 1 classification (coarsest wetland type classification). We then calculated the acres for each wetland (WetSze). We developed a manual priority rank classification scheme based on the distribution of the wetland sizes (Figure 28).



Value (Ac)	Rank
0	0
0-3	1
3-10	2
10-25	3
25-50	4
50-100	5
100-250	6
250-500	7
500-1000	8
1000-2500	9
2500-150000	10

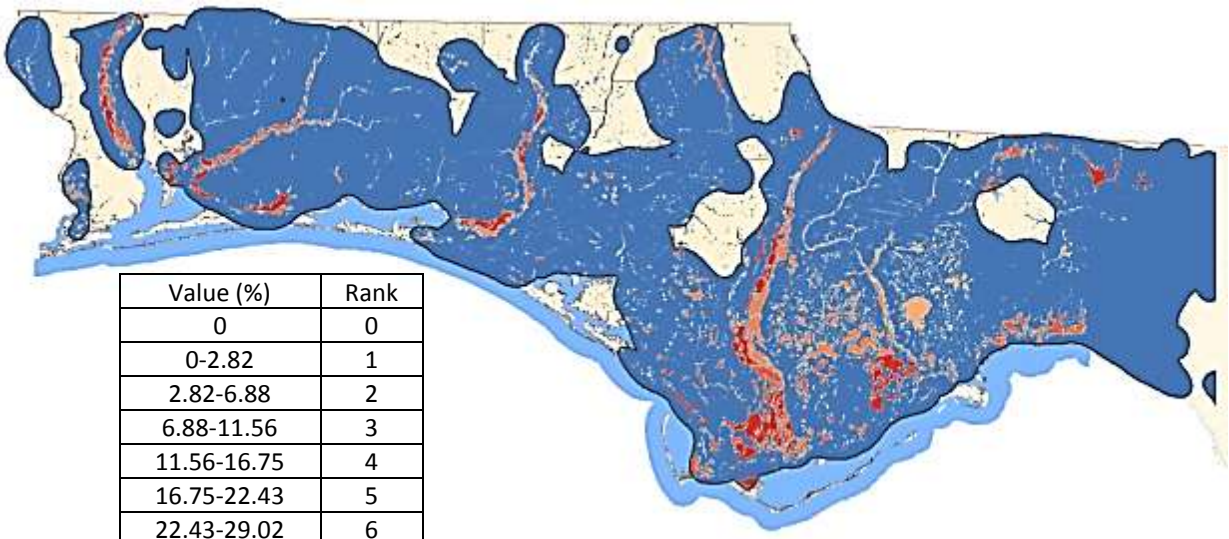
Figure 28. Reclassification Wetland Size metric with reclassification table.

Greater Core Area (CoreArea). *Wetlands with greater percent interior core area are more valuable than those that have lower percent of interior core area.*

To calculate percent interior core area we used the Level 1 dissolved wetland layer created for the wetland size metric. We generated an interior buffer (100m) within each wetland. We retained the part of the wetland that remained after removing the interior buffer (interior core) and then for each wetland calculated acres of the remaining part (acres of interior core (CoreAc)). To obtain the percent interior core area metric values, we calculated the percentage by dividing the acres of interior core, CoreAc, by the total acres of the entire wetland and then multiplying by 100.

$$PrcntCore = (CoreAc/WetSze)*100$$

Priority ranks were assigned based on a manual classification scheme in which we defined class breaks based on the distribution of the data (Figure 29). Lower percent interior core values were given lower priority ranks while higher percent interior core area received higher priority ranks.



Value (%)	Rank
0	0
0-2.82	1
2.82-6.88	2
6.88-11.56	3
11.56-16.75	4
16.75-22.43	5
22.43-29.02	6
29.02-36.85	7
36.85-46.74	8
46.74-59.48	9
59.48-83.49	10

Figure 29. Reclassification Greater Core Area metric with reclassification table.

Prioritization Criteria Metric Overlay. After creating each of the input prioritization metrics, we produced a prioritization layer for each of the Prioritization Criteria by conducting an additive overlay analysis of the metrics within each criterion (Figure 30).

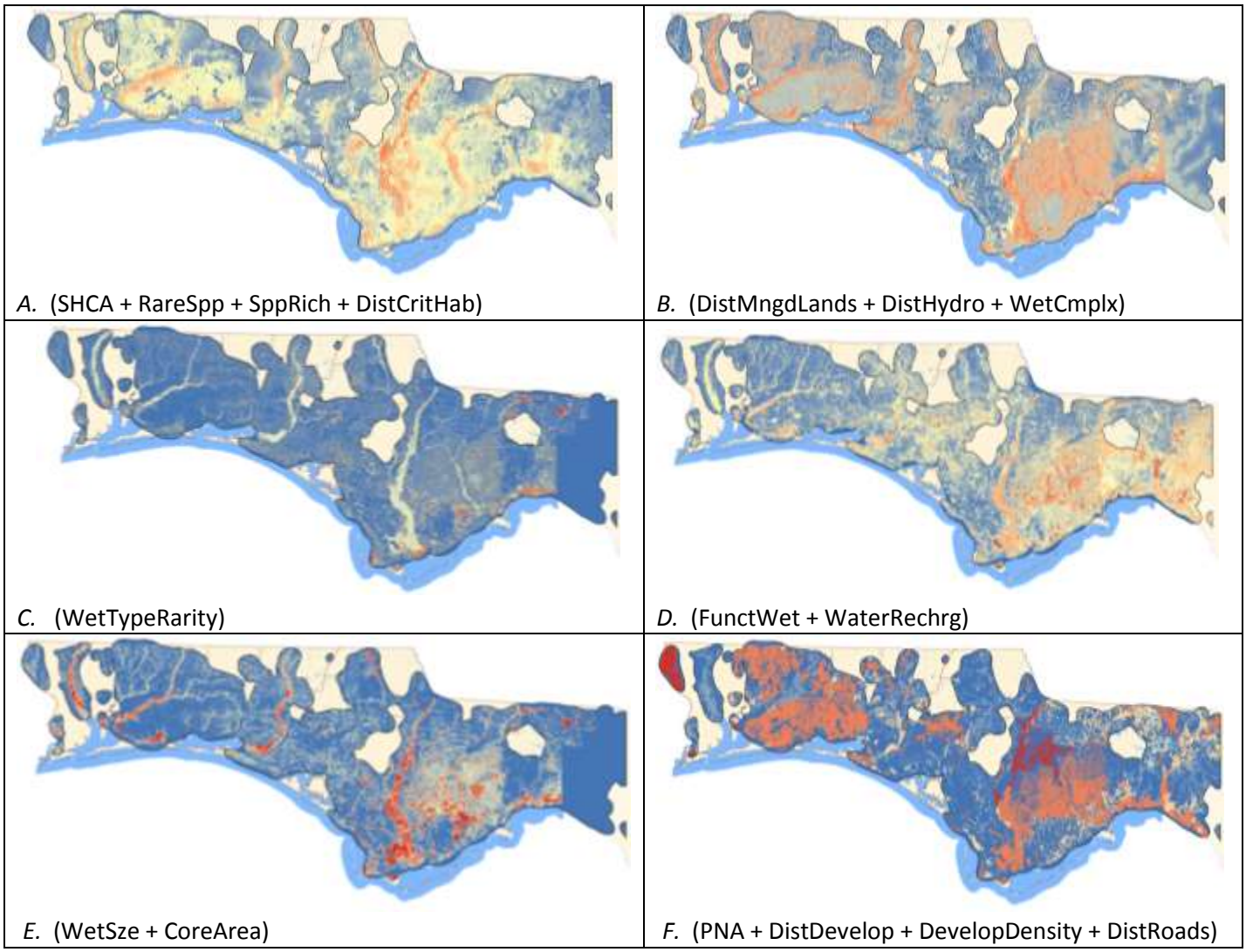


Figure 30. Prioritization Criteria Metric Overlay: A. Listed Species Priority; B. Connectivity Priority; C. Type/Rarity Priority; D. Wetland Functionality Priority; E. Wetland Characteristics Priority; F. Natural Habitat Priority.

Prioritization Criteria Overlay Model. The Prioritization Criteria layers, in Figure 30, were combined to produce with the following additive overlay expression:

Wetland Prioritization Criteria Model = Listed Species Priority + Connectivity Priority + Type/Rarity Priority + Wetland Functionality Priority + Wetland Characteristics Priority + Natural Habitat Priority

This produced the final wetland criteria prioritization model layer (Figure 31) comprised of 28,923,001 cells. Values ranged from 6-134, out of a potential range of 0-160, and a mean of 70 (Figure 32). This layer became the foundation for assigning priority values to the wetlands.

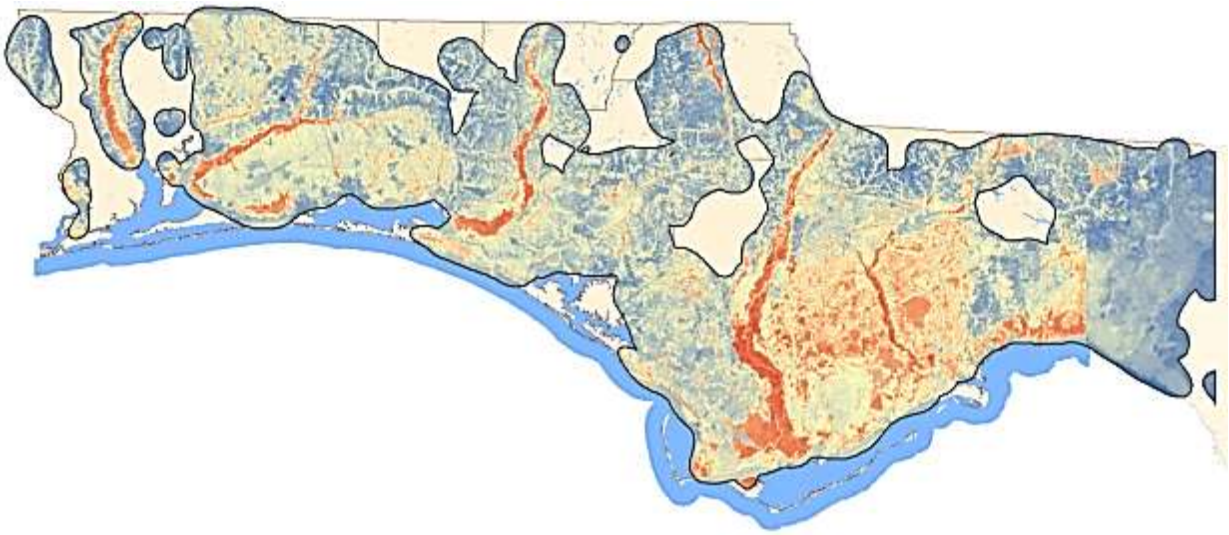


Figure 31. Wetland Prioritization Criteria Overlay result.

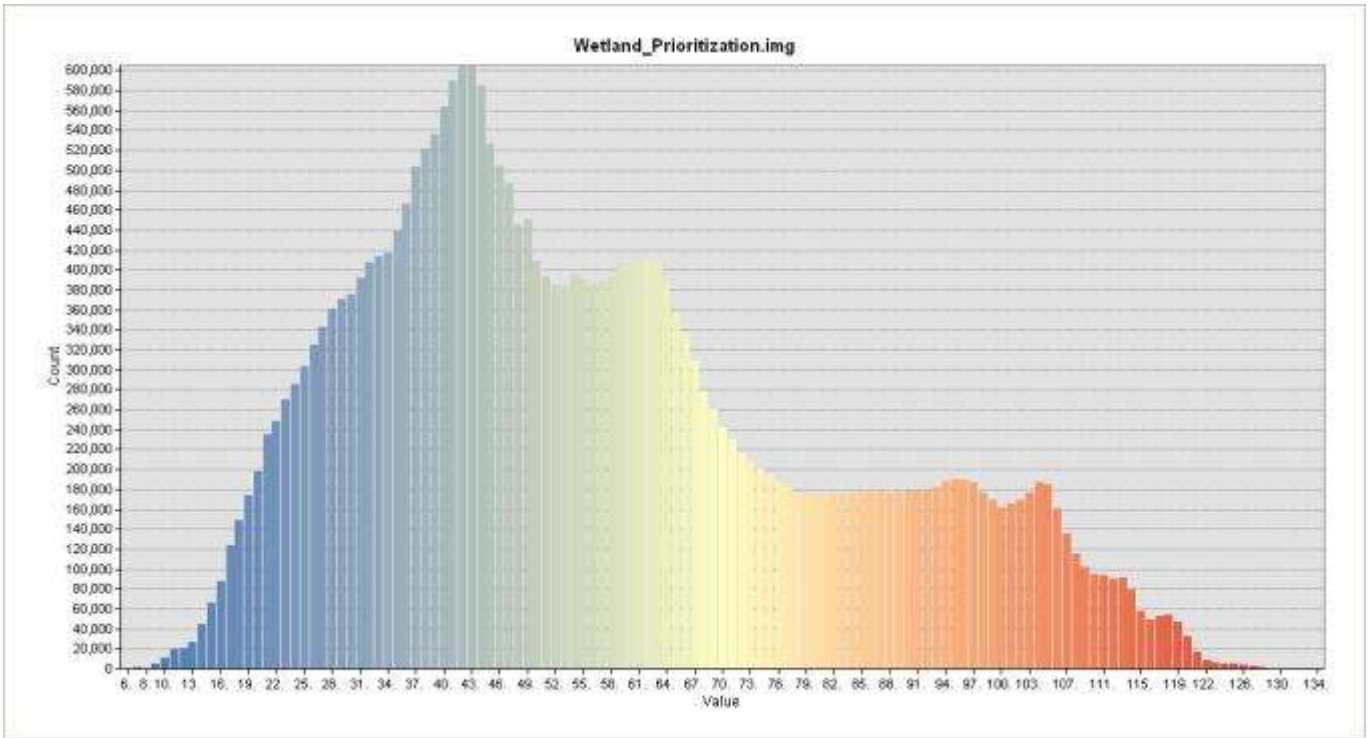


Figure 32. Histogram of priority values assigned to the wetlands within the WCA seen in Figure 31.

Wetland Prioritization Assignment: Final Model

The final model was generated by assigning priority values to the wetlands within the WCA based on the values from the Wetland Criteria Model. This was done by generating zonal statistics for each wetland. We chose this method because within each wetland boundary multiple cells with potentially different values occurred. By using this method we were able to assign an overall priority value to each wetland. Each wetland was assigned a unique number which defined the zones and a majority statistic was generated for each wetland. Each wetland received its value based on the results of the majority statistic (Figure 33).

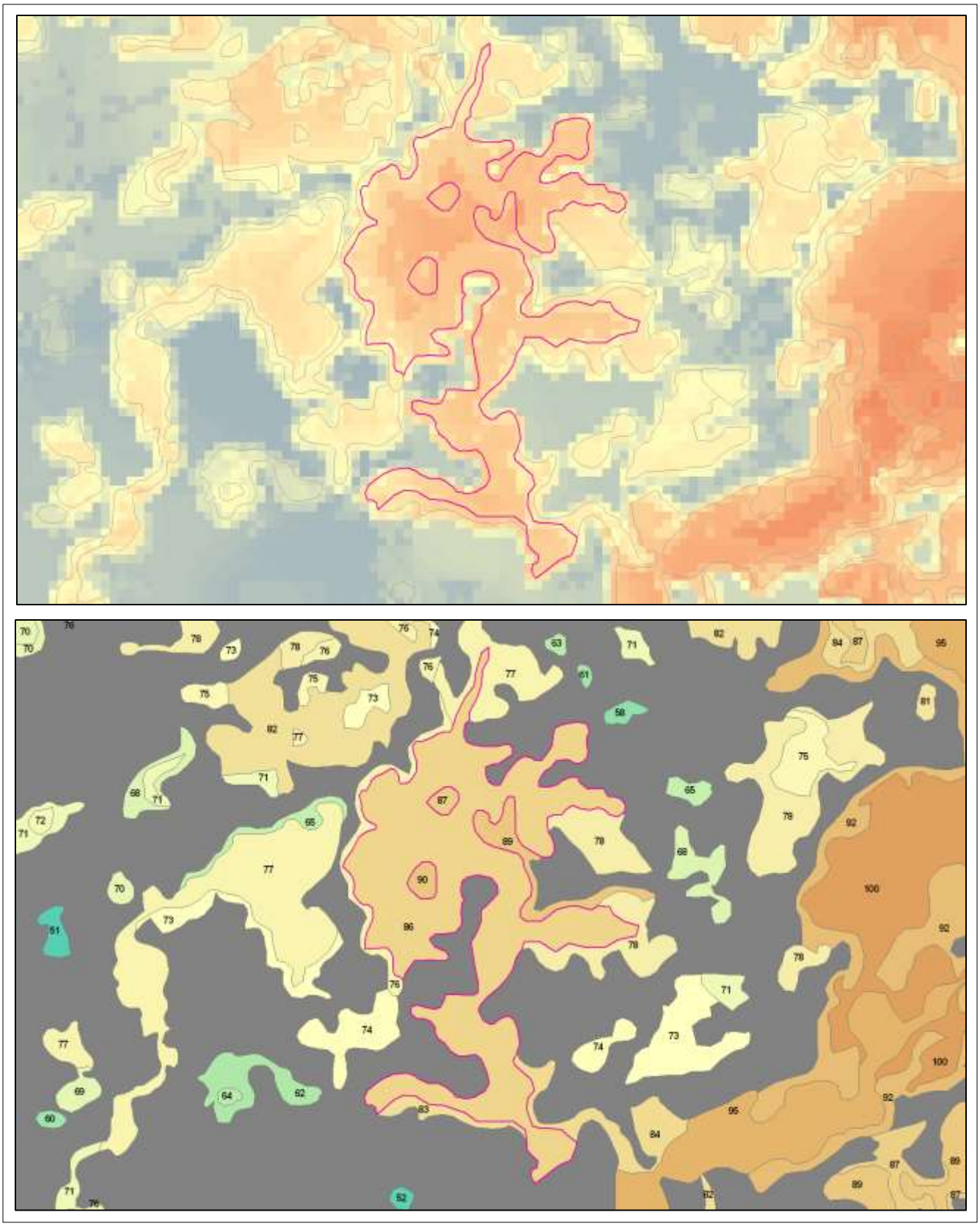


Figure 33. Wetland priority assignment. A sample (magenta) wetland shown overlaid on the Wetland Prioritization Criteria Model (top image). The image shows how a wetland is made up of multiple cells with multiple values. Warmer colors represent higher priority areas; cooler colors represent lower priority areas. The bottom image shows the priority values (numbers) assigned to the wetlands (sample wetland in magenta). Warmer colors represent wetlands of higher priority; cooler colors represent wetlands of lower priority..

The majority statistic was chosen because it calculates a value for the polygon based on the cell value that has the greatest frequency within the polygon (ESRI 2011). We felt this was a more appropriate metric for assigning a priority value than the mean, sum or some other statistic.

In all 81,808 wetlands, that made up 1,750,901.12 acres (684,672.20 ha) of the 6,432,236.05 total acres (2,603,043.99 ha) within the WCA (Figure 34), were analyzed. One hundred-five of the 81,808 wetlands received a value of zero through the zonal statistic function. These wetlands were very small, < 1 ac. It appeared the majority statistic could not be calculated for these wetlands for a variety of reasons: 1) lack of sufficient number of cells, 2) wetland too small, 3) no value was in a majority, or 4) some other undetermined reason. Because determining the majority value by hand was problematic, we removed these wetlands from the model; therefore 81,703 wetlands were in the final model (Figure 34). Priority values for these wetlands ranged from 20 to 130 with an average of 74 and a mode of 71.

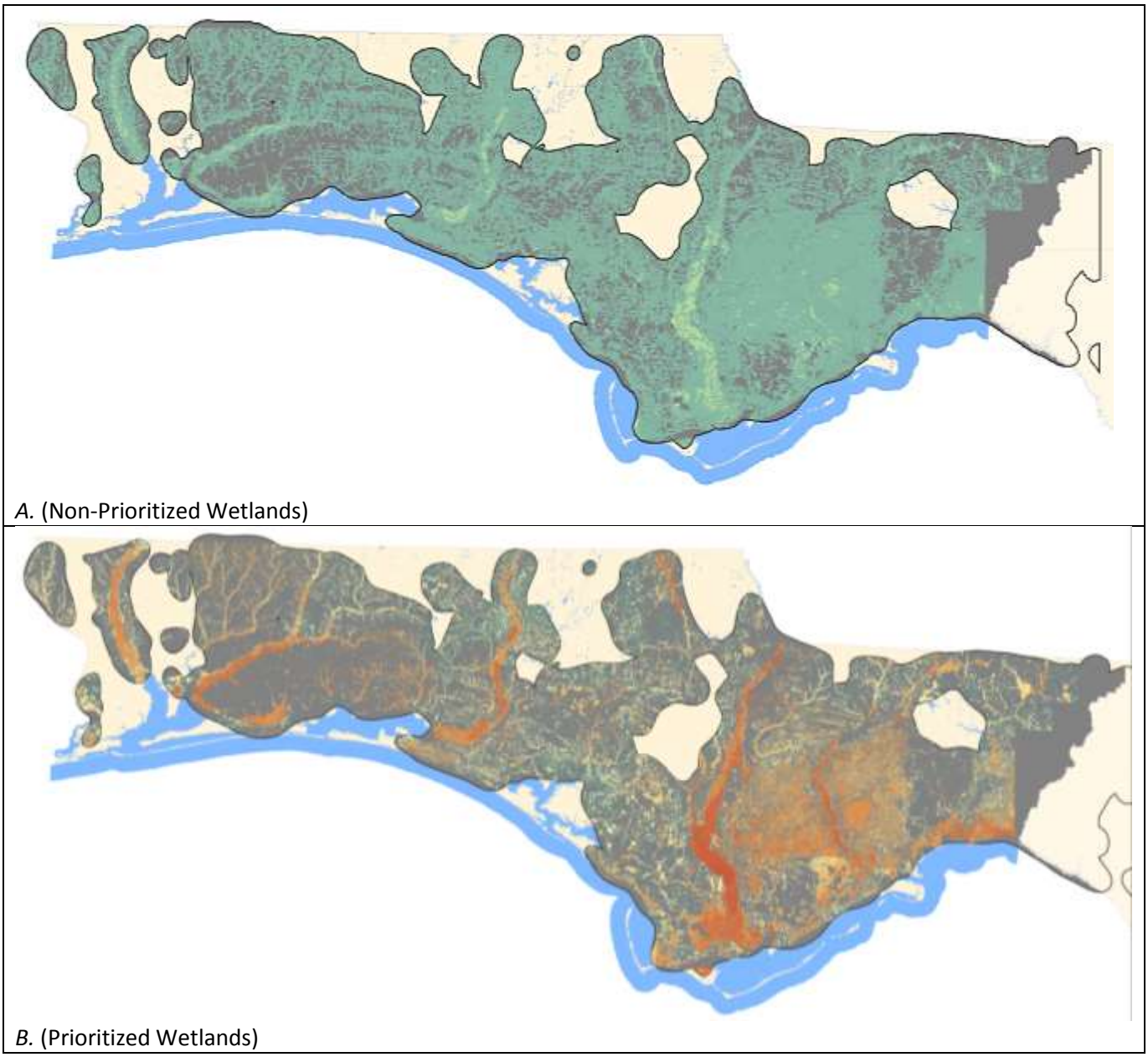
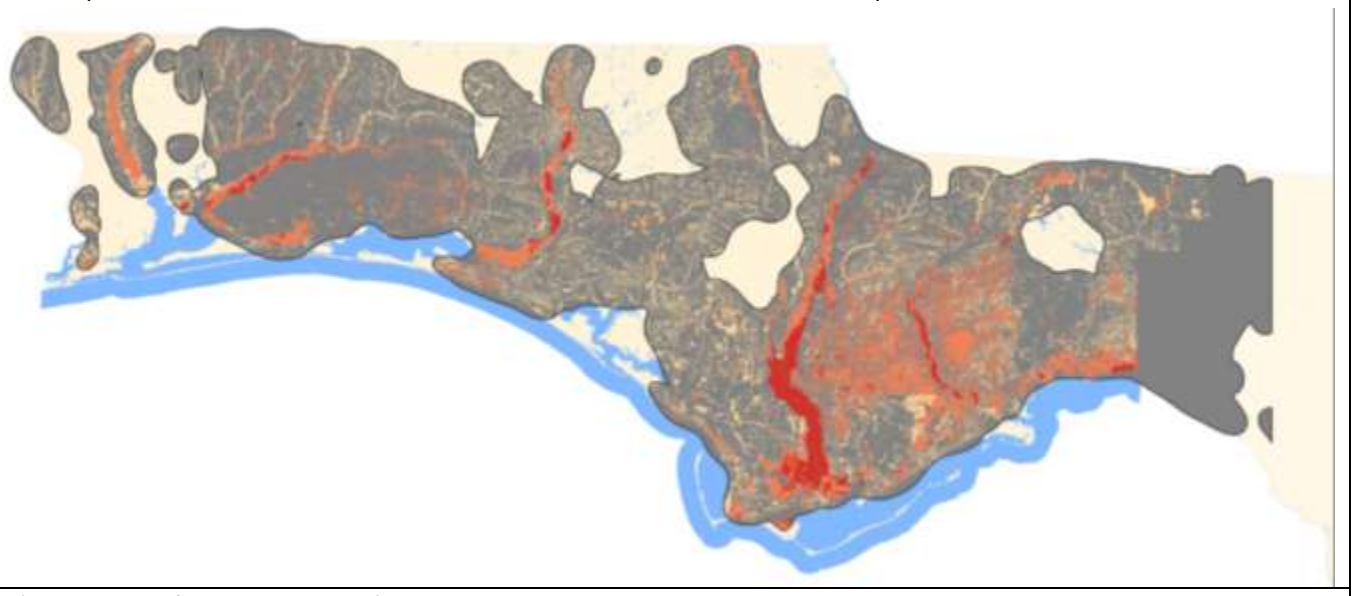


Figure 34. Wetlands within the WCA. A. Non-prioritized wetlands within the WCA; B. Prioritized wetlands based on priority value assignment. Warmer colored wetlands have higher priority values; cooler colored wetlands have lower priority values.

Wetland Prioritization Overlay

To better interpret the results, relative to the data distribution and variability, and to aid in the implementation of the model we applied a standard deviation classification scheme. This classification showed a total of 64,892 wetlands within ±1 s.d. around the mean (74); 14,862 wetlands within 1-2 s.d. (Majority values 94-113); 546 wetlands greater than 2s.d. (Majority values 114-130); 1403 wetlands within (-1) – (-2) s.d. (Majority values 20-35); and no wetlands greater than -2 s.d. (Figure 35).

A. (Standard Deviation Classification Scheme for Prioritized Wetlands)



B. (Histogram of Wetland Values)

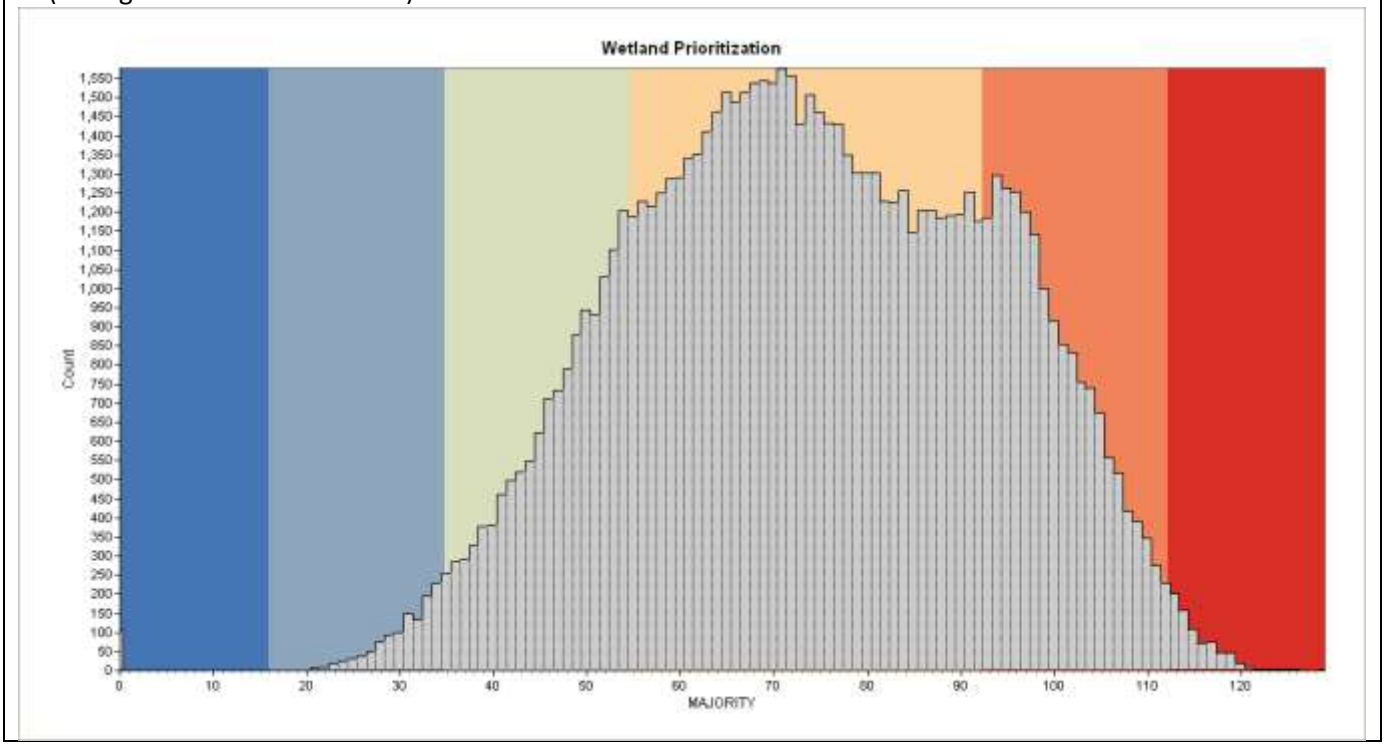


Figure 35. Wetland Prioritization Model majority zonal statistic rendered by standard deviation. A. Shows the six class standard deviation classification scheme applied to wetlands. B. Shows the histogram of majority statistic values of the wetlands with the standard deviation classes in the background (The colors correspond to the standard deviation classes shown in Figure 35A.

WETLAND CONSERVATION AREA MODEL COMPARISON TO BINARY OVERLAY MODEL

There are many approaches to modeling the prioritization of resources using the GIS. In order to informally validate the results of our landscape scale model approach, we compared our model to a more traditional raster overlay analysis by developing a binary, ranking overlay model (Berry 2007). We chose this type of model because it is one of the simplest overlay models; therefore allowing us an easy means to compare the output of our landscape model. To develop the binary model we reclassified the suite of inputs used in our surface model to a 0 and 1, where 1 was the feature of interest and 0 is not the feature of interest. The reclassified input layers were added together using simple Map Algebra functionality. The result produced a map of cells where the input target features were coincident on the landscape (Figure 36).

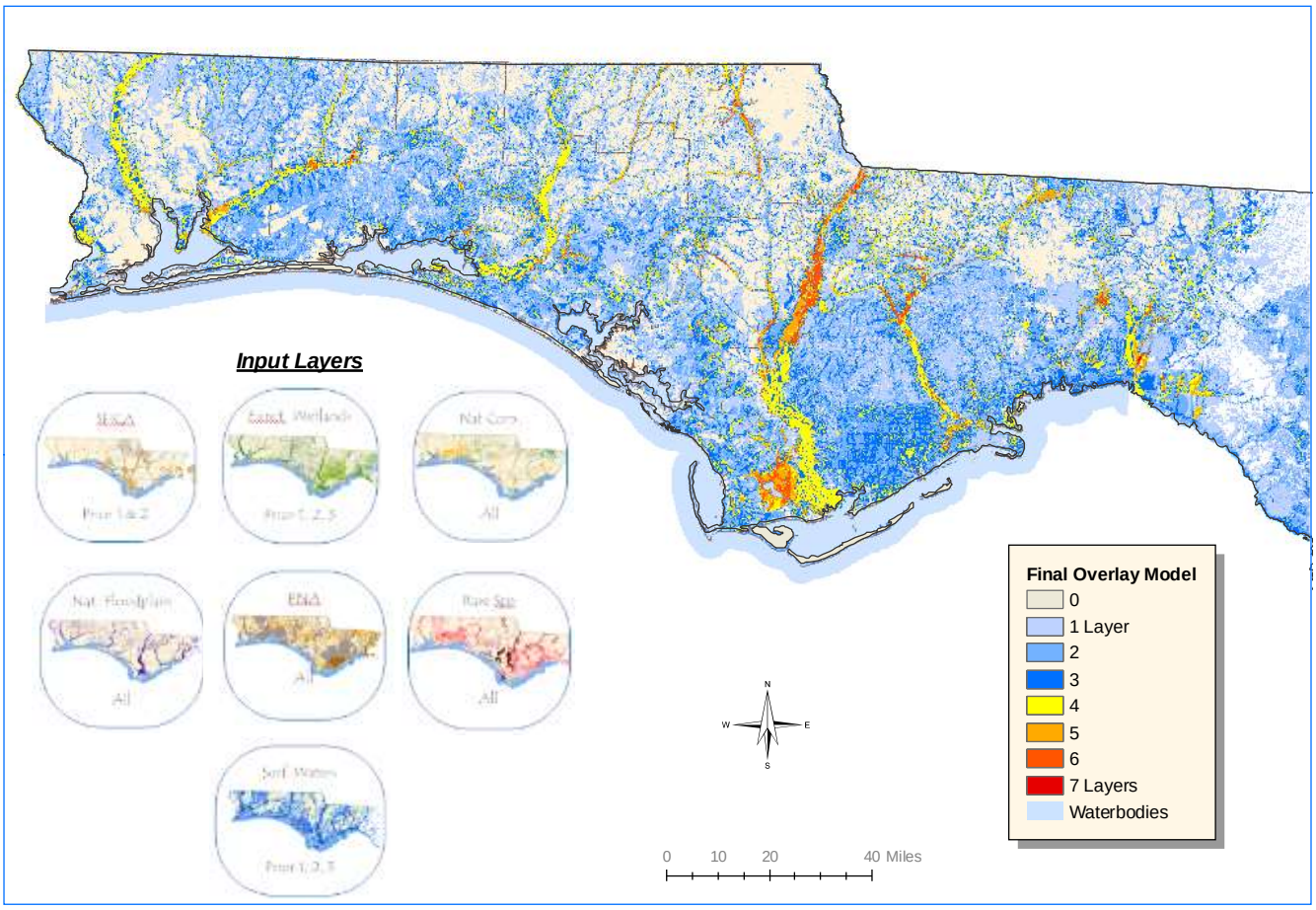


Figure 36. Binary ranking overlay model of landscape level model inputs as used in the wetland conservation area model.

We overlaid these results with our model and found good agreement between the two models. Areas identified as hot spots in the binary model corresponded to those areas that appeared as higher density areas in our model; non-hot spots areas in the binary model were depicted as low density (Figure 37).

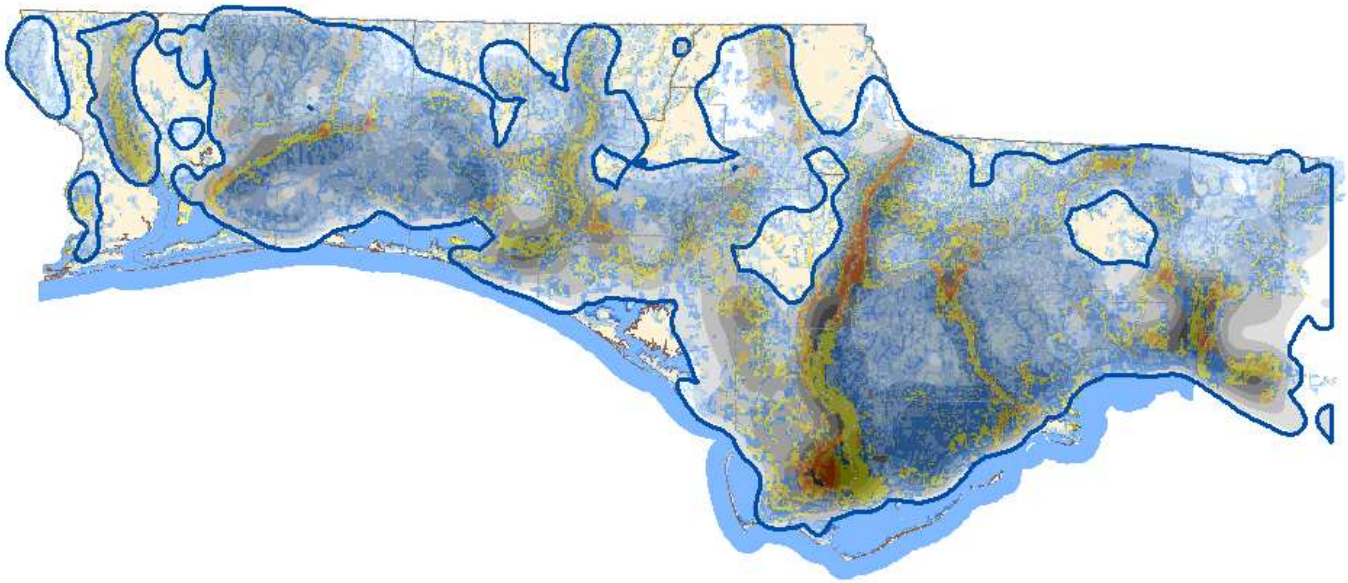


Figure 37. Overlay of Wetland Conservation Area model and Binary, ranking overlay model. Darker gray areas indicate a higher density area, which signifies higher priority ecological area..

DISCUSSION

The WCP model is a top down modeling approach where we applied a landscape scale model and within the bounds of that we developed a local scale model. We chose this approach because it allows us to focus wetland conservation at the broad or landscape scale, in these large contiguous areas deemed of higher conservation importance through our modeling effort, and then target priority wetlands at the site or local level. In this way, we attempt to narrow our focus on the perceived best of the best: the best wetlands within the best places on the landscape. We know that we cannot protect all of the wetlands within our work area, but we believe that if we strategically target wetlands, the conservation actions we place on the ground (i.e., protection, restoration, easements) will collectively feed into the overall conservation of the landscape scale ecological services and integrity. This strategic approach affords us the opportunity to step back, look at the big picture and then focus our on-the-ground conservation efforts in the "right" places.

WETLAND CONSERVATION AREA

With this top-down approach, our first objective was to focus our project area to encompass areas of higher ecological value. There are several ways this can be accomplished within the GIS. We chose a density surfaces approach for several reasons. First of all because density surfaces take the target feature's values spread them across the landscape (McCoy and Johnston 2001, ESRI 2010b) they are particularly suited for showing spatial patterns of the target features across the landscape (Mitchell 1999, Lloyd et al. 2003). In our case we were looking for patterns of variables we selected to represent ecological value across the landscape. We also selected density surfaces over a more traditional cell by cell based system because the density surface approach produces a continuous surface (gradient) representing the density value of the target feature over the analysis area (Figure 38).

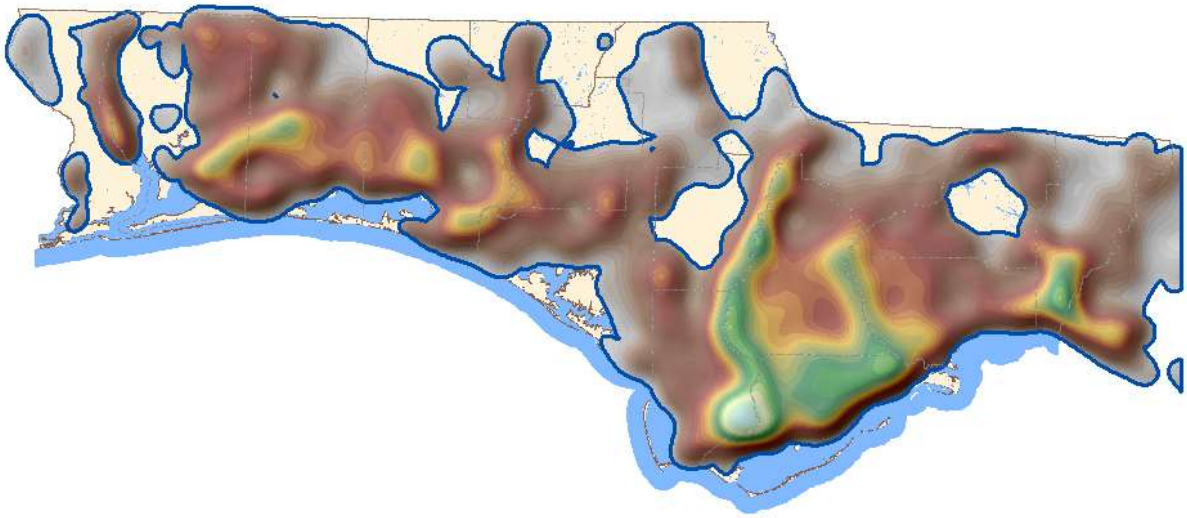


Figure 38. Density surface in three dimensions showing the gradient of density values going from the lower density areas (light gray-reddish browns) to the higher density areas (yellow-light green).

So if we think of it in a three dimensional context, areas of lower density (lower ecological value) are the "valleys," while areas of higher density (higher ecological value) are the "peaks" (Figure 39), we strive to "select" the point (value) along the surface gradient in which we deem the threshold ecological value (density value) defines the desired boundary, the fine balance between connectivity and isolation. Here in lies some of the subjectivity of this process. Where the threshold of the "desired" boundary is, that balance between having several small isolated islands throughout the landscape or having one large connected area, is subject to opinion. Another area of subjectivity that comes into play in density surface analysis is the selection of a search radius for calculating the feature densities. The "appropriate" search radius value for the data or ecological question being analyzed many times is not readily known, because at times the ecological value(s) for which the system operates, are unknown. When this is the case we attempt to select a search radius that achieves that balance between isolation and connectivity. Too small or large a search distance the pattern(s) can be obscured (Mitchell 1999). So, as the search distance goes down the pattern trends to take on the original look of the data and we get small islands, while as the search distance increases and the patterns begin to merge into one. Spatial statistics can help inform the analyst the "appropriate" search distance by statistically identifying the scale at which the data operates (ESRI 2010c). We attempted to employ this with our model, however, we were unable to run such analysis due to a limit on the total number of points the clustering algorithm can use. We will be pursuing this avenue in future updates to the model. However once the search distance is selected and the density threshold value is agreed upon the boundary that defines the spatial extent will be consistent among all that use this value.

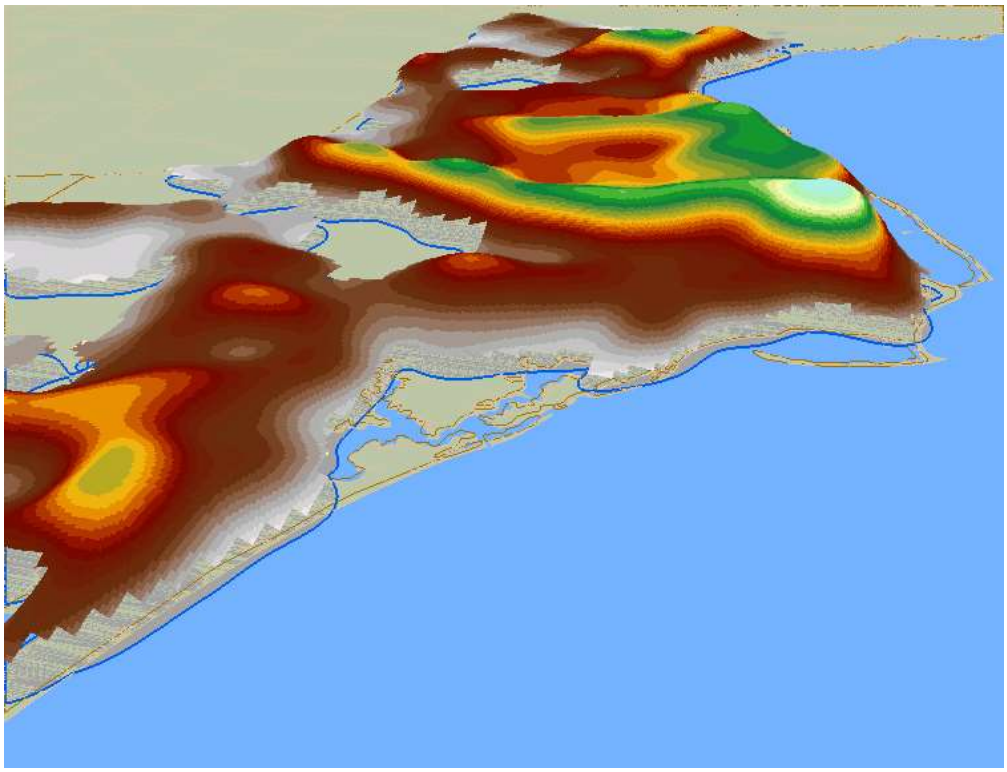


Figure 39. Oblique view of density surface in three dimensions. This shows the "peaks" and "valleys" of the density surface shown in Figure 38.

Density surface analysis used to develop our landscape level priority areas appears to be a viable alternative approach. Furthermore, we would argue that it is a more robust approach than a more traditional approach like binary overlay models. Binary model results are limited, as Berry (2007) states "things are either good or bad with no degrees of goodness." A surface density approach, on the other hand, by its nature depicts the feature of interest in a gradient of value, or "goodness" as Berry would refer to it. Because of this, by simply being more restrictive or less restrictive in the retention of density classes we can narrow or increase, respectively, our landscape focus. While this process is relatively simple and straightforward and results in a sharp in/out boundary, we need to keep in mind this line is not intended to be a precise location that if you are on one side you are in and on the other you are out. As with certain boundaries there is an implied fuzziness (Lloyd et al. 2003), especially ecological boundaries like ours.

This approach focuses our area of interest at the landscape level, however, in doing so there is a risk that some high quality wetlands will be missed because they occur outside the WCA. Some of these may even be of higher quality/value than those in the WCA, however it is a presumption that the on-the-ground resources, wetlands being one of them, within the WCA collectively feed into the overall landscape integrity. So, by not focusing our efforts at the landscape level we will continue to fragment our conservation actions in a manner with little strategic vision. We perpetuate the business as usual, shotgun approach or salt and pepper conservation and while our conservation actions are benefiting nature her and there they are not collectively, strategically, adding to that landscape integrity. Therefore, by using our approach we recognize the risk but realize the bigger picture gain. This does not mean that if an opportunity comes up from time to time outside the WCA we do not entertain them; on the contrary, we assess their conservation benefit and make an informed decision according while always keeping our eye on that bigger picture, strategic conservation ball.

WETLAND PRIORITIZATION

Our model takes a step back and looks at wetlands in context of the landscape and the ecological system: how far is the wetland from managed lands, how much core interior area the wetland has, how many listed species potentially may occur there and how do all these factors relate to other wetlands in the panhandle. Some of these factors are straight-forward and directly calculable (e.g. wetland size), while others are not as straight-forward with available data so we used surrogate metrics to address these factors. For instance "naturalness," we used distance from roads as one of the analyses. We know that roads impact the environment and that these impacts do extend beyond the road itself. Forman et al. (2003) provides a graphical synthesis of the literature for the effect, in distance, roads have on various landscape components. He showed that these impacts can range from the immediate road/roadside impacts and chemical impacts of up to nearly 200 m to water and aquatic ecosystem impacts of greater than 1000 m. Although we know areas away from roads can have impacts we made the assumption that, in general, they are less impacted than those closer to roads. In approaching the prioritization of wetlands within the WCA from the big picture parameters (i.e., proximity to rivers, proximity to roads, connectivity, etc.) standpoint we did not did not use on-the-ground, site level parameters to rank wetlands. Therefore, the condition or state of the wetland on the ground is not captured by our model. So, for instance, if you were to go to two similarly ranked wetlands (e.g. priority score of 80), it is possible that the wetlands have different site conditions (i.e., one may be more overgrown than the other or one may contain invasive species and the other doesn't, etc.). These site level factors are important to take into consideration when comparing wetlands on the ground, but, as is, our model does not account for these. There are many effective models/tools for assessing or evaluating a wetland at the site level (Fennessy, et al. 2004, USACE 1994, Brinson 1993, USFWS 1980) and these or some sort of site level assessment should be employed when implementing this model on the ground.

Another important tenant of our model is that while the values assigned to each wetland, through the modeling process, have a degree of precision, the relative value is really what we should be focused on. For this reason we present the results by a classification method that allows the combining of the underlying wetland model values into separate classes. So we have to keep in mind, while each wetland received a specific score the relative position within the range of values is primarily the level in which the model should be used. This does not mean that the real values are "valueless" or cannot be used, but instead should be used with reason. For instance, it would not be prudent to say a wetland with a score of 50 is more important than one with a 48 or one with a 100 is less important than one with a 105. Yes the values may indicate this level of specificity, but the resolution of the values is not intended to be applied at this fine a level.

Another aspect that should be noted is that, based on the current version of the model, you cannot readily determine the Prioritization Criteria Metric Overlay component values that went into making up the total score for the wetlands. The number is a cumulative score based on a simple additive expression. If when implementing this model you need to determine to what degree a particular prioritization criteria metric made up the final score you would have to go back to the input prioritization criteria input layers. We may incorporate some tracking system to allow this to be done in future versions.

While species conservation is ultimately the underpinnings of our missions, we chose to take an ecological approach to our wetland model, an approach that attempts to take into account multiple ecological factors instead of one or two. Therefore, we chose to consider all the prioritization metrics to be equal; therefore, we chose not to do any weighted overlay analysis. Depending on the responsibility of the conservation agency or the interest of the individual, the opinion of whether all factors should be considered of equal value or if one factor or another is more important will differ. However, the way the model was built as a hierarchical model, if the management need warrants that species

are considered more strongly, the user of the model can easily go back to the original input prioritization metrics and weight them accordingly. This would change the outcome of the results but would allow for that management need to be better represented.

CONCLUSIONS

Our approach is just one approach. There are many ways to prioritize a resource. This is an ecological based model. It was developed to be a generalist model, what we mean by that is, taking into account many ecological factors (water quality, species, habitat, etc.) and not focusing in on or emphasizing one component of the ecological picture (i.e., species or habitat).

George E. P. Box is credited with saying "All models are wrong, but some are useful." Our model has its strengths and weaknesses, but we believe it can serve as a useful tool to support wetland conservation within the Florida panhandle. Time will answer whether this is a useful tool; however.

At any given time the best that we can do is to utilize the most advanced and available scientific information to make our best decisions, and continuously search for even more advanced and comprehensive information and data sets that will enhance and improve our model. This model is not intended to be the definitive wetland prioritization model. We hope it is a catalyst for greater more open discussion on wetland prioritization and result in a collaborative effort among conservation agencies and organizations to improve upon this effort.

LIMITATIONS

Keep in mind all models are created for a purpose. Our model was created in response to a need to develop a tool to aid our wetland conservation related activities by giving us a means to be more strategic in our efforts, by being a guide for focusing our resources to those areas, based on the modeling parameters, which are deemed of high value. To accomplish this task we chose existing statewide data sets as the foundation for the development of this model. These data sets are well established data sets, recognized as probably the best data available within the state. However, as with all data, there are inherent errors (errors in mapping, errors in classification, omission and commission errors, etc.) that can and will affect the results of a model. For instance, while conducting our field verification we found that several pitcher plant prairies were not mapped as wetlands in the Northwest Florida Water Management District Land Use Land Cover data. As a result, we found out there are errors of omission within the model. It follows that most likely there are errors of commission within our model; these would be seen as areas that were mapped as wetlands but either are not wetlands or are no longer wetlands. Furthermore all models have limitations (limitations in scale, limitations in resolution, temporal limitations, etc.). While our model assigned priority values at the wetland level we used landscape and big picture metrics to accomplish this task. These metrics do not take into account the site condition of the wetland that can greatly affect the health or value of an individual wetland. Therefore, this model should not be used in place of established on-the-ground wetland assessment or field verification.

As with all models there are differing opinions as to what are the best model and/or the "best" approach to develop a prioritization model for an ecological system, in this case wetlands. We took a straight-forward, simplistic approach to prioritizing wetlands. We used factors that are commonly recognized as important parameters for ecological value. There are many factors that make a wetland important or valuable; these vary widely depending on the individual or agency/organization's viewpoint. Our model does not attempt to account for all the factors that may be viewed as parameters that make a wetland important or valuable. The factors we used were defined internally and subsequent analyses to capture these factors were informed by published literature. Our approach is one approach; we do not

believe it is the only approach or necessarily the best approach, but we hope it will foster further refinements and enhancements and lead to a commonly agreed upon model for prioritizing wetlands within Florida.

The Service is not responsible for the misuse of this data or any subset of these data. As with all models or data the user needs to take care in applying the results to his/her particular application. He/she needs to read the entire report, paying particular attention to the datasets used and the analyses performed. If the user has any questions regarding this model, he/she can contact the author listed on the title page.

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ACRONYMS/ABBREVIATIONS

ESRI	Environmental Systems Research Institute
FL	Florida
FNAI	Florida Natural Areas Inventory
FWCC	Florida Fish and Wildlife Conservation Commission
G1/G2	Global Rank
LE	Federally Listed, Endangered
LT	Federally Listed, Threatened
NHD	National Hydrologic Dataset
PNA	Potential Natural Areas
S1/S2	State Rank
SHCA	Strategic Habitat Conservation Area
TIGER	Topologically Integrated Geographic Encoding and Referencing System
US	United States
USFWS	United States Fish and Wildlife Service
WCA	Wetland Conservation Area

ac	Acres
Co	County
ft	Feet
ha	Hectares
m	Meters
sd	Standard deviation
Spp	Species

APPENDIX A. DEFINITIONS

Additive overlay - The process of adding together the values, on a cell-by-cell basis, of two or more spatially "stacked" raster layers.

Background – Non-target cells or features in a raster dataset.

Bin – A range of values, defined by the user, for an attribute. This is commonly referred to within the raster based modeling world.

Binned – The process of placing attribute values into their corresponding bins

Class – Group or category of attributes with similar values.

Class break - The threshold value that divides one class from another.

Clip – The process of extracting features that fall within the boundaries of a polygon. Generally, this is referred to in vector model (See mask for raster model equivalent).

Con() – ArcGIS Spatial Analyst tool for assigning values to cells based on performing a conditional (if/else) operation.

Density surface -

Dissolve – The process of removing shared boundaries between adjacent polygons with the same value for a specified attribute.

Majority statistic – A zonal statistic in which the value of the cells in a zone is assigned based on the cell value that occurs the most within that zone.

Manual classification – The process of defining custom range of attribute values that define individual classes

Mask – A raster layer that defines areas within the target raster that are excluded from the analysis. This procedure is commonly used to extract target raster cells from a raster layer.

Metric – A measure to assign a value to geographic features (e.g. distance from roads).

NULL – The absence of a value for a cell in a raster, meaning no valid value exists for that cell. Commonly, this is also referred to as NoData.

Point layer – A vector layer in which geographic features are represented by a single x,y coordinate. The feature is not represented with any width or length. This is used generally when a feature is too small to be represented by a line or area at that scale.

Polygon layer – A vector based layer in which geographic features are represented by areas made up of three or more sided, closed figures. This is used to represent features that are large enough to at that scale to have width and length.

Raster – A spatial model in which geographic features are represented by rows and columns of cells.

Reclass – The process of changing the original input cell values of a raster into new output cell values.

Scale – The ratio of distance units on a map to distance units on the ground for a corresponding geographic extent.

SETNULL() – ArcGIS Spatial Analyst tool used to convert target cells to NoData.

Straight-line distance – The distance, in a straight-line, from one cell to another.

Vector layer - A spatial model in which geographic features are represented by points, lines, or polygons.

Vectorization – The process of converting a raster layer into a vector layer.

Zonal statistics – The calculation of a statistic(s) for all the cells with the same value defined by another raster (referred to as a zone). A single output value is computed for each cell in each zone.