Refining Conservation Delivery in Nebraska's Central Loess Hills through integration of Decision Support Tools

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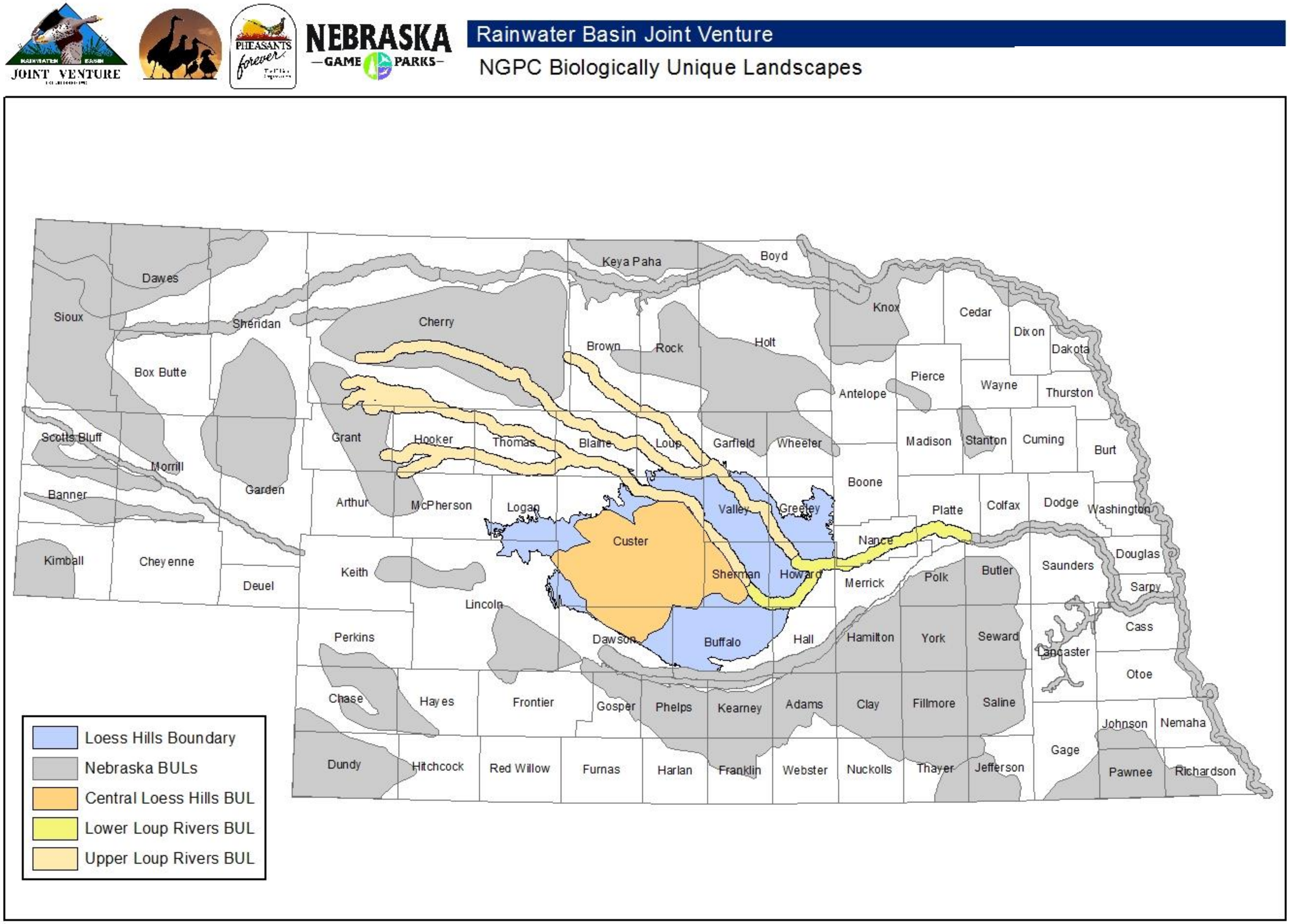
Introduction

In 2001, Congress established the Wildlife Conservation and Restoration program and the State Wildlife Grants programs. These programs provide states with funding to develop proactive measures to maintain biodiversity and address habitat needs of rare and declining species. To receive these funds each state was required to develop a State Wildlife Action Plan (SWAP). Nebraska's plan, the Nebraska Natural Legacy Project (NNLP; Schneider et. al. 2005), is considered a model landscape-scale, science-based SWAP. The Nebraska model has been used as a planning template by several other states. The NNLP used a combination of species occurrence data, landscape inventories, and Geographical Information Systems (GIS) analysis to identify specific "Biologically Unique Landscapes" (BULs) throughout the state. The BUL system was developed to locate areas that harbor at-risk species and provide the greatest opportunity to conserve and restore native natural communities. Based upon this information BULs were delineated with the expectation that conservation delivery in these landscapes would significantly contribute to the sustainability of rare and declining species, maintain unique habitats, and ultimately sustain Nebraska's biodiversity.

The Central Loess Hills Region (CLHR) of Nebraska was identified in the NNLP and contains three of these BULs (Central Loess Hills BUL, Lower Loup River BUL, and Upper Loup BUL) (Figure 1). The Central Loess Hills region consists of rolling to steep loess hills, dissected by the valleys of the Loup Rivers. The hills are now a mosaic of mixed-grass prairie and cropland. The meadows associated with the Loup Rivers are some of the most intact meadow systems in the state. Aggressive management of grazing on grasslands, exotic plant invasion, widespread herbicide spraying, and the removal of fire from the ecosystem have resulted in the degradation of the majority of central loess hills grasslands. The flatter tablelands of this landscape contain playa wetlands that are used by whooping cranes and numerous other waterbirds during migration (Schneider et. al 2005). Priority species identified for the BULs include: river otter, bell's vireo, burrowing owl, greater prairie chicken, loggerhead shrike, trumpeter swan, whooping crane, regal fritillary, and plains topminnow. Priority vegetation communities include: cottonwood-peachleaf willow, riparian woodland, dry upland bur oak woodland, sandbar willow shrubland, riparian dogwood-false indigobush shrubland, buckbrush shrubland, freshwater seep, playa wetland, cattail shallow marsh, reed marsh, loess mixed-grass prairie, perennial sandbar, and sandbar/mudflat.

Figure 1. BULs within the Central Loess Hills Region of Nebraska



To increase conservation delivery activities in the BULs, coordinating wildlife biologist positions were added to increase delivery capacity. Personnel or delivery capacity was identified as the limiting factor in conservation delivery to benefit the priority species and communities in each BUL. The coordinating wildlife biologists closely interact with the different conservation agencies and organizations that function within the BUL. This close coordination increases communication and ensures conservation programs are leveraged to maximize conservation resources to areas in the landscape that have the greatest potential to benefit the priorities. As the biologist and partners began the process of focusing their efforts in the Central Loess Hills BUL it became apparent that there were data gaps and key uncertainties that prevented implementation of focused and targeted conservation activities in areas with the greatest potential to benefit the priority species.

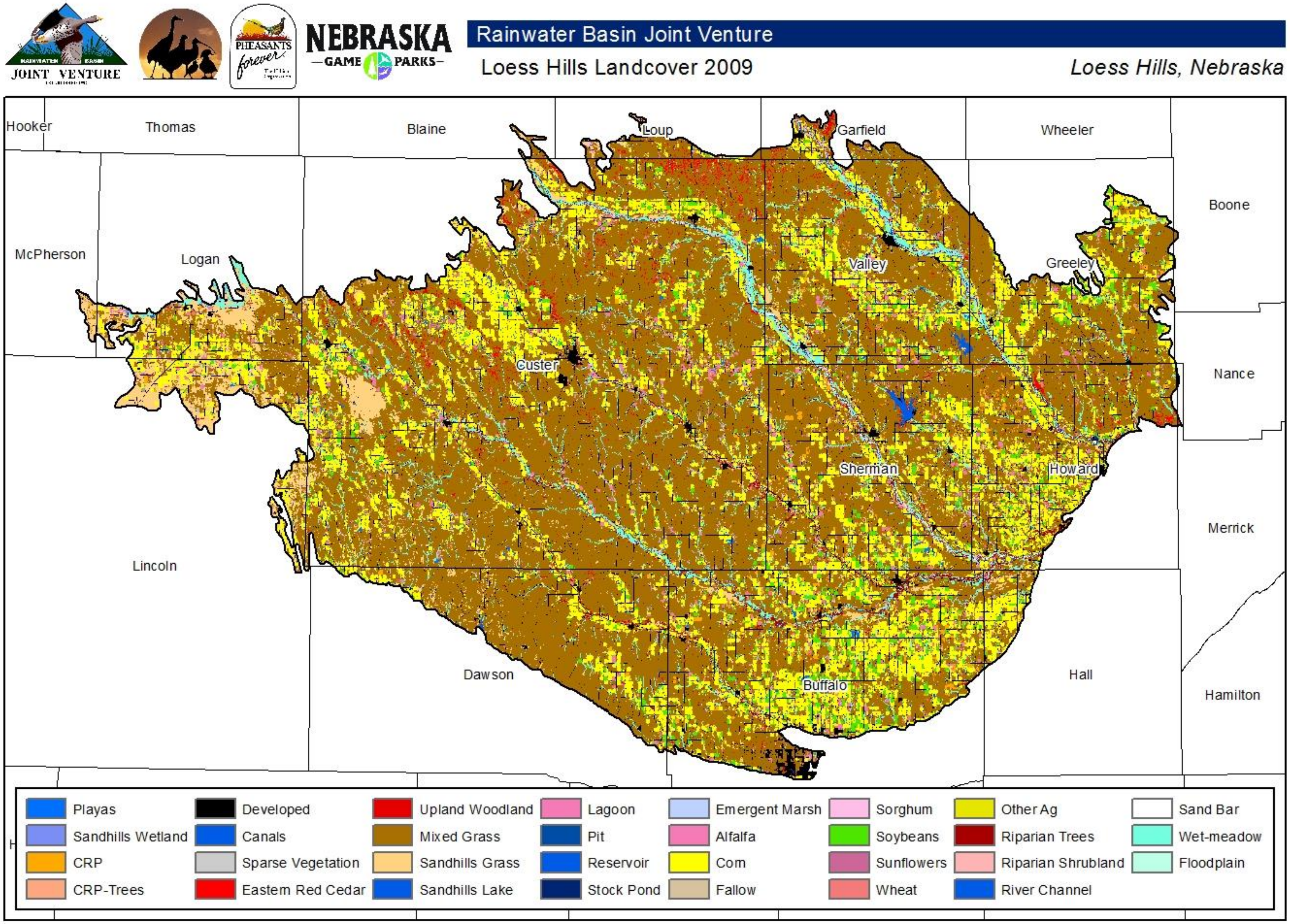
Working with the conservation partnership in the Central Loess Hills BUL, this project was designed to develop the necessary baseline data and species habitat models needed to guide targeted conservation. Development of a conservation portfolio for the Central Loess Hills required five separate but equally important elements. The elements of this project were: 1) Develop a spatially accurate landcover that delineates key habitats to which at-risk species respond, 2) Analyze landcover to develop meaningful landscape indices that can be used to develop spatially explicit species habitat models, 3) Collect and compile occurrence data for priority species (greater prairie-chicken, whooping crane, and waterfowl), 4) develop conceptual and empirical models that describe species habitat relationships and priority areas and habitat features on the landscape that should be targets for future conservation activities, 5) Establish population targets that can be translated to habitat objectives necessary to support priority species at target levels.

Landcover Development

Strategic implementation of conservation requires landcover data that accurately represent the current conservation state, including explicit documentation of the biological communities that influence species-habitat relationships. Landcover mapping often is addressed at a national or state-wide scale, but evaluating conservation strategies and effectively targeting specific conservation actions requires accurate ecoregional data (Thogmartin 2004). Development of a comprehensive, seamless regional landcover for the assessment area required new habitat inventories, refinement of relevant existing data, and integration of existing datasets to refine the landscape representation.

In 2010, the Rainwater Basin Joint Venture (RWBJV) began an initial mapping process for the CLHR with the goal of creating a baseline habitat inventory, by incorporating the most current datasets available (e.g., National Land Cover dataset; NLCD, GAP) (Playa Lakes Joint Venture 2004). We adopted the Hierarchical All-Bird Strategy (HABS) landcover classification system developed by Playa Lakes Joint Venture (PLJV) for this landcover classification, because it delineates habitats relevant to bird conservation. Peer review of the PLJV landcover (2004) by conservation professionals indicated that certain landscape features (e.g., tree canopies, wetland features) were frequently omitted, and dry-land cropping systems and grassland habitats were misclassified because of the scale at which data had been collected and classified. Indeed, such errors were manifested in the 2009 central loess hills landcover (Figure 1). Further steps were therefore needed in order to refine the PLJV landcover data to a finer scale, accurately represent the landscape and develop accurate species habitat models.

Figure 2. Original Central Loess Hills Region Landcover (Based on 2004 PLJV Landcover Protocol)



The refined 2010 landcover created for the CLHR significantly increased the spatial resolution and delineation of important habitats including trees, developed areas, and describe wetland features including wet-meadows and playa wetlands. Increased spatial resolution and accuracy is important since these habitat features have been identified as landscape factors influencing the distribution and abundance of priority species in the CLHR. The refined landcover was primarily based on the Farm Service Agency (FSA) Common Land Unit (CLU) dataset, originally created to administer FSA conservation programs and farming practices. The CLU is a vector dataset mapped to the field level, which is the level necessary for targeted conservation delivery; in addition, it provided a base geometry that could be used to refine landcover classes. The CLU was integrated with wetland features delineated in the National Wetlands Inventory (NWI) dataset and soil survey geographic dataset, and was further refined by photo interpretation. During this process technicians validated current features including: cropping activity, developed areas, riparian corridors and shelterbelts, and changes in playa wetland function through photo-interpretation. The photo-interpreted refinement was based on 2010 one-meter spatial resolution National Agriculture Imagery Program (NAIP) color imagery viewed at a 1:5,000 scale. Following photo-interpretation, the data was integrated into a seamless landcover following the methods described in Bishop et al. 2009 (Figure 3). The final landcover provides a substantially different, and more accurate, interpretation of the landscape compared to the initial 2009 product (Table 1).

It should be clearly pointed out that the refined landcover inventory does not represent landcover change from 2009 to 2010, but rather indicates how a finite mapping procedure more accurately delineates and refines habitat features across the CLHR. This dataset highlights that there is significantly less grassland and wet-meadow habitat than previously thought. The dataset also highlights a 33% reduction in original playas that were believed to occur in this region. Surprisingly, agriculture acres also decreased as part of this inventory; it is believed that a majority of these agriculture acres were reclassified as farmed playas and rural developed or farmstead infrastructure associated with agriculture operations. The eastern red cedar habitat class experienced the greatest increase as part of the refined inventory. This would be expected, as small patches of eastern red cedar are often difficult to delineate using traditional remote sensing methods and 30-meter resolution data.

Figure 3. 2010 Refined Central Loess Hills Landcover (Based on 2009 Landcover Methods)

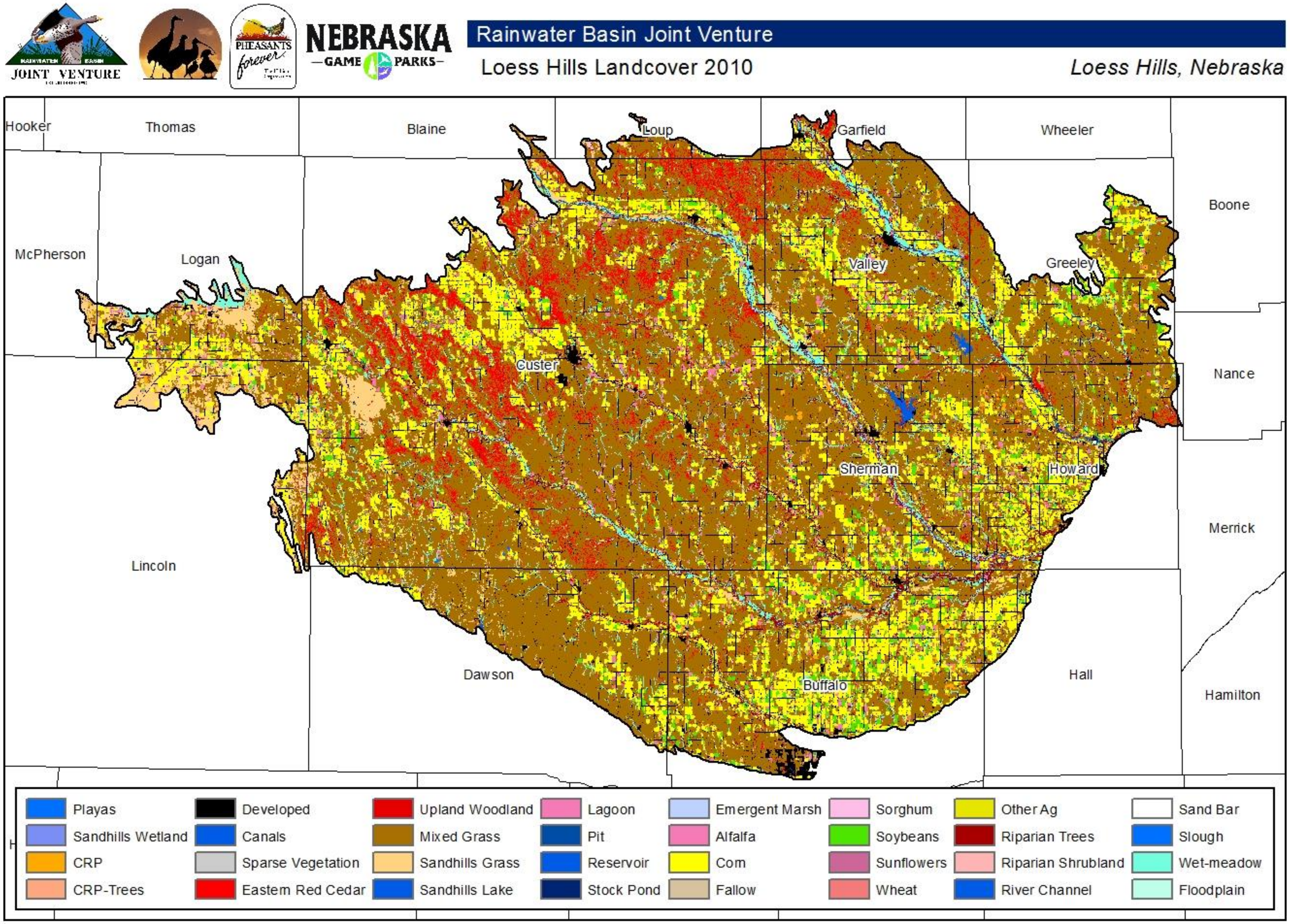


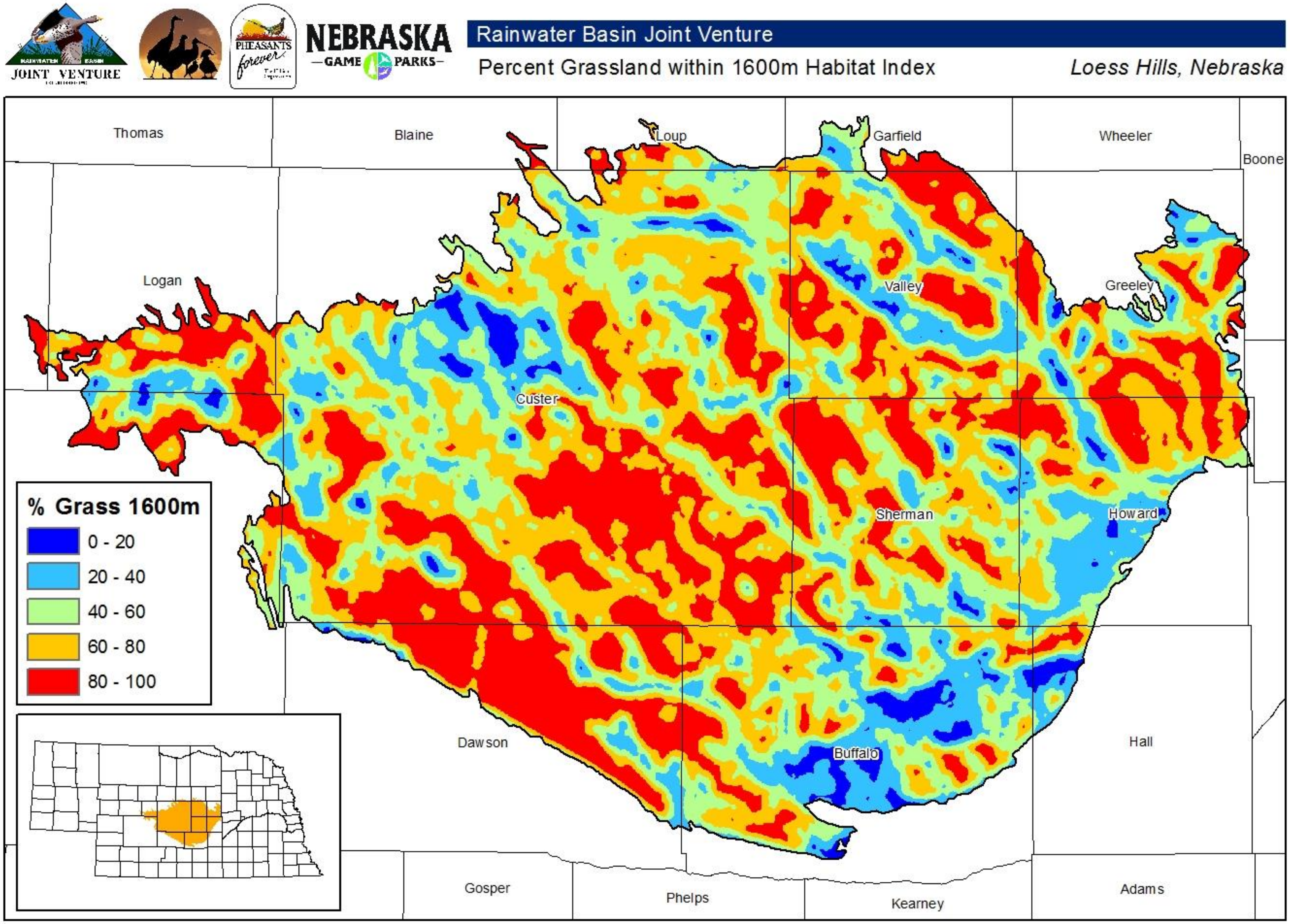
Table 1. Landcover Comparison: PLJV and 2010 Landscape Assessments

Condition	Value	Count	PLJV Acres	Acres 2010	Difference
CRP-grass	31	111724	25,075	24,847	-229
CRP-trees-upland	32	3587	817	798	-19
CRP-trees-riparian	33	938	225	209	-16
CRP-wetland	34	1128	252	251	-1
CRP other practices	36	297	66	66	0
CRP	39	9393	2,100	2,089	-11
CRP Total			**28,535**	**28,259**	-277
Other roads	41	425965	94,732	94,732	0
Rural developed	42	162731	30,194	36,190	5,997
4-lane roads	44	10381	2,309	2,309	0
Urban/suburban	46	80094	17,377	17,812	436
Canals	48	2865	632	637	5
Developed Total			**145,243**	**151,681**	**6,437**
Badlands/cliffs/outcrops	**51**	**503**	**128**	**112**	**-16**
Grassland-mixed grass	71	9032094	2,151,344	2,008,683	-142,661
Grassland-sandhills grassland	73	576303	127,784	128,166	382
Grassland Total			**2,279,129**	**2,136,849**	**-142,279**
Freshwater lake	101	382	94	85	-9
Lagoon	102	1925	87	428	341
Pit	103	7528	1,710	1,674	-36
Reservoir	104	22582	5,100	5,022	-77
Stock pond	106	61700	10,733	13,722	2,989
Lakes Total			**17,724**	**20,931**	**3,207**
Playas*			18,483	0	-6,536
Playa-farmed**	121	39681	0	8,825	N/A
Playa-grass**	122	14040	0	3,122	N/A
Emergent marsh	152	232	63	52	-11
Sandhills Wetlands	13	976	834	217	-617
Warmwater slough	246	1282	0	285	285
Floodplain marsh	248	1409	234	313	80
Wetlands Total			**19,614**	**12,814**	**-6,800**
Wet meadow	**247**	**557034**	**137,060**	**123,881**	**-13,179**
general ag			8,986	0	-8,986
Alfalfa	201	356603	82,547	79,306	-3,241
Corn	202	2853965	639,208	634,705	-4,503
Fallow	203	16749	3,864	3,725	-139
Sorghum	206	41924	9,745	9,324	-421
Soybeans	207	470475	105,297	104,631	-666
Sunflowers	208	160	36	36	0
Wheat	209	95404	21,666	21,217	-448
Cropland-other	211	4583	1,077	1,019	-58
Cropland Total			**872,425**	**853,962**	**-18,462**
Eastern red cedar	59	744830	26,124	165,646	139,522
Forest/woodland upland	61	188987	29,470	42,030	12,559
Riparian canopy	241	194184	19,903	43,185	23,282
Woodland Total			**75,497**	**250,861**	**175,364**
Riparian shrubland-exotic	242	31	7	7	0
Riparian shrubland-native	243	15214	7,573	3,384	-4,190
River channel	244	44190	7,075	9,828	2,753
Unvegetated sandbar	245	8686	4,501	1,932	-2,570
Riparian Total			**19,156**	**15,150**	**-4,006**
			3,594,511	**3,594,514**	

Habitat Indices:

Landcover data are critical to understand the state of broad landscapes, but such data must be post-processed to be effectively used in species habitat modeling. To understand landscape scale and habitat features that affect distribution of priority species in the CLHR, we created habitat indexes at several spatial scales (800 meters, 1 km, 1600 meters, and 2 km). These indices were calculated using a circular moving-window analysis in Earth Resources Data Analysis System-Imagine (ERDAS 1999). The output from a habitat index is a digital dataset that describes either the percent or number of habitat features at explicit spatial scales. Some examples include percent grassland within a1600 meter radius (Figure 4) or the number of wetlands within a 1 km radius. Some of the landscape features evaluated were: grassland, wet meadow, Conservation Reserve Program (CRP), cropland, woodland, wetland, developed areas, and roads. In total, fifty habitat indices were calculated at each of the four spatial scales. This process effectively translated the spatially accurate landcover into meaningful datasets that can be used to model species habitat relationships and ultimately target conservation to benefit priority species.

Figure 4. 1600 Meter Grassland Habitat Index



Species Occurrence Data

Rigorous statistical analysis provides a mechanism to confidently identify the landscape (spatial) scale and habitat elements that most significantly influence species distribution or relative probability of occurrence. Creating empirical models requires field data collection of species occurrence data. To develop robust logistic regression models, spatially balanced sampling that collects both positive and negative data associated with species occurrence is required. Once the field data are collected, the detailed landcover index data can be integrated to produce empirical models that predict the relative probability of occurrence across the project area. Empirical models provide the most robust and spatially accurate method to describe spatial scale, habitat selection, and the landscape features that influence probability of occurrence by priority species. These tools are useful for conservation planning and provide a high level of confidence to justify the expenditure of funds for delivering habitat projects for priority species.

To develop an empirical model for greater prairie-chicken, traditional roadside surveys were performed to identify and record greater prairie-chicken leks. Leks are spring gathering sites where males competitively display to attract potential mates. Males assemble daily at leks before and during the breeding season. In the Central Loess Hills, ten routes were developed and completed every year since 2009. Routes were run annually from March 15 through May 31. Surveys started 45 minutes before sunrise on days with calm winds (<10 mph) and low cloud cover. Along the routes, survey stops are made at approximately one-mile increments. The surveyor spends two minutes at each stop, listening and scanning for displaying males, and records the presence or absence of leks at each location. If a lek is heard or spotted, its position is triangulated and plotted on hard-copy maps, or the lek's Global Position System (GPS) coordinates are recorded. For each year all routes, as well as positive and negative locations, were converted into a GIS database for analysis (Figure 5).

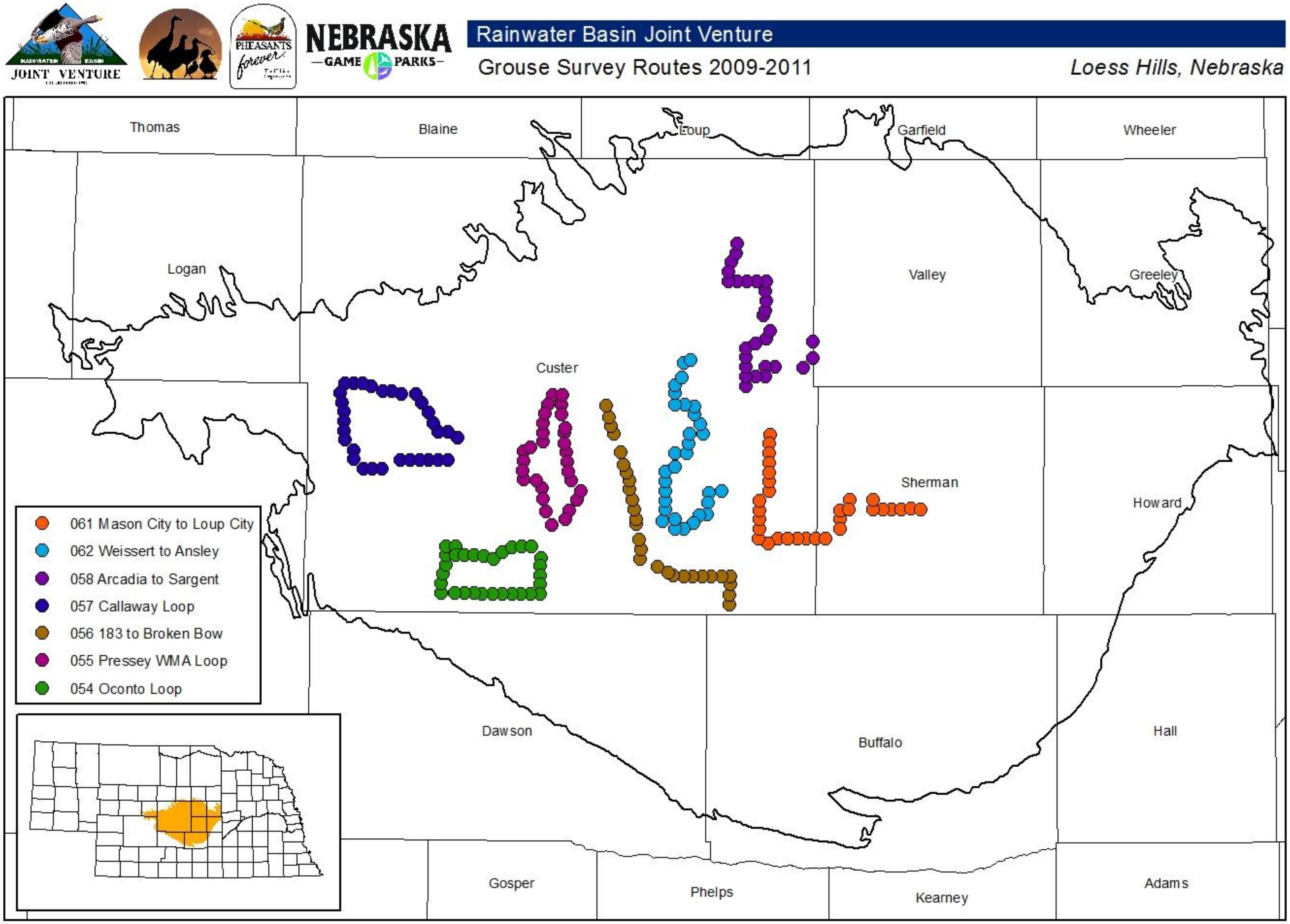
Emperical Model Development for Greater Prairie-Chicken

To complete the statistical analysis, all positive and negative points were attributed with information from the multi-scale habitat indices (i.e. percent grassland at spatial scale X, percent trees at spatial scale X, etc). Analysis was conducted on an annual basis, thereby creating models for 2009, 2010, and 2011. Number Cruncher Statistical System (Hintze 2004) was used to conduct the logistic regression analysis and produce the predicted probability of lek occurrence; and Akaike's Information Criterion was used to select the model inputs that most influenced relative probability of occurrence.

Table 2. Number of parameters (K), Akaike's Information Criterion (AIC_c), and ΔAIC_c used to rank model containing factors hypothesized to predict greater prairie-chicken abundance in the Loess Hills, Nebraska, 2009-2010. Models with smaller AIC_c and larger ROC have more support.

Year	Scale	Inputs	K	AICc	ΔAICc	ROC
2009	1600m	grass, dvlp, wdlnd	3	309.0565		0.7396
2010	1600m	grass, dvlp, wdlnd	3	239.9832	-69.0733	0.7962
2011	1600m	crop, grass, dvlp, wdlnd	4	245.4106	5.4274	0.7900

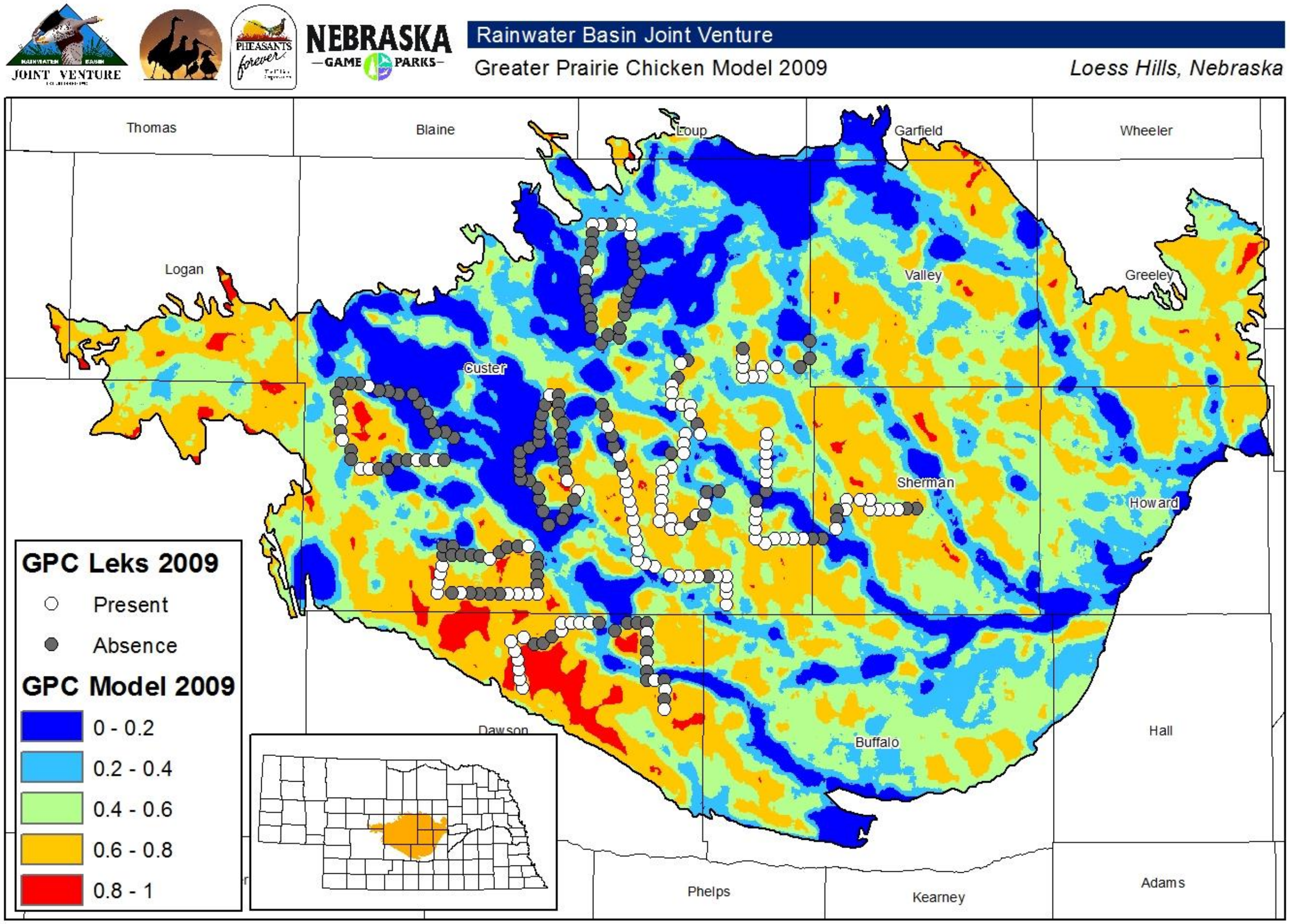
Figure 5. Lek Routes Completed in the Central Loess Hills Assessment Area



In all years, probability of occurrence was best predicted at the 1600 meter scale. In 2009, percent grassland was positively associated with probability of lek occurrence, while percent woodland, and percent developed were both negatively associated with lek occurrence (Figure 6). The 2009 model was the poorest performing model with a Receiver Operator Coefficient (ROC) of 0.739.

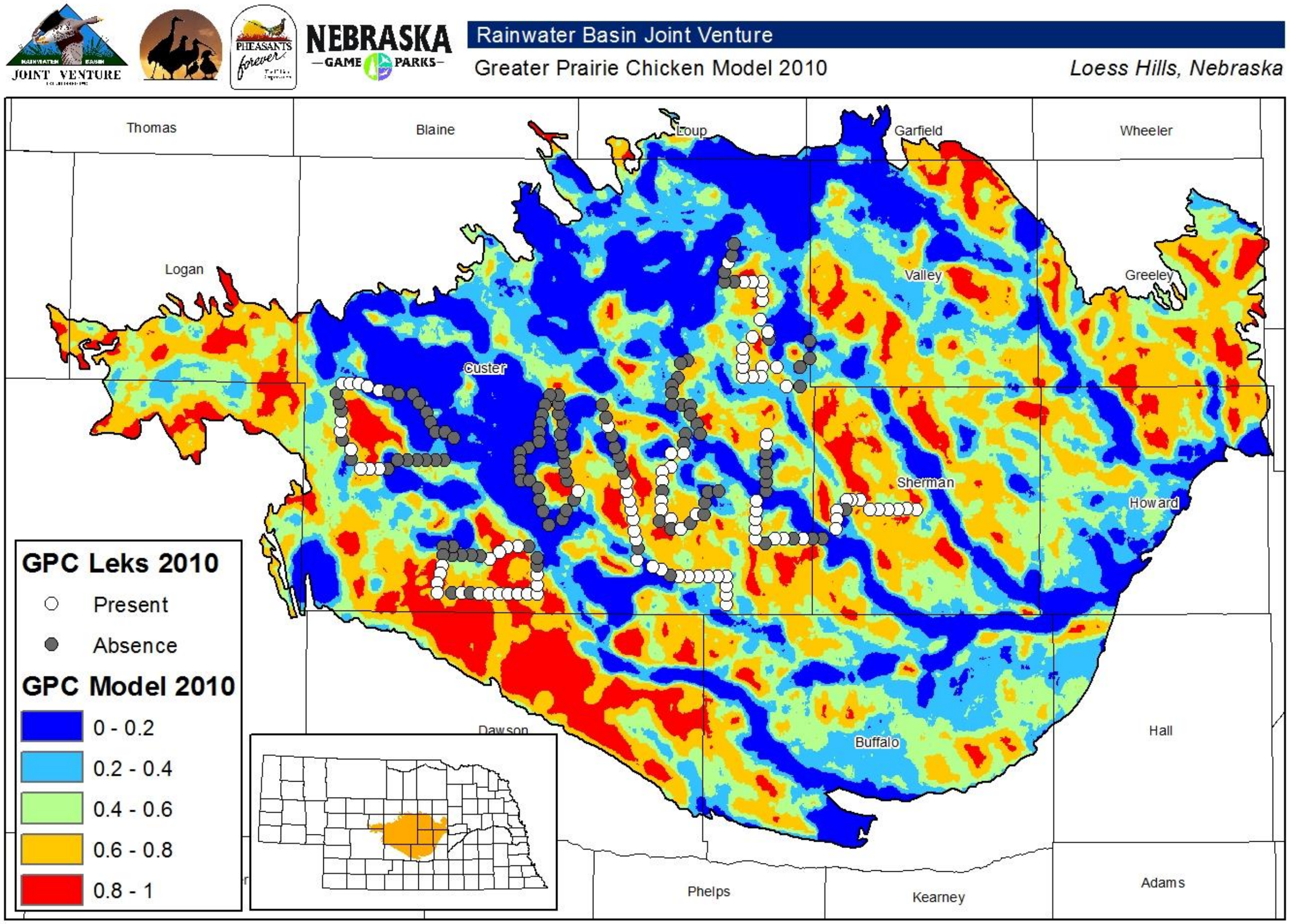
Figure 6. 2009 Probability of occurrence for greater prairie-chicken in the Central Loess Hills

2009 Probability of GPC lek occurrence = Exp (-.21751 + (- .09866*pdevlp1600) + (.01761*pgrass1600) + (-.13800*pwdlnd1600))/(1+ Exp (-.21751 + (- .09866*pdevlp1600) + (.01761*pgrass1600) + (-.13800*pwdlnd1600)))



In 2010, percent grassland was again positively associated with probability of lek occurrence, while percent woodland and percent developed were both negatively associated with lek occurrence (Figure 7). The 2010 model was the best performing model for all three years, with an ROC of 0.796.

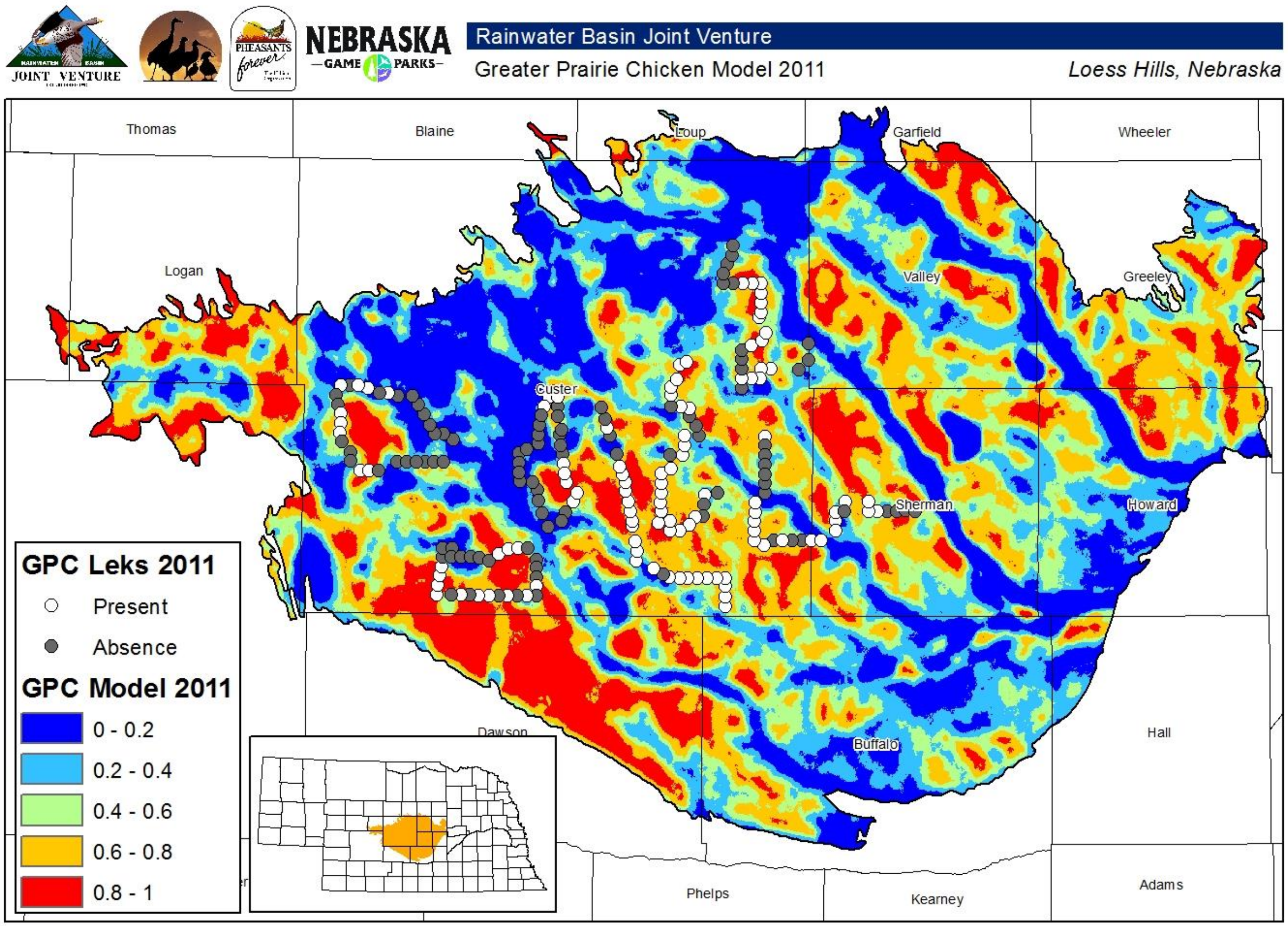
Figure 7. 2010 Probability of occurrence for greater prairie-chicken in the Central Loess hills Region
2010 Probability of GPC lek occurrence = Exp (-.51535 + (-.12120*pdevlp1600) + (.02574*pgrass1600) + (-.19071*pwdlnd1600))/(1+ Exp (-.51535 + (-.12120*pdevlp1600) + (.02574*pgrass1600) + (-.19071*pwdlnd1600)))



In 2011, percent grassland was again positively associated with probability of lek occurrence, while percent woodland, percent developed, and percent cropland were all negatively associated with lek occurrence (Figure 8). The 2011 model also performed well, with an ROC of 0.790.

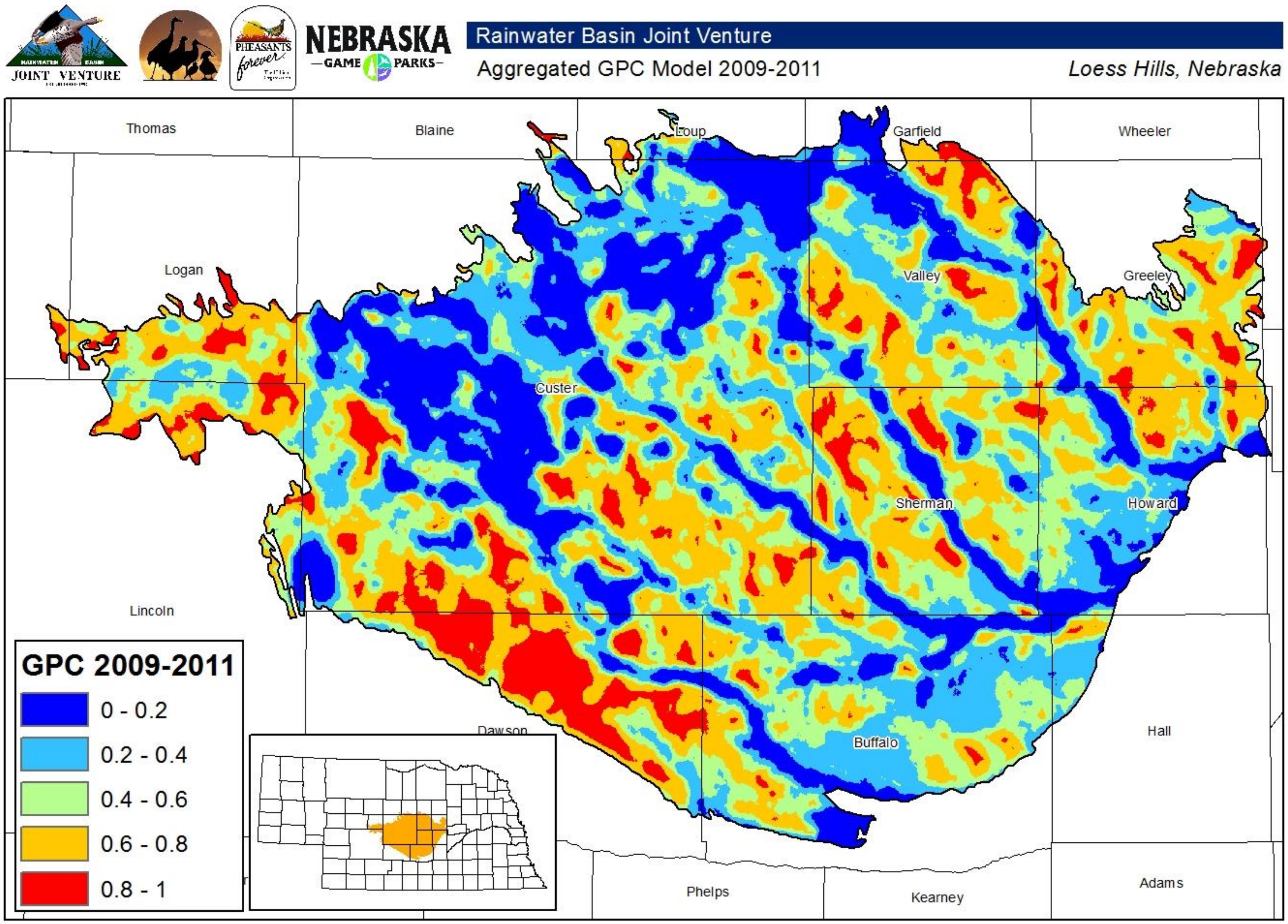
Figure 8. 2011 Probability of occurrence of greater prairie-chicken in the Central Loess Hills region

2011 Probability of GPC lek occurrence = Exp (-22.06065 + (.20599*pcrop1600) + (.14830*pdevlp1600) + (.24832*pgrass1600) + (.09787*pwdlnd1600))/(1+ Exp (-22.06065 + (.20599*pcrop1600) + (.14830*pdevlp1600) + (.24832*pgrass1600) + (.09787*pwdlnd1600)))



Once the individual year models were completed, an aggregate model was produced by averaging the relative probability of occurrence from each model to produce a product that represented the average probability of occurrence over three years (Figure 9). The aggregate model represents the final product used to guide conservation delivery for this priority species.

Figure 9. Aggregate Probability of Occurrence of GPC Leks in the Central Loess Hills



Conceptual Model Development for Whooping Cranes and Waterfowl

Whooping Cranes

Multiple coarse-scale landscape analyses have documented whooping crane selection of wetland complexes rather than isolated wetlands (USFWS 2007, Austin and Richert 2001). To target wetland restoration and enhancement in the Central Table Playa Wetland Complex associated with the CLHR at the site scale, a conceptual model was developed for the CLHR. The conceptual model was built by using an additive modeling approach in which different habitat values were scored based on professional opinion and other existing models within published literature detailing whooping crane life history. Conceptual models provide a method to integrate both spatial and biological data to develop a more comprehensive understanding of habitat distribution and areas that have a high probability to support priority species. For this model a combination of datasets were analyzed to develop secondary products that describe habitat relationships and potential suitability.

During development of the refined 2010 CLHR landcover, a contemporary wetland dataset was generated which serves as the primary habitat feature for this model. Contemporary playa distribution described in this dataset was defined through a combination of National Wetland Inventory (NWI), SSURGO soil data, and photo-interpretation. During processing, wetland function was evaluated based on the condition in 2009. "Functional wetland" is described as the spatial extent of wetland area that ponds water or grows hydrophytic vegetation. In this manner, historic wetlands present in soil data and NWI that have been drained or altered were filtered by their current functional extent.

Restoration priorities were determined based on five equally weighted factors: wetland size, number of wetlands within 5 km, wetland area within 5 km, proximity to roads, and location within the whooping crane migration corridor. Site-specific habitat variables were determined for each wetland footprint. These results are used to evaluate the effect of anthropogenic disturbances and wetland distribution on habitat selection by whooping cranes.

The pre-processing of the GIS data created the foundational datasets used to calculate the restoration potential for wetlands that demonstrate function. As described, GIS data were processed to assess site and landscape habitat features. This model can be used to prioritize future restoration activities based on the wetland's potential to provide quality habitat. In essence, the model provides an index to understand the potential restoration benefit.

Whooping Crane Model Development

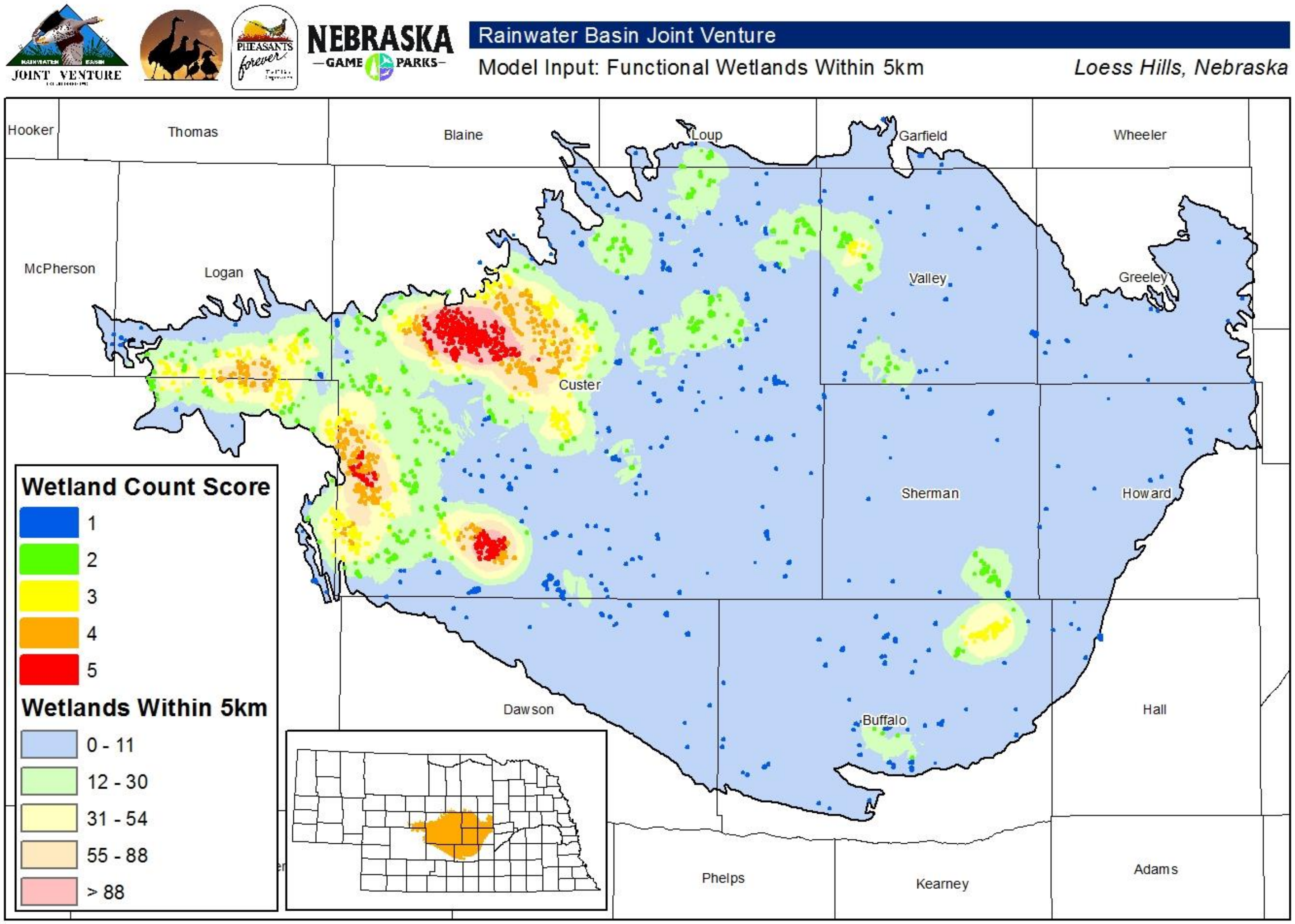
Biologists hypothesize that whooping crane selection of a particular wetland is influenced both by the landscape features within a 5 km radius and by site-specific features. Therefore, this conceptual model includes parameters related to both the landscape and site-scale variables.

Factors 1 & 2 – Functional Wetland Number and Area within 5 km

The first steps in the modeling process were to characterize the landscape by developing wetland indices. Two measures were evaluated: 1) the number of functioning wetlands larger than 1 acre within a 5 km radius, and 2) the total number of functioning wetland acres within the 5 km radius. Both assessments were completed using a moving window analysis in the Earth Resources Data Analysis System (ERDAS) software package.

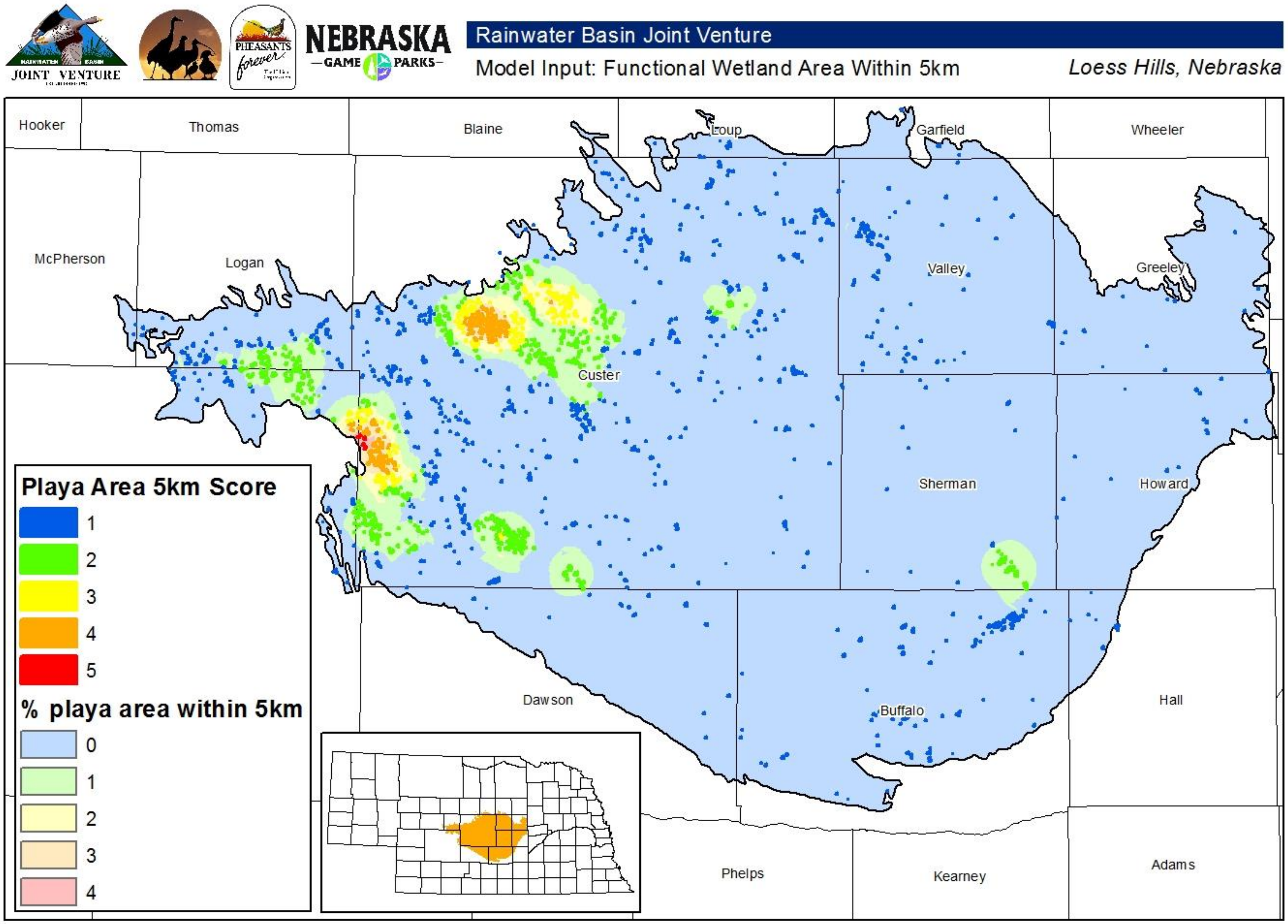
Functional wetland footprints were sorted by the number of wetlands within a 5 km radius and divided into equal classes ranging from 1-5 (Figure 10). The classes were assigned as follows: (1) wetlands with 1-11 adjacent wetlands, (2) wetlands with 12-30 adjacent wetlands, (3) wetlands with 31-54 adjacent wetlands, (4) wetlands with 55-88 adjacent wetlands, (5) wetlands with more than 88 adjacent wetlands within a 5 km radius.

Figure 10. Whooping Crane Model Input Factor 1 – Functional Wetlands within 5km



When the wetland area within 5 km was calculated using moving window analysis, the values were divided by the total area of functional wetland within 5 km. Since wetlands occupy a relatively small amount of the total landscape values ranged from 0 to 4% and were assigned scores ranging from 1 to 5 by adding one to the raw percentage value (Figure 11).

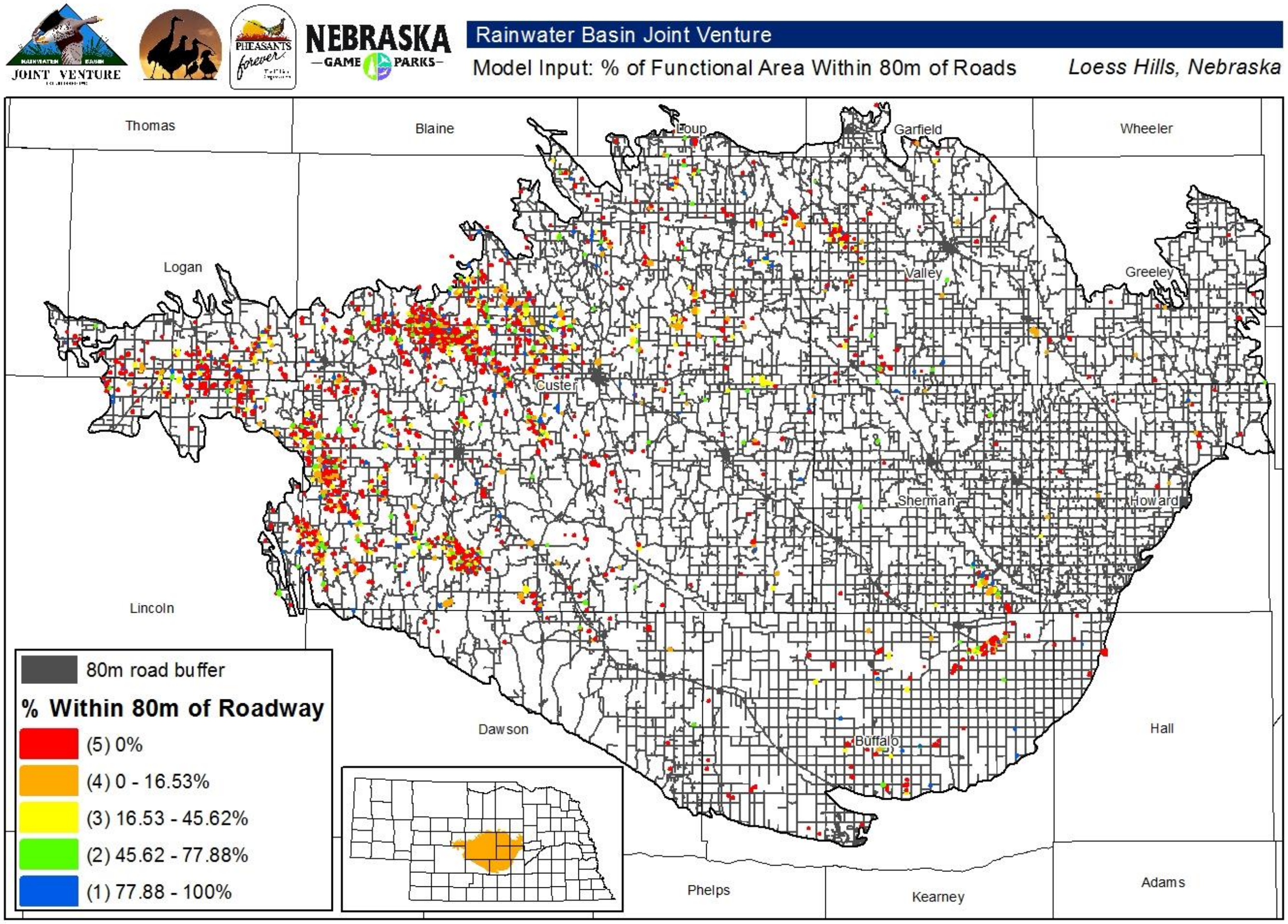
Figure 11. Whooping Crane Model Input Factor 2 – Functional Wetlands Area Within 5km



Factors 3 & 4 – Proximity to Roads & Functional Area

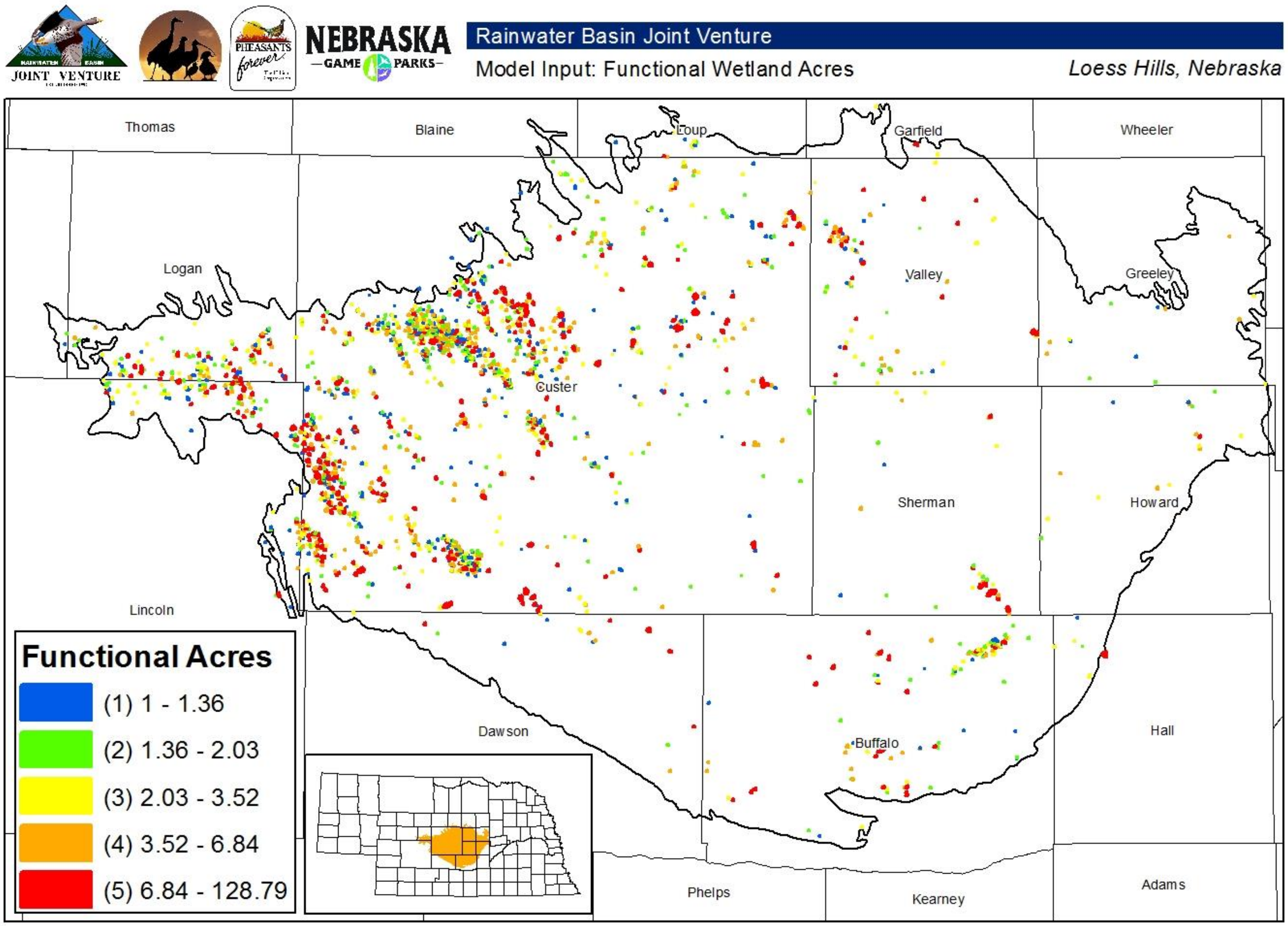
Site-level analysis was completed for each footprint to assess disturbance. Roadways are a conspicuous feature on the landscape and often bisect playas and limit usable habitat regardless of function. To evaluate road disturbance, the percent of functional playa area within 80 m of road centerlines was calculated for each wetland (Figure 12). Eighty meters was used as the analysis unit based on the results presented in Austin and Richert 2001. Again, the results were divided equally into five classes and scored 1-5: (1) 100-77.8% functional area within 80m, (2) 77.8-45.62% functional area within 80m, (3) 45.62-16.53% functional area within 80m, (4) 16.53-0% functional area within 80m, (5) 0% functional area within 80m.

Figure 12. Whooping Crane Model Input Factor 3 – Percent of Functional Area within 80m of Roads



The next site-level assessment evaluates the functional area of the individual wetlands (Figure 13). All wetlands were divided equally into 5 classes using the following values: (1) 1- 1.36 acres, (2) 1.36-2.03 acres, (3) 2.03-3.52 acres, (4) 3.52-6.84 acres, (5) functional wetland area greater than 6.84 acres. This criterion was developed because Whooping Crane use increased with wetland area (Austin and Richert 2001).

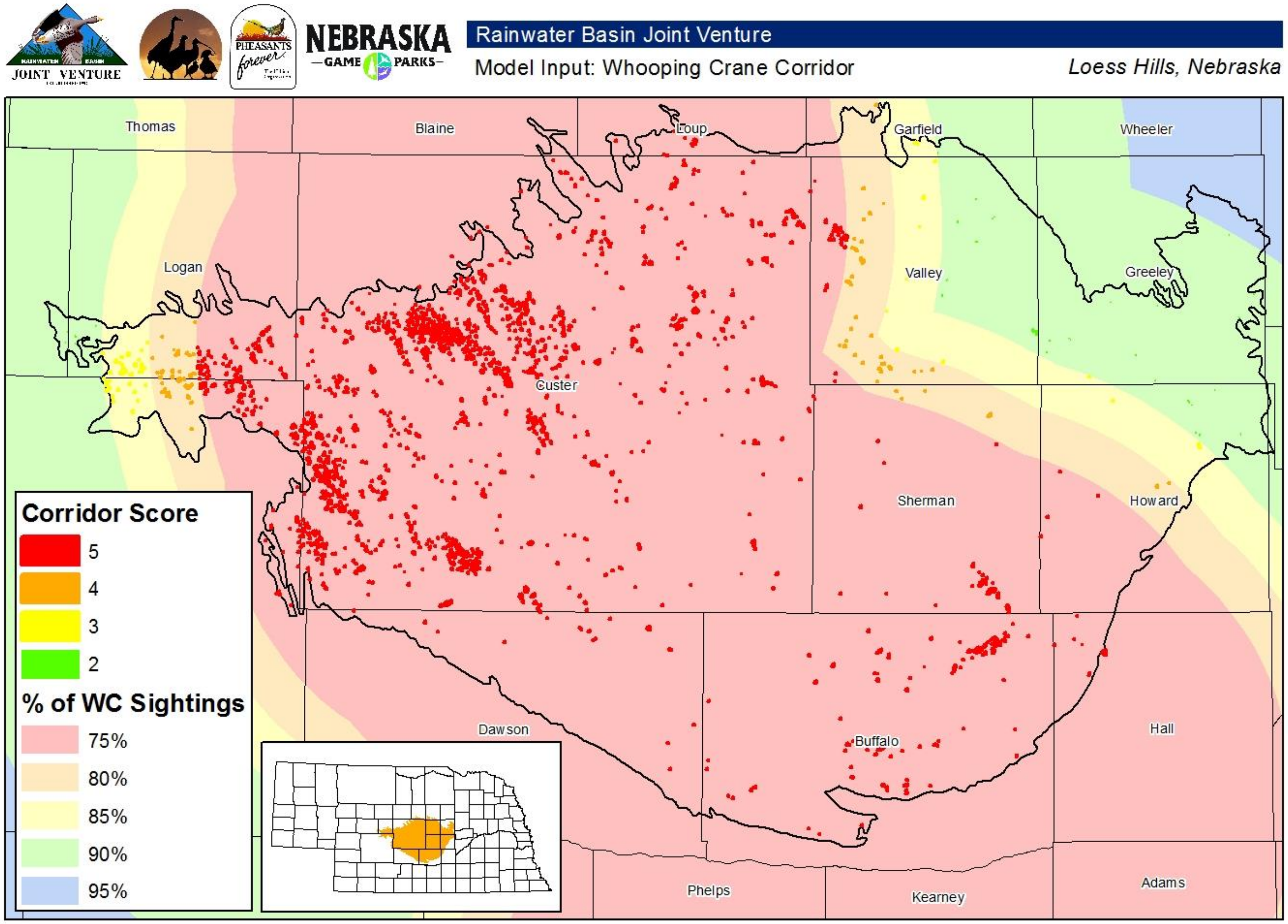
Figure 13. Whooping Crane Model Input Factor 4 – Functional Wetland Area



Factor 5

The corridor was created by calculating a migratory centerline of 431 confirmed whooping crane sightings in Nebraska from 1970 through spring of 2008. We further refined the estimated migratory corridor by calculating the distance from the centerline that represents 75-95 % of the total sightings (Tacha et. al. 2010) (Figure 14). Wetlands were assigned values 1-5 based on the zone in which they were located: (1) 95%, (2) 90%, (3) 85%, (4) 80%, (5) 75%.

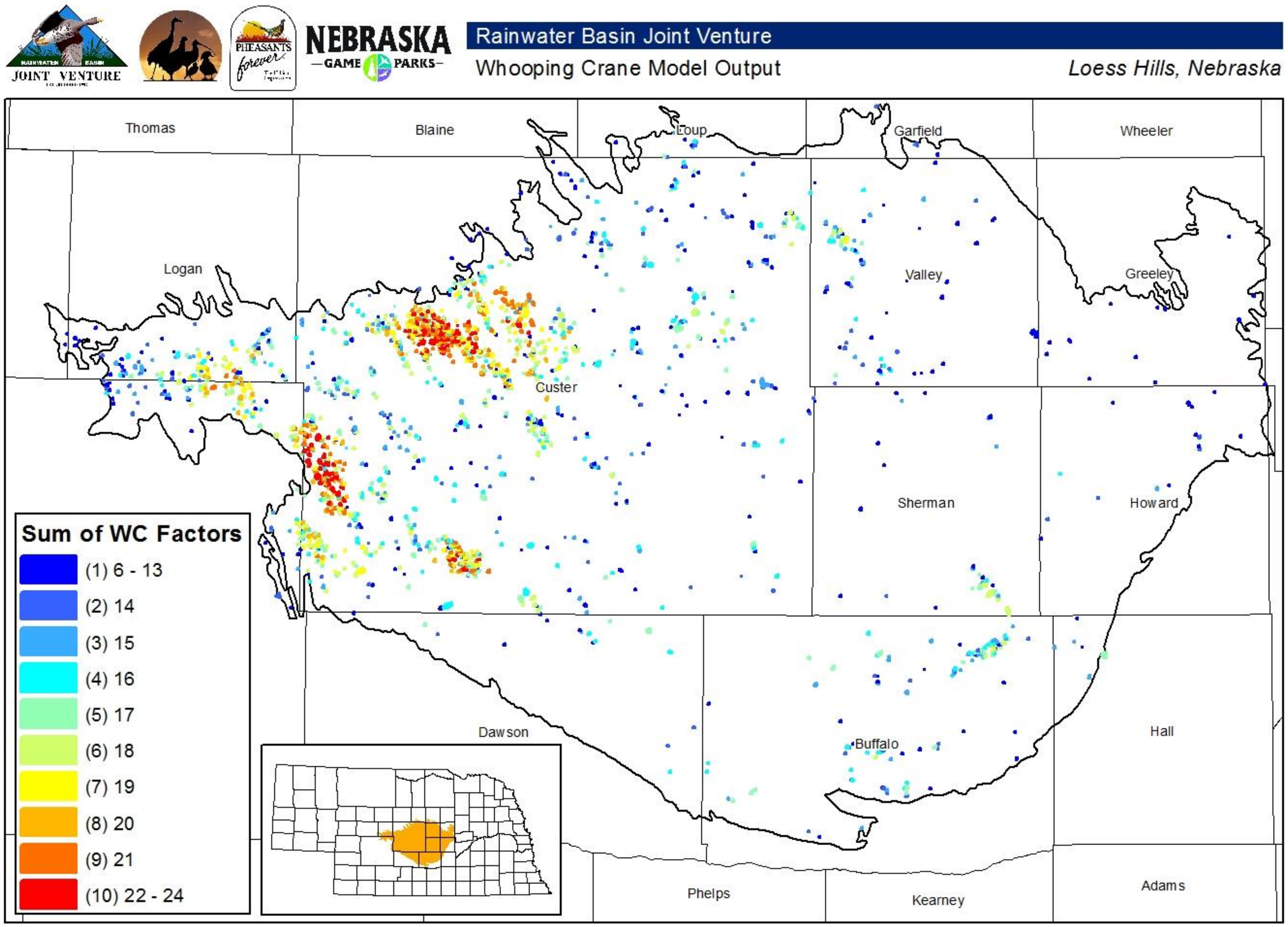
Figure 14. Whooping Crane Model Input Factor 5 – Location within Whooping Crane Migration Corridor



Whooping Crane Model Output

The final whooping crane model output is a summary of all model inputs with values ranging from 6 to 24 (Figure 15). The values of both the whooping crane index and waterfowl model are grouped into equal classes ranging from 1 to 10, so that whooping cranes and waterfowl have an equal input on the final restoration priority model.

Figure 15. Whooping Crane Model



Waterfowl Model Development

A combination of raster and vector-based spatial analysis was performed on the functional wetland footprint. As in the whooping crane model, the functional playa footprints identified during development of the 2010 loess hills landcover serve as the primary processing units to the waterfowl distribution model. The waterfowl model incorporates three inputs that were used in the whooping crane model: number of wetlands within the determined radius, functional wetland area within the determined radius, and functional footprint area. The exception is that the critical radius of the wetland indexes has been reduced from 5km to 4.3 km for the waterfowl model. The 4.3 km window size was selected based on the average distance of northern pintail (*Anas acuta*) roost to forage distance observed during radio-telemetry studies by Pearse et al. (2011).

<u>Waterfowl Factors 1 & 2 – Functional Wetland Number & Area within 4.3km</u>

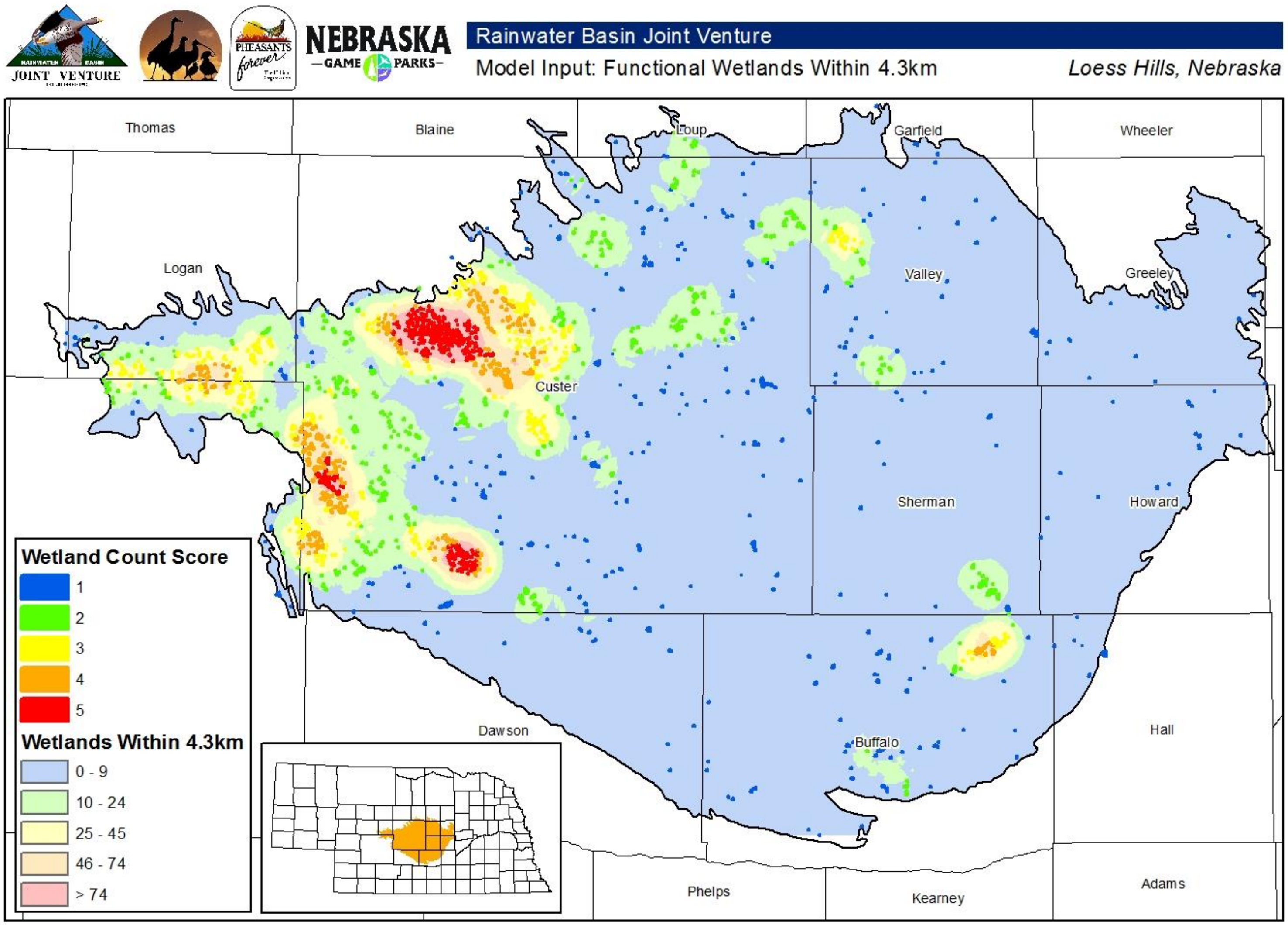
The first steps in the modeling process were to characterize the landscape by developing wetland indices. Two measures were evaluated: 1) the number of functioning wetlands larger than 1 acre within a 4.3 km radius, and 2) the total number of functioning wetland acres within the 4.3km radius. Both assessments were completed using a moving window analysis in the Earth Resources Data Analysis System (ERDAS) software package.

<u>Waterfowl Factors 3 – Functional Area</u>

The third waterfowl model input was previously used as the fourth input for the whooping crane model (Figure 13). The waterfowl model is likewise divided into the same 5 classes using the following values: (1) 1- 1.36 acres, (2) 1.36-2.03 acres, (3) 2.03-3.52 acres, (4) 3.52-6.84 acres, (5) functional wetland area greater than 6.84 acres.

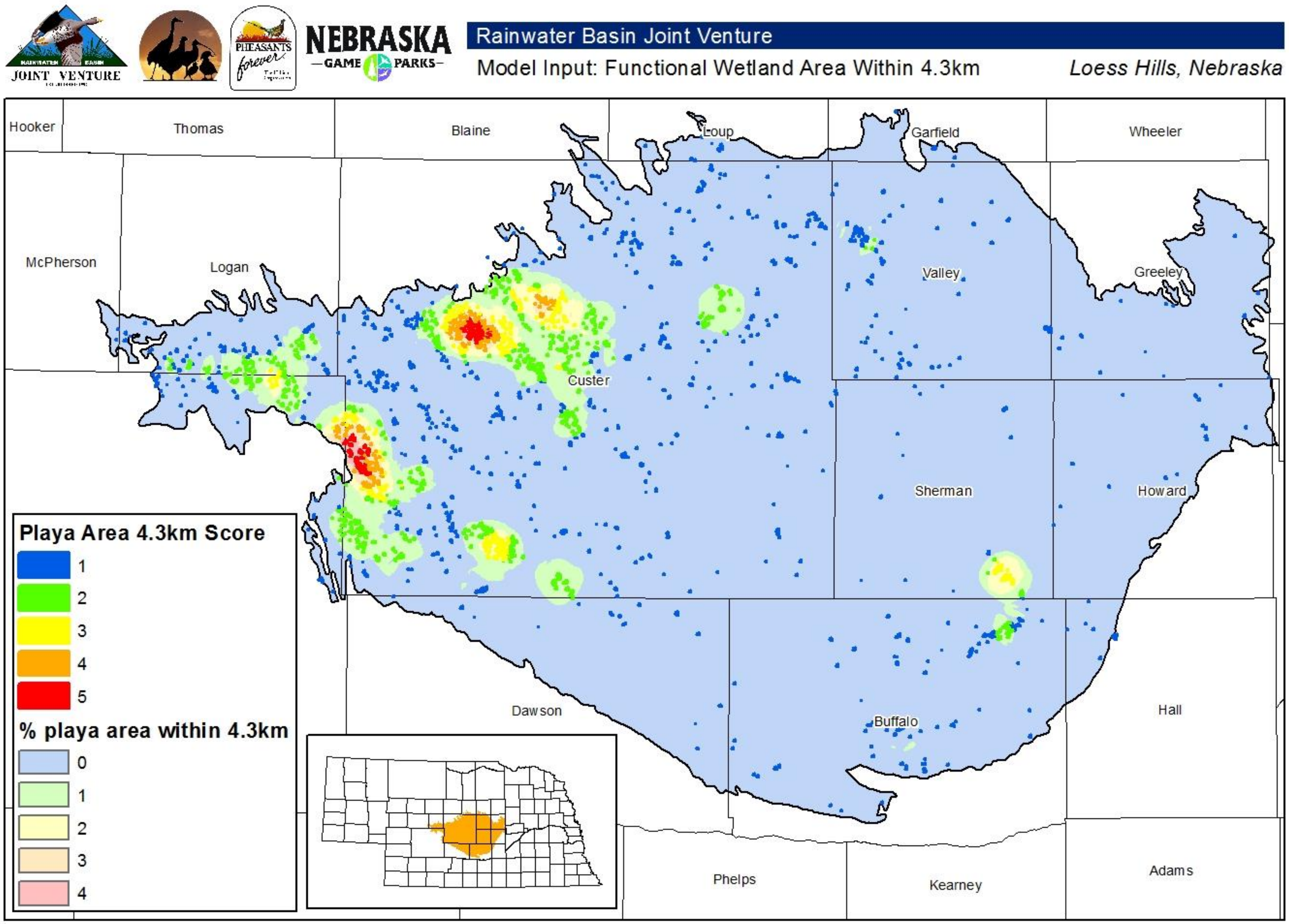
Functional wetland footprints were sorted by the number of wetlands within a 4.3 km radius and divided into equal classes ranging from 1 to 5 (Figure 16). The classes were assigned as follows: (1) wetlands with 1-9 adjacent wetlands, (2) wetlands with 10-24 adjacent wetlands, (3) wetlands with 25-45 adjacent wetlands, (4) wetlands with 46-74 adjacent wetlands, (5) wetlands with more than 74 adjacent wetlands.

Figure 16. Waterfowl Model Input Factor 1 – Functional Wetlands within 4.3km



When the wetland area within 5 km was calculated using moving window analysis, the values were divided by the total area within 5 km. Since wetlands occupy a relatively small amount of the total landscape, values ranged from 0 to 4% and were assigned scores ranging from 1 to 5 by adding one to the raw percentage value (Figure 17).

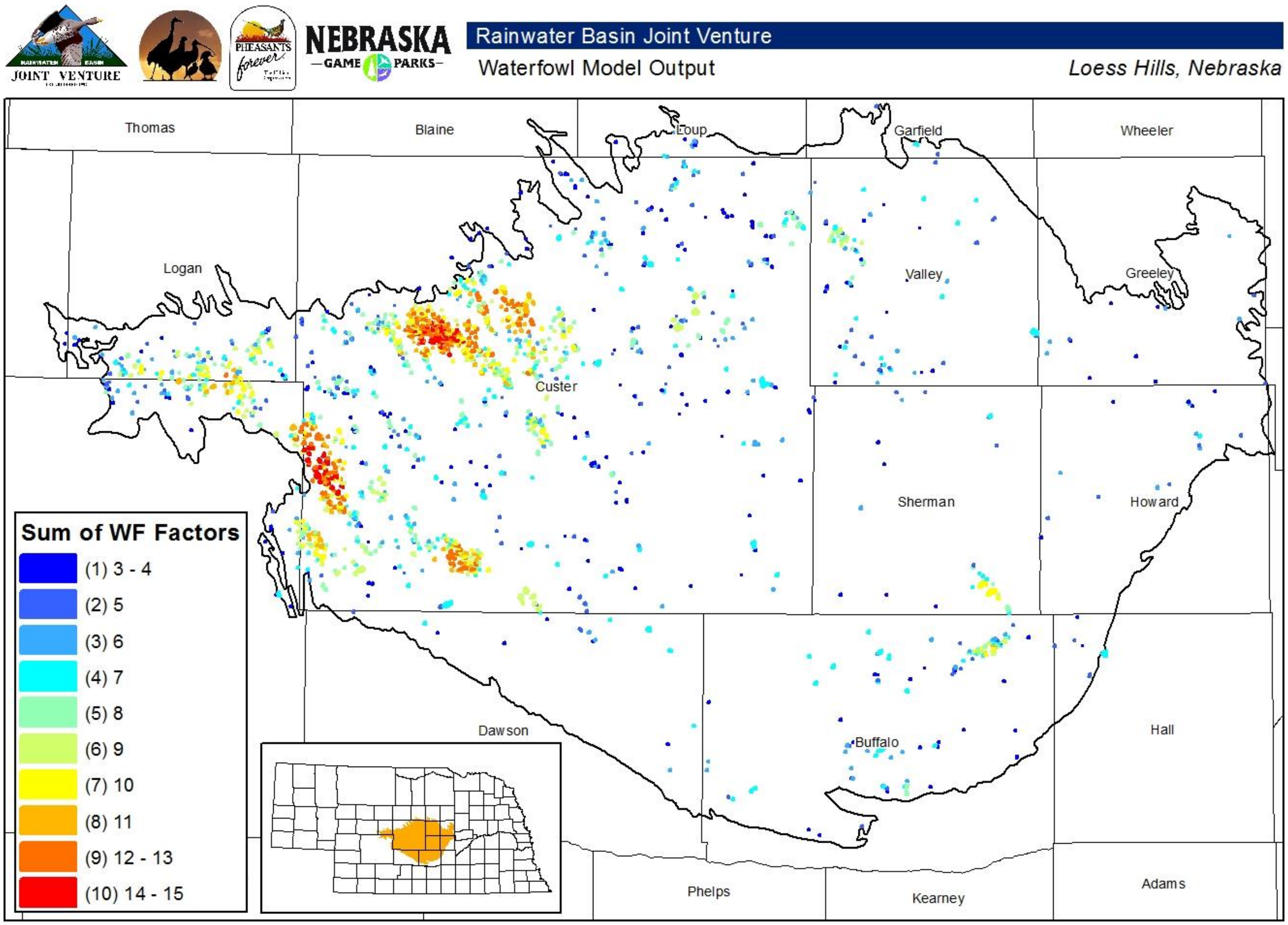
Figure 17. Waterfowl Input Factor 2 – Functional Wetlands Area within 4.3km



Waterfowl Model Output

The final waterfowl model summarizes the three inputs with values ranging from 6 to 24 (Figure 18). Again, the values of both the whooping crane index and waterfowl model were grouped into equal classes ranging from 1 to 10, so that whooping cranes and waterfowl have an equal input on the final restoration priority model.

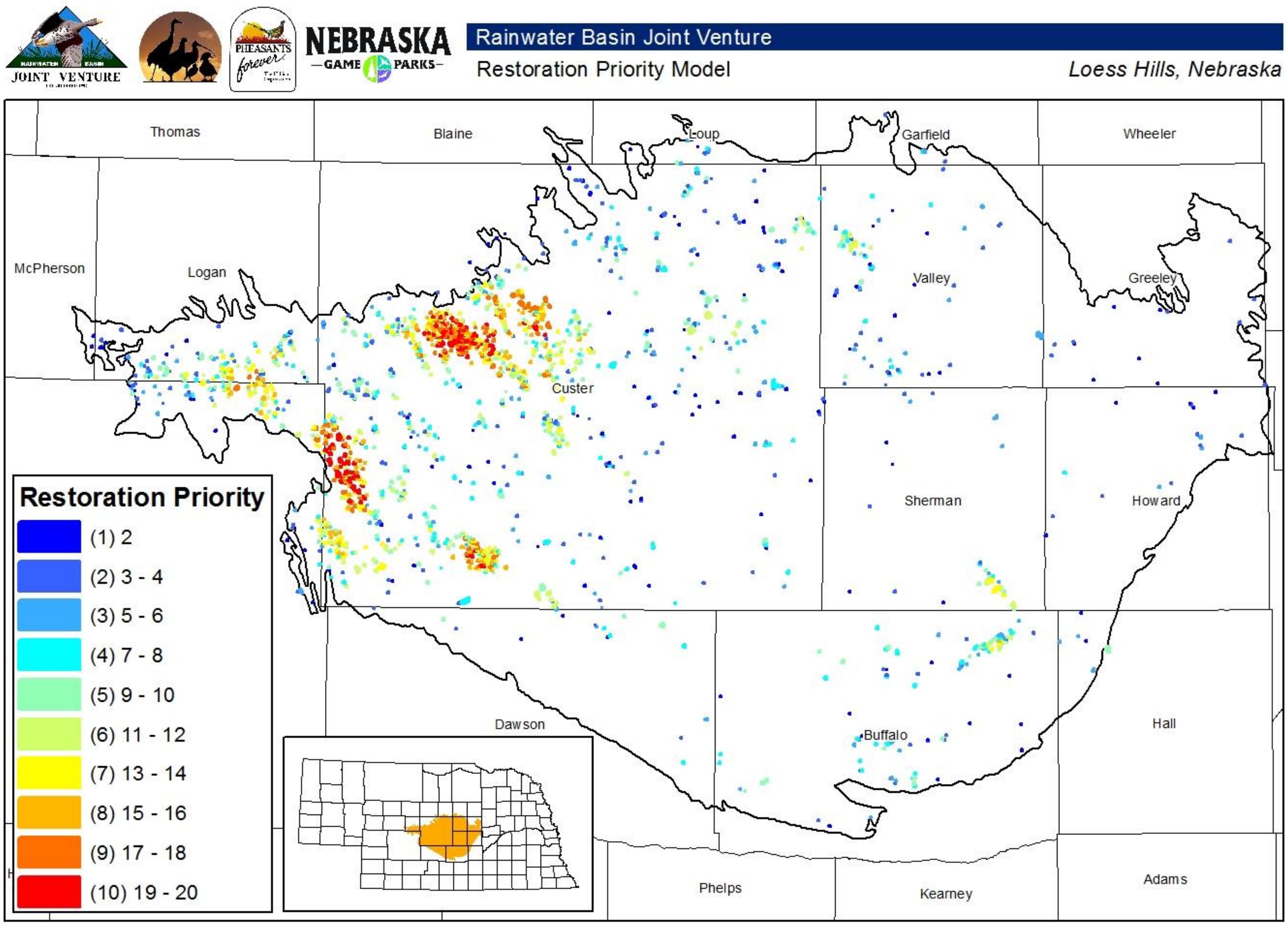
Figure 18. Waterfowl Model



Priority Model

The restoration priority model combines the whooping crane and waterfowl models into a final output where the sum values of both models are grouped into ten final classes (Figure 19).

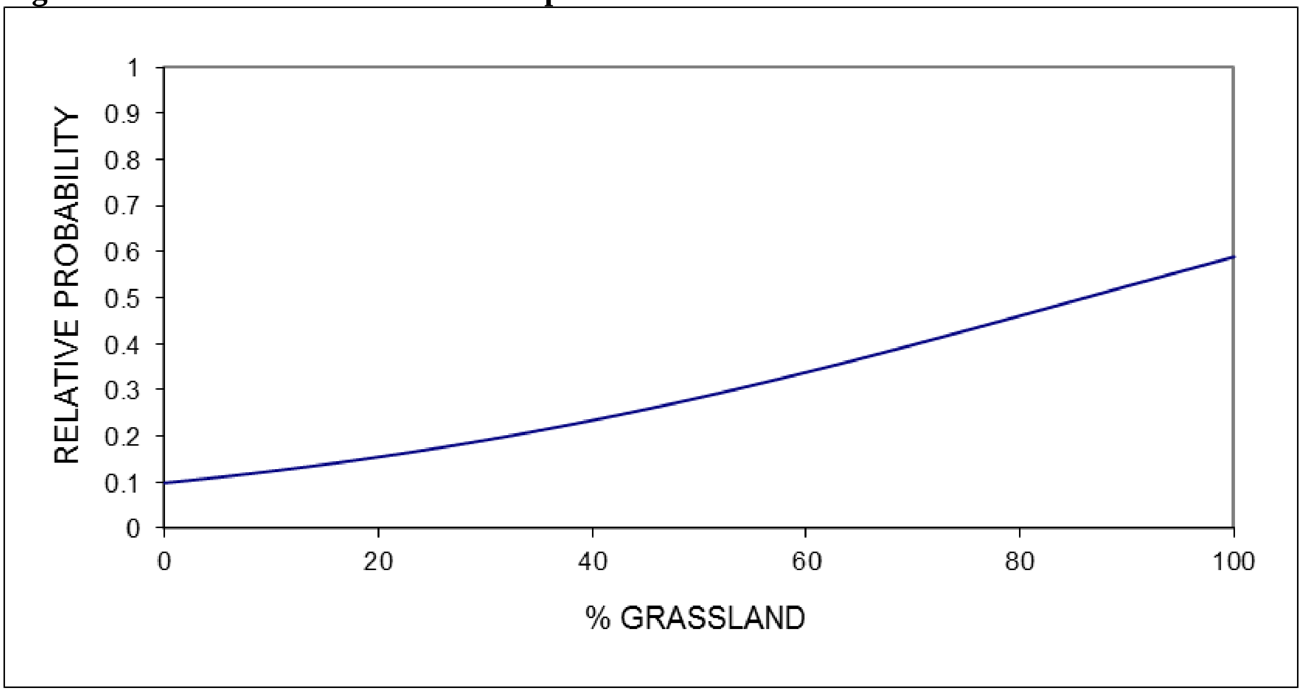
Figure 19. Wetland Restoration Priority Model



Strategic Habitat Delivery

To understand the response of GPC to an increase in grassland distribution and abundance across the landscape, the 2010 GPC model was further analyzed. This model was selected for analysis because it had the highest ROC values and lowest AIC of all the individual year models. In the 2010 model, grassland at 1,600 meters was positively associated with GPC lek occurrence, while percent woodland and developed lands at 1,600 meters negatively predicted GPC lek occurrence. To complete this analysis the CLHR landcover was analyzed to determine the average percent woodland and percent developed. These values were held constant in the 2010 GPC probability of occurrence equation while percent grassland was increased in five percent increments. As described in Figure 20, GPC lek occurrence responds positively as grassland cover increases across the landscape. The segment of the curve between 40% and 80% represents the highest response of GPC lek occurrence to increased grassland cover.

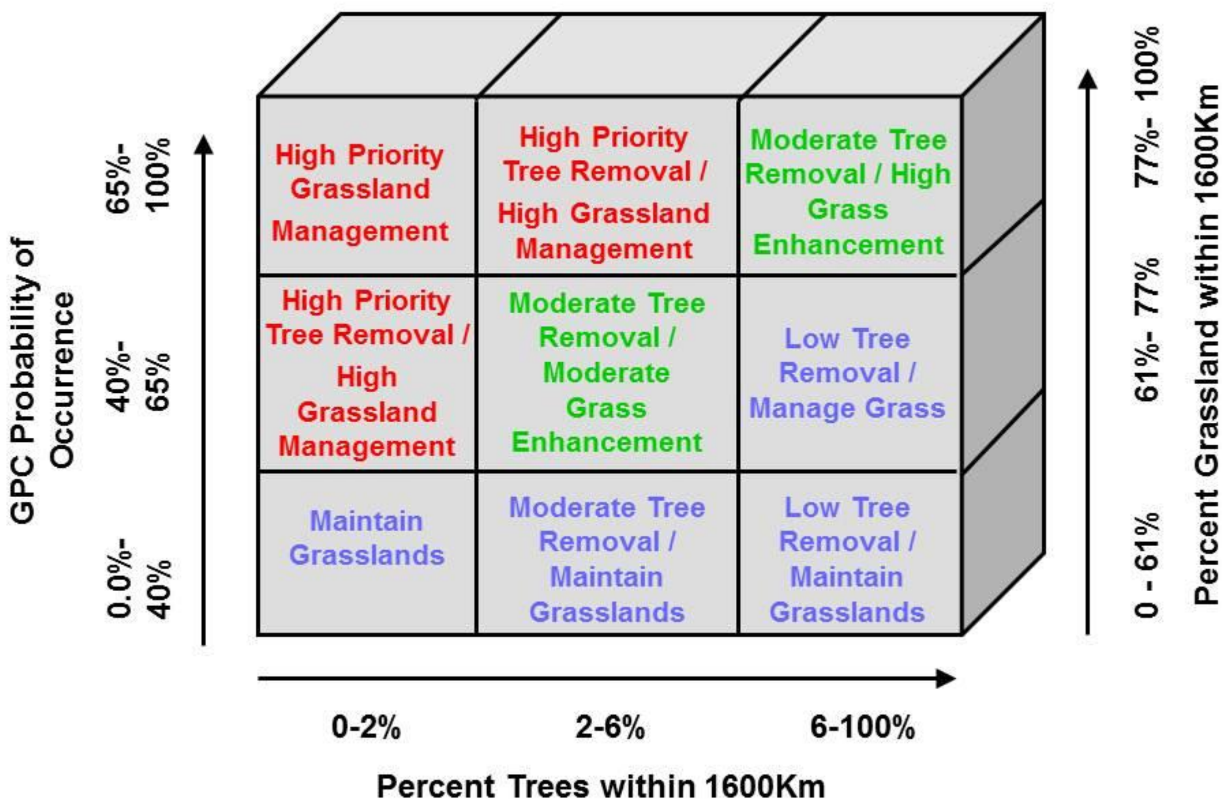
Figure 20. Greater Prairie-Chicken Response to Increased Grassland Cover



Decision Support Tools

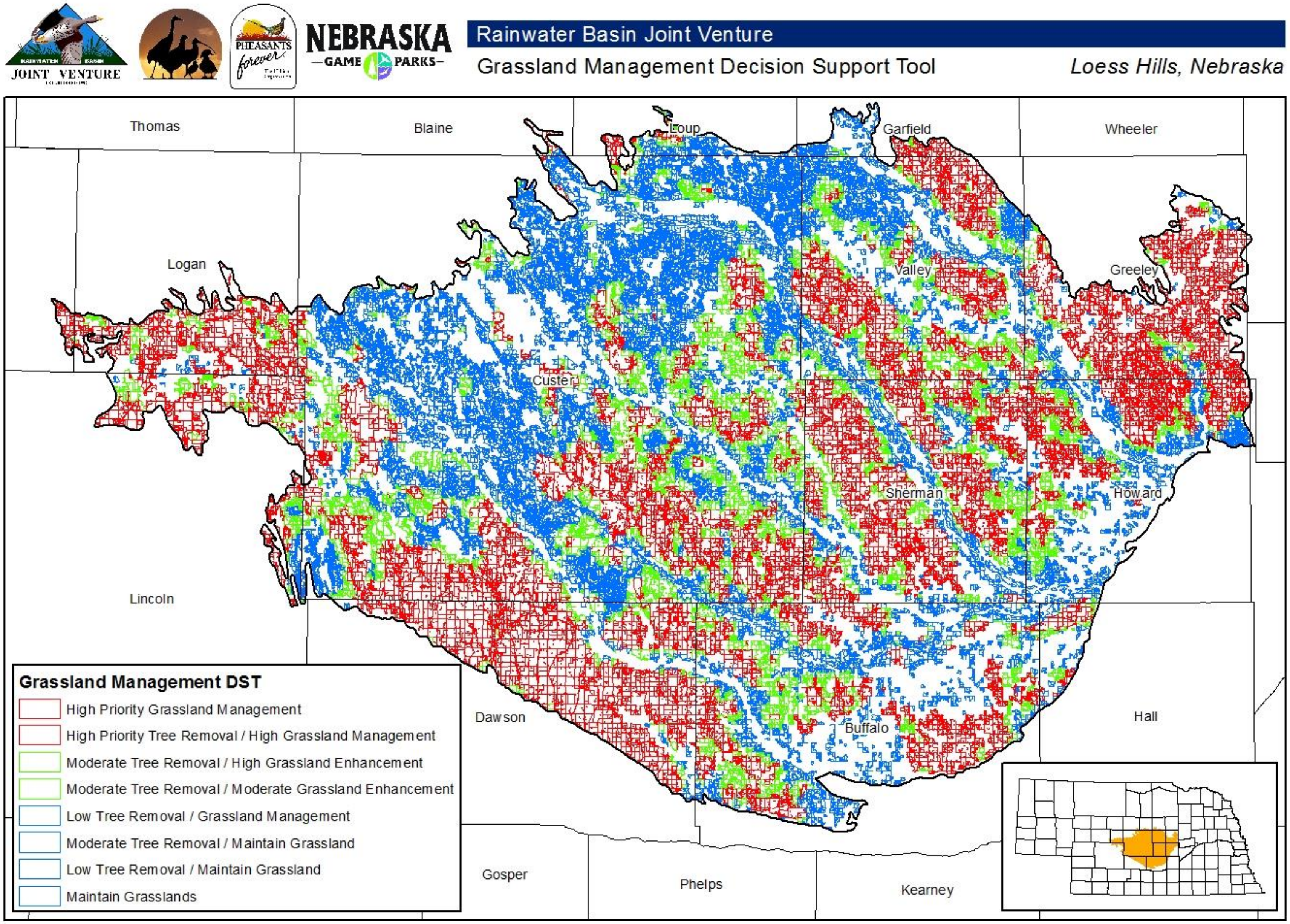
To assist the coordinating wildlife biologist, a Decision Support Tool (DST) was developed to identify tracts that had the highest potential to positively influence GPC lek occurrence in the CLHR. This tool provides the coordinating wildlife biologist with a tool to guide targeted outreach and prioritize landowner contacts when delivering conservation projects. This DST integrates three site characteristics: 1) probability of occurrence for GPC leks, 2) percentage of trees within 1600 km, and 3) the percentage of grass within 1600 km. To develop this DST, the FSA CLU field boundaries GIS dataset was attributed using ERDAS zonal statistics. This process added a data field into the tabular data associated with the CLU to describe the percent grassland, percent woodland cover, and average relative probability of occurrence for each field boundary within the CLU. Once attributed, a query was created that established three categories (high, medium, and low) for each of the data fields. The query was based on a quantile assessment that placed an equal number of fields into each of the three categories. Fields in the “low” category had a probability of GPC lek occurrence between 0.0% and 40.0%; “medium” class probability of lek occurrence was between 40.1% and 77.0%; and the “high” probability fields had a relative probability of lek occurrence between 77.1% and 100%. A similar quantile approximation was created as an index for high, medium and low percentage of grass cover and percentage of woodland cover (Figure 21). This analysis again allows DST maps to be developed to guide existing conservation programs that facilitate grassland management (Figure 22).

Figure 21. Decision Matrix to Guide Grassland Enhancement Activities.



A landscape-scale DST was created to help guide conservation implementation. For each grassland parcel, the matrix variables were calculated. This allowed the decision matrix to be spatially represented for each grassland parcel across the county and throughout the CLHR assessment area. Since this DST was developed in a GIS environment, the dataset can be used at multiple scales by the coordinating wildlife biologist simply by zooming in on the dataset to the desired focus area. This DST can easily be used to guide landowner contacts and conservation delivery.

Figure 21. Grassland Management and Enhancement Decision Support Tool



The RWBJV goal for the Central Table Playas is to protect, restore, and enhance sufficient high-priority playas to provide reliable migration habitat for whooping cranes and waterfowl during migration. All of these wetlands are privately owned, with a majority embedded in center pivot irrigated agricultural fields. Therefore, to achieve this goal will require the development of a compatible easement program that will not negatively impact adjacent croplands, and a targeted approach to contact eligible landowners with high-priority tracts. As part of this project, separate models were developed for both whooping cranes (figure 15) and waterfowl as a guild (Figure 19). These models provide field biologists new tools to market existing conservation programs and explore new nontraditional funding sources like Section 7 dollars.

Whooping Crane Conservation Targets

The highest possible score for whooping crane was 24. Functional wetlands, with scores ≥ 21, reflect those areas that more closely fit the RWBJV's conservation criteria. There are 239 of the 1,926 total footprints that received scores ≥ 12 points. The footprints encompass 2,122 of the 10,537 acres of total wetlands examined. Results from this model can be used as a guide by RWBJV partners to help prioritize wetland protection, restoration, and enhancement activities to maximize benefits to whooping cranes.

Waterfowl Conservation Targets

The total score for each wetland was derived by summing the individual landscape features. The highest possible score a wetland footprint could receive was 15. Historic wetlands, with scores ≥ 12, reflect those areas that more closely fit the conservation priority criteria. There are 236 of the 1,926 total footprints that received scores ≥ 12 points. The footprints encompass 2,130 of the 10,537 acres of total wetlands examined (Figure 19). Results from this model can be used as a guide by partners to help prioritize wetland protection, restoration, and enhancement activities to maximize benefits to migratory waterfowl.

Discussion

Landcover Development

The collection and integration of new datasets was tedious and time consuming, but the effort was validated by the high degree of accuracy (>95%) in the final product. Further evidence of the accuracy of the landcover is provided by application of the lek probability models. Data in both the Northeast and the Southeast models had high ROC values (>.79), indicating a high degree of agreement between the models and observed occurrence. Often with logistic regression analysis, ROC values above 70% are considered acceptable; values greater than 90% are seldom achieved. The high ROC values associated with these models probably could not have been achieved with a more generalized landcover dataset.

Lek Data Collection and Probability Models

In the loess hills greater prairie-chicken model, GPC responded at the 1600m spatial scale although past conceptual models have assumed that GPC require blocks of 5,000 acres (~2.5 km scale)(PLJV 2004). Results indicate either that the grassland area requirement of GPC is less than previously thought, or that GPC are also influenced by local factors within blocks of grassland.

Results suggest that DSTs which reliably guide strategic conservation efforts must be produced from local, rather than statewide or broader-scale, models. These data complement the findings of Johnson and Igl (2001) and Davis et al (2006), which found regional variation of area sensitivity in several priority grassland species. Every GPC model indicated a strong positive response by GPC to grasslands and a negative response to woodland cover and developed lands.

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