Nebraska Land Cover Development

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January 2011

Suggested Citation:

Bishop, A., A. Barenberg, N. Volpe, J. Riens and R. Grosse. 2011. Nebraska Land Cover Development. Rainwater Basin Joint Venture Report. Grand Island, Nebraska, USA.

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Introduction

Spatially explicit habitat data are crucial in development of accurate biological plans or habitat delivery tools. These data at a minimum provide a baseline inventory of the types, composition, and distribution of habitats across the landscape. The datasets can also be used to predict species distribution, model species-habitat relationships, identify areas in conservation need, and monitor changes in habitat. There are a variety of spatial habitat datasets available to conservation planners in Nebraska, each focusing on different habitat types and at different scales of resolution. For example, the Nebraska GAP dataset provides course-scale information on generalized vegetation communities. The National Wetlands Inventory (NWI) provides fine-scale delineation of wetland habitats. Other datasets depict landscape features that affect wildlife habitat such as roads and urban development. None of these datasets alone are sufficient to meet the needs of effective biological planning or conservation program delivery. We need to incorporate spatial data from many sources to sufficiently interpret the landscape; however, this requires time-intensive processing and a thorough assessment of data integrity and quality. When combinations of spatial data are opportunistically used in a disparate manner, it is not only inefficient but it can easily cause misinterpretation of the landscape and result in improper geospatial analysis. Such mistakes translate into ineffective wildlife and habitat conservation whereby populations do not respond in the expected manner.

Methods Overview

The first step in the biological planning process is to define the biological foundation. A biological foundation identifies priority species and the habitats required to support these species. The Hierarchical All Bird System (HABS) planning approach was used to define Nebraska priority bird species and associated habitats. The HABS planning process defines habitat by association and conditions (Table 1). A habitat association is the coarsest land cover class that is mapped with traditional Geographical Information Systems (GIS) and Remote Sensing (RS) techniques. Geospatial data at the habitat association level are sometimes not sufficiently explicit to clearly assess species-habitat relationships. In these cases, habitat associations are refined to habitat conditions, the most specific classification in HABS. Conditions are mapped at sufficient resolution to model species-habitat relationships. For example, most remotely sensed datasets map wetland features with an extensive open water component as “open water.” This is an accurate mapping technique, but when trying to assess habitat response we often need to refine the “open water” class to explicit types of wetlands. Ancillary datasets are used to refine the “open water” class to more explicit subclasses (e.g. stock pond, reservoir). These different wetland habitats provide unique habitat niches used differently by different species.

Table 1 HABS Habitat Associations, Conditions, and Codes for Nebraska Landcover

"DIVISION"	"TYPE"	ASSOCIATION	CONDITION
Aquatic	Open Water	1 – Reservoirs/ Lakes/Ponds	101 - Sandhill Lake
			102 - Lagoon
			103 - Pit
			104 - Reservoir
			106 - Stock pond
	Wetlands	12 - Playas	121 – Farmed*
			122 - Grassland/Buffered*
		13 - Sandhill Wetlands	
		14 - Rainwater Basins	141 - RWB farmed
			142 - RWB early successional
			143 - RWB late successional
		15 - Other Wetlands	152 - Emergent marsh
			153 - Saline
	Riverine Systems	24 - Riverine Systems	241 - Riparian canopy
			242 - Exotic riparian shrubland
			243 - Native riparian shrubland
			244 - River channel
			245 - Unvegetated sandbar
			246 - Warmwater slough
			247 - Wet meadow
			248 - Floodplain marsh
Anthropogenic	Agricultural	38 - Cropland	201 - Alfalfa
			202 - Corn
			203 - Fallow
			206 - Sorghum
			207 - Soybeans
			208 - Sunflowers
			209 - Wheat
			211 - Other
		39 - CRP	31 - Grasses
			32 - Trees - upland
			33 - Trees - riparian
			34 - Wetland
			35 - Playa/non-floodplain wetland
			36 - CRP other practices
Other	Other	40 - Other	48 - All other types
			46 - Urban/Suburban
			44 – 4 lane roads
			42 - Rural developed
			41 - Other roads
Terrestrial	Sparsely Vegetated	51 - Badlands	
	Forests/Woodlands	61 - Forest/ Woodland (upland)	61 - Forest/Woodland (Upland)
			59 - Eastern red cedar
		66 - Juniper	
		63 - Ponderosa Pine	69 - Few trees, grassy understory
			60 – Many trees, little grassy understory

Table 1 HABS Habitat Associations, Conditions, and Codes for Nebraska (Cont)

"DIVISION"	"TYPE"	ASSOCIATION	CONDITION
Terrestrial	Grasslands	71 – Mixed-grass	
		73 - Sandhills Grasslands	
		75 - Shortgrass	
		77 - Tallgrass	
		87 - Sand Sage	

*Loess Hills (Table Playas) and Loess Canyons classes only.

HABS Associations and Conditions Descriptions

Many of these associations and conditions appear straightforward as habitat classes, but it is important to clarify in some detail the definitive characteristics of each class. This will provide clarity and ensure the data are not misused when evaluating landscape condition, assessing carrying capacity, or developing species-specific habitat models.

Reservoirs/Lakes/Ponds Associations and Conditions

Freshwater lake (101): These features are lacustrine systems found primarily in the Sandhills. The groundwater-fed shallow lakes often have aquatic bed vegetation and are bounded by emergent marsh vegetation including cattails (*Typha* spp) and bulrush (*Schoenoplectus* spp). Sandpits are also in this category. These pits, the byproduct of gravel mining operations, occur in close association with the Republican, Loup, and Platte River systems. The excavation of material results in large groundwater-connected water bodies.

Lagoon (102): These features are storage basins associated with confined animal feed operations or human wastewater treatment facilities.

Pit (103): Concentration pit or irrigation re-use pit. Both of these excavated features are associated with agricultural water management. Concentration pits are dug in shallow wetlands to increase cropping acres by reducing flooding extent. Irrigation re-use pits are used in gravity irrigation to capture unused irrigation water and return it to the up-slope portion of the field for irrigation.

Reservoir (104): Lacustrine systems formed by damming a river channel. Full pool is defined by the contour approximating normal spillway elevation or summer pool elevation.

Stock Pond (106): Lacustrine systems formed by damming an upland drainage. The extent is determined by the dam elevation and watershed extent.

Wetland Associations and Conditions

Playa (12): The "playa" association has three conditions including wet, dry, and wet pit only. A "Wet Playa" (121) describes a playa that has been partially or completely filled by rainwater or irrigation runoff so that water exists in the original shallow basin. Wet playas may or may not have a pit beneath the surface of the water, but if so, water extends beyond the margins of the pit. A playa that has only the pit saturated falls into the condition "Wet Pit Only" (122). This describes playas in which pits have been excavated and only the pit is wet, not the surrounding area which could be inundated with water if the pit were not in place. A "Dry Playa" describes a playa, pitted or not, which is not currently holding water. These conditions are ephemeral and have only been mapped at several study sites. These results only represent a snapshot in time, but are important for documenting the abundance of playas under different climatic conditions.

Rainwater Basins (14) are playa wetlands confined to the Peorian Loess soils in central Nebraska. Rainwater Basin wetlands are classified into three conditions. These include "RWB Farmed", "RWB Early Succession", and "RWB Late Succession". RWB Farmed (141) are Rainwater Basin wetlands that exhibit some level of function, embedded in agriculture fields, and are often cultivated in dry years. RWB Early Succession (142) features are Rainwater Basins dominated by early successional annual hydrophytes. RWB Late Succession (143) features are Rainwater Basins dominated by late successional perennial hydrophytes.

The "Other Wetlands" (15) association has two conditions, "Emergent Marsh" (152) and "Saline Wetlands" (153). Emergent marshes (152) are palustrine wetlands that occur throughout the state. This general wetland class occurs in both lentic and lotic systems. These marshes typically have both deep water and shallow zones. The deep water zone may be dominated by open water, cattail, bulrush, or common reed (*Phragmites australis*). The shallow peripheral zones are dominated by annual hydrophytes. Saline wetlands (153) are unique wetlands found in isolated pockets throughout the state. These wetlands have high salinity or alkalinity with vegetation adapted to this environment.

Riverine Systems Associations and Conditions

Riverine systems (24) are associated with the major lotic systems (Platte, Niobrara, Loup, Republican, etc.) found in Nebraska. Riparian canopy (241) is deciduous woodland/forest that occurs in the floodplain. This gallery forest is dominated by cottonwood (*Populus* spp), but often has an elm (*Ulmus* spp*)* and/or ash (*Fraxinus* spp*)* understory. The riparian shrubland (exotic 242 and native 243) occurs along banks and on sandbars in the active channel. Dominant native species include willow (*Salix* spp), and dogwood (*Cornus* spp), while exotic species are typically saltcedar (*Tamarix ramosissima*) or Russian olive (*Elaeagnus angustifolia*). River channel (244) is the active channel of flowing water in contiguous, connected channels. Unvegetated sandbars (245) are sandbars within the active river channel. These are often maintained by scouring action of floods and ice. Floodplain marsh (248) is the emergent marsh (including oxbows, etc.) within river floodplains. Warm-water sloughs (246) are groundwater influenced side channels. These normally do not freeze during winter and are primarily found along the Platte and Loup Rivers. Wet meadows (247) are traditionally used as pasture lands along these rivers. These grassy areas within the floodplain are interconnected with groundwater, causing the soils to be saturated. Often there is an undulation of ridges and swales in these meadows. The ridges are dominated by upland grasses that transition into sedges (*Carex* spp*)* in the swales. Although not in a riverine

system, wet meadows also occur in the Sandhills as a result of the high water table. Wet meadows in the Sandhills are larger and do not have the ridge-swale transitions. In the Sandhills, topographic low points and a high water table interact to produce large sedge meadows.

Agriculture and CRP Associations and Conditions

This class represents the agriculture component of the landscape. Major crop types were defined including alfalfa (201), corn (202), fallow (203), sorghum (206), soybeans (207), sunflowers (208), wheat (209), and "other" agriculture crops (211). The Conservation Reserve Program (CRP) offers agriculture producers several different conservation practices based on conservation goals and eligibility. Major CRP classes include grass (31), upland trees (32), riparian trees (33), wetland practices (34), playa practices (35), and all other CRP practices (36).

Anthropogenic Associations and Conditions

This category is used to map 4-lane roads (44), other roads (41), rural developed (42), and urban/suburban (46).

Badlands/Cliffs/Outcrops Association

The badlands/cliffs/outcrops (51) association is not further defined to conditions. All of these sparsely vegetated areas are jointly considered at the association level.

Forests and Woodlands

Forests and woodlands have expanded in Nebraska as a result of agricultural practices, development, and fire suppression. Trees classed in the "Forest/Woodlands" (61) association have frequently been planted (shelterbelts or woodlots), or are trees that grow in upland areas of drainages up-slope from streams. Species composition may be deciduous, coniferous, or mixed. Deciduous species most commonly include oak (*Quercus* spp), elm, ash, or hackberry (*Celtis occidentalis*), while conifers are a variety of non-native species. "Eastern Red Cedar" (59) (*Juniperus virginiana*) is defined as a condition within this forest/woodland association. Eastern red cedar has long been planted to provide protection from the wind and weather and has now invaded rangelands throughout the state. The "Juniper" association (66) (i.e. *Juniperus scopulorum*) is found in relationship with ponderosa pine (*Pinus ponderosa*) occurring in the Pine Ridge and Wildcat Hills regions of western Nebraska. The "Ponderosa Pine" association, occurring along the bluffs associated with the Niobrara River, Pine Ridge, and Wildcat Hills, is further defined to two conditions based on tree density and understory vegetation. Ponderosa pine stands with high tree density and little understory vegetation (60) are evidence of lack of management or low fire frequency. Ponderosa pine stands with fewer, but larger, trees and a significant herbaceous component in the understory are evidence of increased management or fire frequency.

Grassland Associations and Conditions

Grasslands once dominated Nebraska, but agricultural conversion has dramatically reduced the abundance of these communities and resulted in a fragmented distribution. As the name suggests, the "Mixed-grass Prairie" association (71) represents a transitional community in which both traditional shortgrass and tallgrass prairie species co-occur. Dominant grasses include big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), blue grama (*Bouteloua gracilis*), buffalograss (*Bouteloua dactyloides*), little bluestem

(*Schizachyrium scoparium*), and sideoats grama (*Bouteloua curtipendula*). Common forbs include Illinois bundleflower (*Desmanthus illinoensis*), prairie clovers (*Dalea* spp), leadplant (*Amorpha canescens*), ironweed (*Vernonia* spp), goldenrods (*Solidago* spp), and coneflowers (*Ratibida* spp, *Rudbeckia* spp, *Echinacea* spp).

Unique to Nebraska are the expansive "Sandhills Grasslands" (73). Grass species include prairie sandreed (*Calamovilfa longifolia*), hairy grama (*Bouteloua hirsuta*), little bluestem, big bluestem, Indiangrass, and sand bluestem (*Andropogon hallii*). Switchgrass and prairie cordgrass *(Spartina pectinata*) often mark the transition between the uplands and wet meadows. Other common species include yucca *(Yucca* spp*),* wild roses (*Rosa* spp), leadplant, and sunflowers (*Helianthus* spp).

Shortgrass Prairies are adapted for resilience to harsh, dry conditions that can occur throughout their range. Shorter stature species dominate the "Shortgrass Prairie" (75) community. Dominant grasses include buffalograss, blue grama, and sideoats grama. Other plants associated with this community include prickly pear (*Opuntia* spp) and milkvetches *(Astragalus* spp).

Tallgrass Prairie is the dominant grassland association in eastern Nebraska. "Tallgrass Prairie" (77) is composed of taller-stature grasses such as big bluestem, Indiangrass, switchgrass, and Canada wildrye (*Elymus canadensis*). Tallgrass prairie may also support a diverse forb community including goldenrods, asters (*Aster* spp), and coneflowers.

The "Sand Sage" (87) association typically occurs on sandy soils and is dominated by sagebrush (*Artemisia* spp). Generally grass species typical of mixed-grass prairie are an associated understory. Sand Sage occurs in the Panhandle and southwestern Nebraska.

Data Layer Sources and Methods

To build the seamless dataset for the Nebraska land cover, we integrated multiple existing spatial data layers. To develop the final dataset, we used the mosaic tool in ERDAS Imagine. This function involves a stacking process where more accurate or explicit data sets are "stacked" on top of less accurate or explicit data. The higher stacked data take precedence over the underlying dataset. The order by which we stacked data for Nebraska is as follows, starting at the bottom stack:

1) Nebraska Ecosystem layer
2) Nebraska cropping layer derived from National Agriculture Statistics Service data
3) Farm Service Agency (FSA) Conservation Reserve Program (CRP) data layer
4) Regional wet meadow mask
5) Regional forest/woodland mask
6) Regional developed lands mask
7) Statewide National Wetlands Inventory (NWI) mosaic
8) Rainwater Basin (RWB) wetland vegetation layer
9) RWB hydrological modification layer
10) Regional sandsage mask
11) Regional badlands/cliffs mask
12) Roads layers

Each of these datasets provides a unique representation of habitats or features that influence habitat selection and use by different species. By clearly understanding the limitations of each of these datasets we developed a protocol that allowed us to integrate datasets extracting more accurate data from the different sets. The resulting landcover represents contemporary conditions to the best extent currently possible. Following is a description of the various datasets incorporated into the final land cover and any processing completed.

Nebraska Ecosystem Data Layer

The Nebraska Ecosystem data were extracted from the Nature Serve Ecosystems Landuse data layer. Nature Serve created this dataset by merging the existing GAP data for Nebraska, Kansas, Colorado, South Dakota, and Wyoming. These five states represent Region 2 of the U.S. Forest Service. In addition to using the GAP data and additional modeling techniques, Nature Serve integrated ancillary data during development. The minimum mapping unit for most classes was 100 hectares, while other classes were mapped at 0.09 hectares. The Ecosystem data layer is the coarsest-scale data used in developing our Nebraska land cover (Figure 1). The initial step in creating the landcover was to evaluate the current classes and crosswalk classes to the habitat associations and conditions used in HABS (Table 2).

Table 2 Ecosystem Crosswalk to the HABS Land Cover Classes

Ecosystems Landcover Type	ES Code	HABS Association	HABS Condition	HABS Code
Central Mixedgrass Prairie	1	Mixedgrass Prairie		71
Commercial/Industrial/ Transportation	4	Other	Urban/suburban	46
Herbaceous Planted/Cultivated	11	Cropland		38
Low Intensity Residential	22	Other	Urban/suburban	46
North Central Interior Maple - Basswood Forest	29	Forest/Woodland (upland)		61
Northwestern Great Plains Mixedgrass Prairie	33	Mixedgrass Prairie		71
Open Water	35	Reservoirs, Lakes & Ponds		1
Rocky Mountain Foothill Limber Pine - Juniper Woodland	75	Juniper		66
Rocky Mountain Juniper Woodland and Savanna	46	Juniper		66
Rocky Mountain Ponderosa Pine Savanna	52	Ponderosa Pine	few trees, grassy understory	69
Rocky Mountain Ponderosa Pine Woodland	53	Ponderosa Pine	many trees, little grassy understory	60
Western Great Plains Cliff and Outcrop	60	Badlands/Cliffs/ Outcrops		51
Western Great Plains Closed Depression*	61	Riverine Systems	Wet-meadow	247
Western Great Plains Riparian/Western Great Plains Floodplain	64	Riverine		24
Western Great Plains Sand Prairie	66	Mixedgrass		71
Western Great Plains Sandhill Shrubland	67	Sand Sage		87
Western Great Plains Shortgrass Prairie	70	Shortgrass		75
Central Tallgrass Prairie	2	Tallgrass		77
North Central Interior Floodplain/Wooded Draw	28	Riverine	Riparian Canopy	241

*Through visual assessment of aerial photography, we noted that features from this class were more frequently wet meadows than playas.

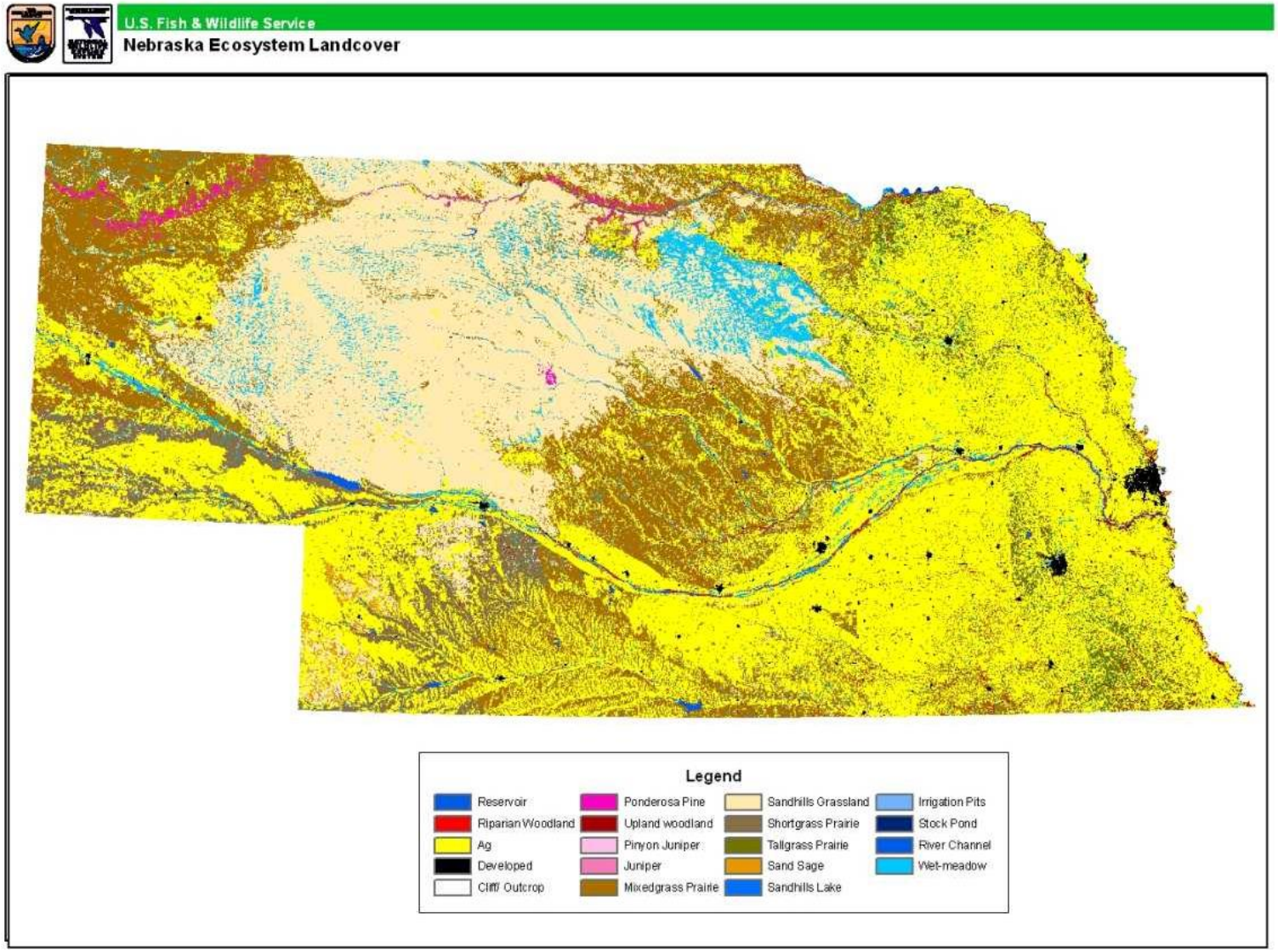
Through visual assessment of aerial photography, we noted that the wet-meadow, riparian, and upland woodland classes were frequently misrepresented in the Ecosystem layer. To help rectify these deficiencies, SSURGO (Soil Survey Geographic Database) data were used to identify frequently-flooded soils and sub-irrigated soils. In the SSURGO dataset, soils are mapped based on several physical characteristics, two of which are flooding occurrence and groundwater influence.

In the SSURGO dataset "frequently flooded areas" are described as areas where "flooding is likely to occur often under usual weather conditions; more than 50 percent chance of flooding in any year or more than 50 times in100 years, but less than a 50 percent chance of flooding in all months in any year." These delineations represented the floodplains and thereby could be used to refine riverine-associated habitats. Using these frequently flooded soil data, we created a rule set to distinguish between upland and riparian woodlands (Ruleset 1/R1), and identify those grasslands that functioned as wet meadows rather than upland grasslands (Ruleset 2/R2) (Appendix A). Therefore, if woodland in the ecosystem layer coincided with SSURGO frequently-flooded soils, it was classed as riparian canopy; woodland that did not coincide with frequently-flooded soils was classified as upland forest/woodland (R1). Grasslands in the Ecosystem layer coinciding with frequently-flooded soils were classified as wet meadow, while all other grasslands maintained the appropriate grassland classification (e.g. shortgrass, etc)(R2).

The SSURGO dataset also classifies soils based on ecological site characteristics. An "ecological site" is the product of all the environmental factors responsible for its development. Soils characterized as subirrigated ecological sites are influenced by groundwater and have a vegetation community dominated by wet-meadow species or those that transition between wetland and upland regions. These soils were used to develop a ruleset to refine the distribution of wet meadow in the Sandhills (Ruleset 3/R3). Using this ruleset, wet meadows could only occur on subirrigated soils or frequently flooded soils (described above). Wet meadows in the Sandhills that did not occur on these soils were converted to sandhills grassland.

The Ecosystem data layer grouped all wetland features with an open water component into a single class called "open water". Again, SSURGO data were used to refine this class. All open water pixels were reclassified to the appropriate HABS land cover class. For example all "open water" pixels that intersected SSURGO-delineated reservoirs were classified as Reservoir (104). This process was repeated for river channel (244), lakes (101), stock pond (106), and pits (103).

Figure 1. Nebraska Ecosystem Data Layer



Agriculture and Nebraska Cropping Data

NASS Dataset Refinement

The National Agriculture Statistics Service (NASS) dataset is a seamless landcover with a focus on evaluating annual cropping patterns. These data are created through RS to identify different crop types. Data from the National Land Cover Data (NLCD) layer are used to classify non-agriculture features. The NASS dataset has the highest overall accuracy of the multiple statewide datasets that were available to us (92% accuracy for crop classes, 84% non-agriculture classes, (Shawn Buckohls and Rick Muehler, FSA pers. comm.). However, the NASS dataset defines non-agricultural classes too broadly (e.g. "open water") to be meaningful for the intended applications of our final landcover. We therefore applied the same rule sets used in refinement of the Ecosystem layer and developed additional rule sets when necessary to refine the NASS dataset to delineate narrower classes including wet meadows, specific water features, and grassland and woodland communities.

The NASS dataset was crosswalked for consistency to HABS values (Table 3). We grouped similar NASS classes into broad habitat associations to facilitate refinement. The grassland classes used by NASS were "NLCD - Herbaceous grasslands", "Grass/Pasture/Non-Ag", "Clover/Wildflowers", and "NLCD - Herbaceous wetlands". If any of these grassland features coincided with SSURGO frequently flooded soils, they were converted to wet meadow (247) (R2). Wet meadow (247) was also coded in areas where the "NLCD-Herbaceous wetlands" class occurred in the Sandhills region.

Any grassland feature not identified as wet meadow was re-classified to the specific HABS grassland community (i.e. sandhills grassland (73), shortgrass (75), tallgrass (77), and mixed grass prairie (71)). Using descriptions of the dominant grassland community associated with each ecoregion in the Level IV Ecoregions of Kansas and Nebraska, we created a crosswalk to the HABS grassland associations (Table 4) and re-coded grasslands based on ecoregional location. For example, a NASS-identified grassland occurring in the "Central Nebraska Loess Plains" ecoregion was classed as mixed grass prairie (71).

Next the woodland classes were extracted from the NASS dataset and reclassified. Woodland classes in the NASS dataset included "Woodland", "Christmas Trees", "NLCD Deciduous Forest", "NLCD Evergreen Forest", "NLCD Mixed Forest", "NLCD Woody Wetlands". A cedar/ponderosa pine rule set was created to refine "Christmas Trees" and "NLCD Evergreen Forest" (R4). These trees were classified as "Eastern Red Cedar" (59) unless occurring in the Wildcat Hills or in the Pine Ridge, then "Ponderosa Pine" (69). The remaining trees were classified as "Forest/Woodland" (61) or "Riparian Canopy" (241) based on whether they occurred on SSURGO frequently-flooded soils (R1).

The "NLCD – Shrubland" class was reclassified to "Riparian Shrubland" (243) if occurring on frequently flooded soils, to Sandsage (87) if occurring in the shortgrass prairie ecoregion, or to Eastern Red Cedar for all other areas (R5).

As with most satellite-derived data, nearly all of the NASS wetland features were large lacustrine features. The SSURGO data was used to refine this class by reclassifying all open water pixels to the appropriate HABS land cover class (R6). For example, all "open water" pixels that intersected SSURGO-delineated reservoirs were classified as Reservoir (104). This process was repeated for river channel (244), freshwater lakes (101), stock ponds (106), and pits (103). These refined components of the NASS datasets were then re-compiled to a seamless refined NASS data layer.

Potential Agriculture Mask Development and Feature Attributes

In addition to the NASS dataset, the Nature Serve Ecosystem layer and Farm Service Agency (FSA) Common Land Unit (CLU) datasets delineate agriculture lands. The FSA's CLU data are used to track potential agricultural lands and the conservation programs administered by FSA.

Both the Ecosystems and CLU datasets over-represent agriculture. In the Ecosystem layer, agriculture is over-represented as a result of the large minimum mapping unit (100 hectares). The agriculture class therefore frequently incorporated smaller patches of other classes due to the smoothing processes used in data development. In the CLU dataset, over-representation can occur as a result of a field being taken out of production (e.g. due to urban growth) or sold. According to FSA rules, the producer can move "base acres" to other tracts, even if they are not being actively cultivated. These transferred "base acres" are then reported as cropland, although they are not currently under cultivation.

We compared the agriculture acres in the three datasets. The Ecosystem layer mapped 20.5 million acres of agriculture, while the CLU mapped 20.1 million acres. When the datasets were combined, there were approximately 23.5 million acres of agriculture mapped by these datasets in Nebraska. The NASS dataset only mapped 14.4 million acres as agriculture, with the highest known accuracy of the three datasets. When we compared the NASS cropping data to the Ecosystems and CLU combined data, 500,000 acres of NASS crop acres were missed by Ecosystems and CLU, representing 4.0% of the total crop acres mapped by NASS. These acres probably represent new development since 1992 when imagery for the Ecosystem layer was acquired. Acres missed by the CLU are most likely explained by administration and reporting procedures of the Farm Bill. Most of the fields that were missed by CLU occurred along the border of the state. Producers can choose which FSA county office to administer their programs. Our data only came from offices in Nebraska, so enrolled fields occurring in Nebraska but administered by county offices in other states would be missed. New development occurring since the 2006 CLU data that we used were developed could also add to the error. In rare cases, producers choose not to enroll in Farm Bill programs, therefore these acres would also be missed by the CLU.

To address these errors, the NASS acres missed by the other two datasets were added to create a comprehensive potential agriculture mask from the Ecosystems, CLU, and NASS datasets. To assign attributes to the features mapped in the potential agriculture mask, we assigned the value from the previously-described refined NASS dataset. We therefore imposed a validation process whereby agricultural features in the final dataset were classified as agriculture only if they were mapped as agriculture in the NASS data layer. As a result, some fields originally classified as

agriculture in the Ecosystem or CLU layers were re-classified to the non-agriculture classes identified in the NASS dataset (Table 3).

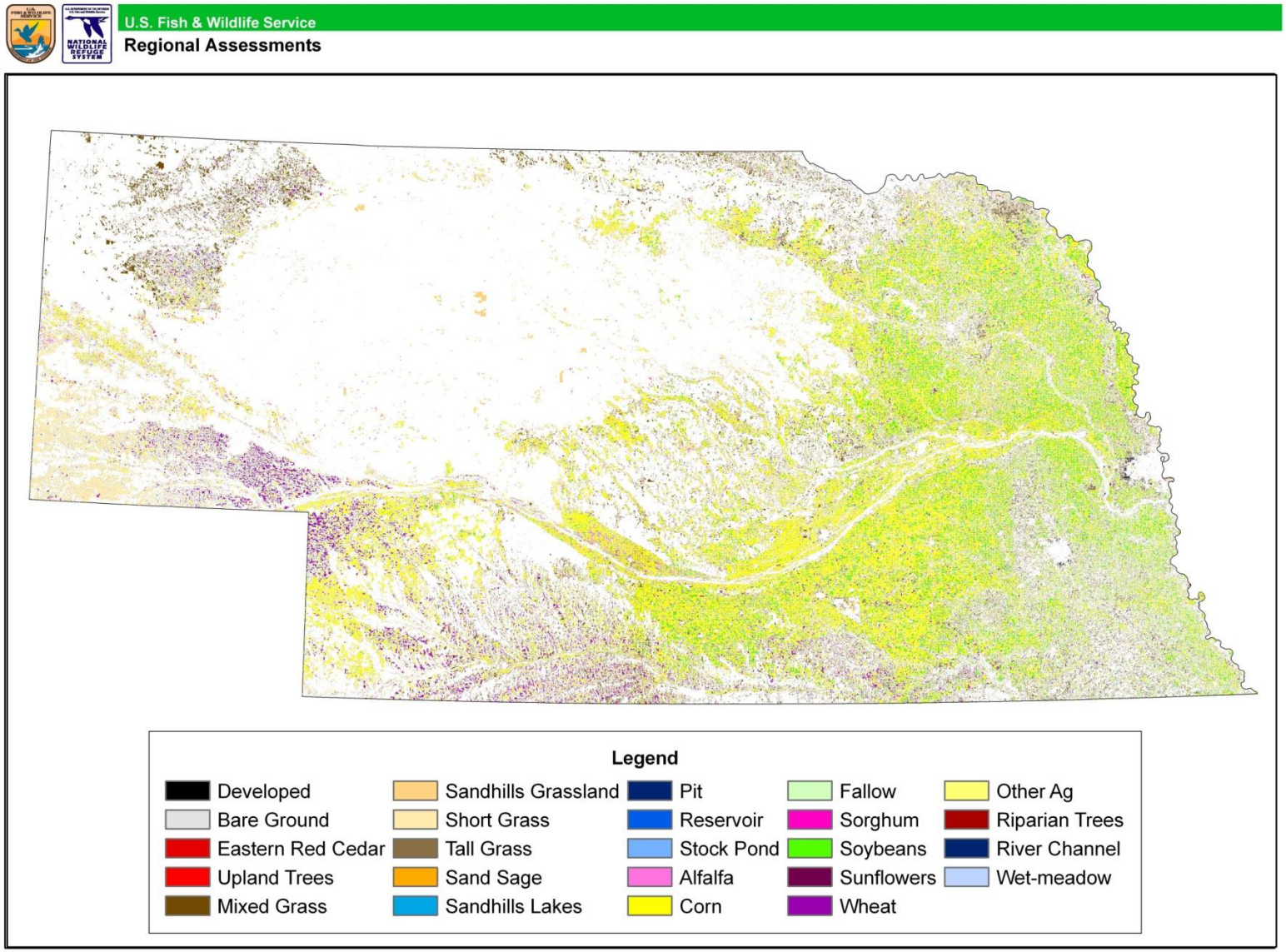
Table 3. NASS Crosswalk to the HABS Land Cover Classes

Type	NASS Code	HABS Association	HABS Condition	HABS Code
Corn	1	Agriculture	Corn	202
Sorghum	4	Agriculture	Sorghum	206
Soybeans	5	Agriculture	Soybeans	207
Sunflowers	6	Agriculture	Sunflowers	208
Barley	21	Agriculture	Other Agriculture	211
Spring Wheat	23	Agriculture	Wheat	209
Winter Wheat	24	Agriculture	Wheat	209
Other Small Grains	25	Agriculture	Wheat	211
Winter Wheat/Soybeans Double Cropped	26	Agriculture	Wheat	209
Rye	27	Agriculture	Other Agriculture	211
Oats	28	Agriculture	Other Agriculture	211
Millet	29	Agriculture	Other Agriculture	211
Canola	31	Agriculture	Other Agriculture	211
Alfalfa	36	Agriculture	Alfalfa	201
Sugarbeets	41	Agriculture	Other Agriculture	211
Dry Beans	42	Agriculture	Other Agriculture	211
Potatoes	43	Agriculture	Other Agriculture	211
Other Crops	44	Agriculture	Other Agriculture	211
Misc. Vegs. & Fruits	47	Agriculture	Other Agriculture	211
Clover/Wildflowers	58	Grassland	Habs Ruleset R2	71, 73, 75, 77, 247
Fallow/Idle Cropland	61	Agriculture	Fallow	203
Grass/Pasture/Non-Ag	62	Grassland	Habs Ruleset R2	71, 73, 75, 77, 247
Woodland	63	Woodland	Habs Ruleset R1	61 or 241
Christmas Trees	70	Woodland	Habs Ruleset R1	61 or 241
Wetlands	87	Wetlands	Habs Ruleset R6	101 - 153
NLCD - Open Water	111	Wetlands	Habs Ruleset R6	101 - 153
NLCD - Developed Open Space	121	Other	Rural Developed	42
NLCD - Developed/Low Intensity	122	Other	Urban/Suburban	46
NLCD - Developed Medium Intensity	123	Other	Urban/Suburban	46
NLCD - Developed High Intensity	124	Other	Urban/Suburban	46
NLCD - Barren	131	Badlands/Cliffs/Outcrops		51
NLCD - Deciduous Forest	141	Woodland	Habs Ruleset R1	61 or 241
NLCD - Evergreen Forest	142	Ponderosa Pine	Ponderosa Pine	63
NLCD - Mixed Forest	143	Woodland	Habs Ruleset R1	61 or 241
NLCD - Shrubland	152	Shrubland	Habs Ruleset R5	87 or 243
NLCD - Grassland Herbaceous	171	Grassland	Habs Ruleset R2	71, 73, 75, 77, 247
NLCD - Woody Wetlands	190	Woodland	Habs Ruleset R1	61 or 241
NLCD - Herbaceous Wetlands	195	Grassland	Habs Ruleset R2	71, 73, 75, 77, 247

Table 4 Chapman (2001) Ecoregions and Associated HABS Grassland

Level 4 Ecoregion	HABS Condition	HABS Code
Central Nebraska Loess Plains	Mixed Grass Prairie	71
Flat to Rolling Cropland	Mixed Grass Prairie	71
Holt Tablelands	Mixed Grass Prairie	71
Keya Paha Tablelands	Mixed Grass Prairie	71
Niobrara River Breaks	Mixed Grass Prairie	71
Pine Ridge Escarpment	Mixed Grass Prairie	71
Platte River Valley	Mixed Grass Prairie	71
Ponca Plains	Mixed Grass Prairie	71
Rainwater Basin Plains	Mixed Grass Prairie	71
Rolling Plains and Breaks	Mixed Grass Prairie	71
Sand Hills	Mixed Grass Prairie	71
Sandy and Silty Tablelands	Mixed Grass Prairie	71
Semiarid Pierre Shale Plains	Mixed Grass Prairie	71
Smoky Hills	Mixed Grass Prairie	71
Southern River Breaks	Mixed Grass Prairie	71
White River Badlands	Mixed Grass Prairie	71
Alkaline Lakes Area	Sandhills Prairie	73
Lakes Area	Sandhills Prairie	73
Sand Hills	Sandhills Prairie	73
Wet Meadow and Marsh Plain	Sandhills Prairie	73
Flat to Rolling Cropland	Shortgrass Prairie	75
Moderate Relief Rangeland	Shortgrass Prairie	75
Pine Bluffs and Hills	Shortgrass Prairie	75
Platte River Valley and Terraces	Shortgrass Prairie	75
Rolling Sand Plains	Shortgrass Prairie	75
Loess and Glacial Drift Hills	Tall Grass Prairie	77
Lower Platte Alluvial Plain	Tall Grass Prairie	77
Missouri Alluvial Plain	Tall Grass Prairie	77
Nebraska/Kansas Loess Hills	Tall Grass Prairie	77
Northeastern Nebraska Loess Hills	Tall Grass Prairie	77
Transitional Sandy Plain	Tall Grass Prairie	77

Figure 2. Potential Agriculture Mask following Feature Population using NASS.



FSA Conservation Reserve Program (CRP) Data Layer

The CRP data were acquired through a memorandum of understanding between the agencies involved. The CRP data include all of the associated practice information. These data were grouped with emphasis on the types of habitat that these practices would provide (Table 5). We have authorization only for internal use of these data; we will therefore re-classify CRP as agriculture in any copies of the land cover that are made for distribution.

Table 5 CRP Codes and Associated HABS Habitat Class

CRP Code	Description	HABS Association	HABS Condition	HABS Code
CP1	Introducted new grass and legumes planting	CRP	Grass	31
CP10	Existing grass	CRP	Grass	31
CP11	Existing trees	CRP	Trees- upland	32
CP12	Wildlife food plots	CRP	Other	36
CP13	Vegetative filter strips	CRP	Grass	31
CP13A	Vegetative filter strips	CRP	Grass	31
CP13C	Vegetative filter strips	CRP	Grass	31
CP13D	Vegetative filter strips	CRP	Grass	31
CP14	Grass terrace upland	CRP	Grass	31
CP15	Contour grass strips	CRP	Grass	31
CP15A	Contour grass strips	CRP	Grass	31
CP15B	Contour grass strips	CRP	Grass	31
CP16	Shelter belts	CRP	Trees- upland	32
CP16A	Shelter belts	CRP	Trees- upland	32
CP17	Living snow fences	CRP	Trees- upland	32
CP17A	Living snow fences	CRP	Trees- upland	32
CP18	Establishment of permanent vegetation to reduce salinity	CRP	Grass	31
CP18A	Establishment of permanent salt tolerant vegetative cover	CRP	Grass	31
CP18B	Establishment of permanent vegetation to reduce salinity	CRP	Grass	31
CP18C	Establishment of permanent salt tolerant vegetative cover	CRP	Grass	31
CP19	Alley cropping - trees	CRP	Trees- upland	32
CP2	Native new grass planting	CRP	Grass	31
CP20	Alternative perennials	CRP	Grass	31
CP21	Filter strips (grass)	CRP	Grass	31
CP22	Riparian buffers (trees)	CRP	Trees - riparian	33
CP23	Wetland restoration	CRP	Wetland	34
CP23A	Wetland restoration non-floodplain and playa	CRP	Wetland - playa/ non-floodplain	35
CP24	Cross wind trap strips	CRP	Trees- upland	32
CP25	Rare and decling wildife habitat	CRP	Grass	31
CP27	Farmable wetland (wetland)	CRP	Wetland	34
CP28	Farmable wetland buffer (upland)	CRP	Grass	31
CP29	Wildlife habitat buffer on marginal pasture	CRP	Grass	31
CP3	Softwood new tree planting	CRP	Trees- upland	32
CP30	Wetland Buffer	CRP	Grass	31
CP30	Wetland buffer on marginal pasture	CRP	Grass	31
CP31	Bottomland hardwood trees	CRP	Trees- riparian	33

Table 5 CRP Codes and Associated HABS Habitat Class (Continued)

CRP Code	Description	HABS Association	HABS Condition	HABS Code
CP32	Hardwood trees (previously expired contract)	CRP	Trees- upland	32
CP33	Upland bird habitat (quail) buffers	CRP	Grass	31
CP3A	Longleaf pine new tree planting	CRP	Trees- upland	32
CP4	Wildlife Habitat	CRP	Grass	31
CP4B	Wildlife Habitat	CRP	Grass	31
CP4C	Wildlife Habitat	CRP	Grass	31
CP4D	Permanent wildlife habitat (non-easement)	CRP	Grass	31
CP5	Field Windbreaks	CRP	Trees- upland	32
CP5A	Field Windbreaks	CRP	Trees- upland	32
CP6	Diversion and Erosion Control Structure	CRP	Other	36
CP7	Diversion and Erosion Control Structure	CRP	Other	36
CP8	Grass Waterways (includes 8A)	CRP	Other	36
CP8A	Grass Waterways (includes 8A)	CRP	Other	36
CP9	Shallow water for wildife	CRP	Wetland	34
None		CRP	CRP	39

National Wetlands Inventory

To map the distribution of wetlands, the National Wetlands Inventory (NWI) was integrated into the landcover. Although the NWI is 25 years old, it provides the most comprehensive spatially-explicit delineation of wetlands. Nebraska is one of the few states that is comprehensive in coverage and has been converted to a digital format. The NWI maps features at a finer resolution and in more detail than required for habitat modeling, therefore we crosswalked the NWI codes to the appropriate HABS conditions. Due to the variety of NWI codes, Appendix B1 outlines that crosswalk and Appendix B2 describes the NWI codes.

Roads Data Layer

We used the Nebraska 911 roads layer developed by the Nebraska Technology Commission. This dataset was developed for emergency navigation by a private company (GIS Workshop, Lincoln, NE). Attributes in the data layer allowed us to discriminate between major roads (4-lane) and other roads. We incorporated the roads layer into the land cover as the final stack without any additional processing.

Regional Inventory Data

Spatial datasets such as the Ecosystems layer are developed for use at broad landscape scales, but conservation decisions and actions occur at more localized scales. For effective and efficient planning and delivery of conservation programs at local scales, higher resolution or more refined spatial datasets are critical. For example, the Nebraska Natural Legacy Project, the state wildlife action plan for Nebraska, has prioritized over 40 “biologically-unique landscapes” (BULs) with high potential for conservation of the state’s biodiversity. To enhance our ability to develop useful and accurate conservation planning tools in these BULs or other localized regions we developed or acquired spatial datasets with a regional focus (Figure 3). Comparable features (i.e. wet meadow, developed, sandsage, etc.) were extracted from each regional dataset and incorporated into regional “masks” representing these broad, related classes (Table 6). The masks were incorporated into the landcover during the stacking process.

Figure 3 Regional Assessments Completed in Nebraska

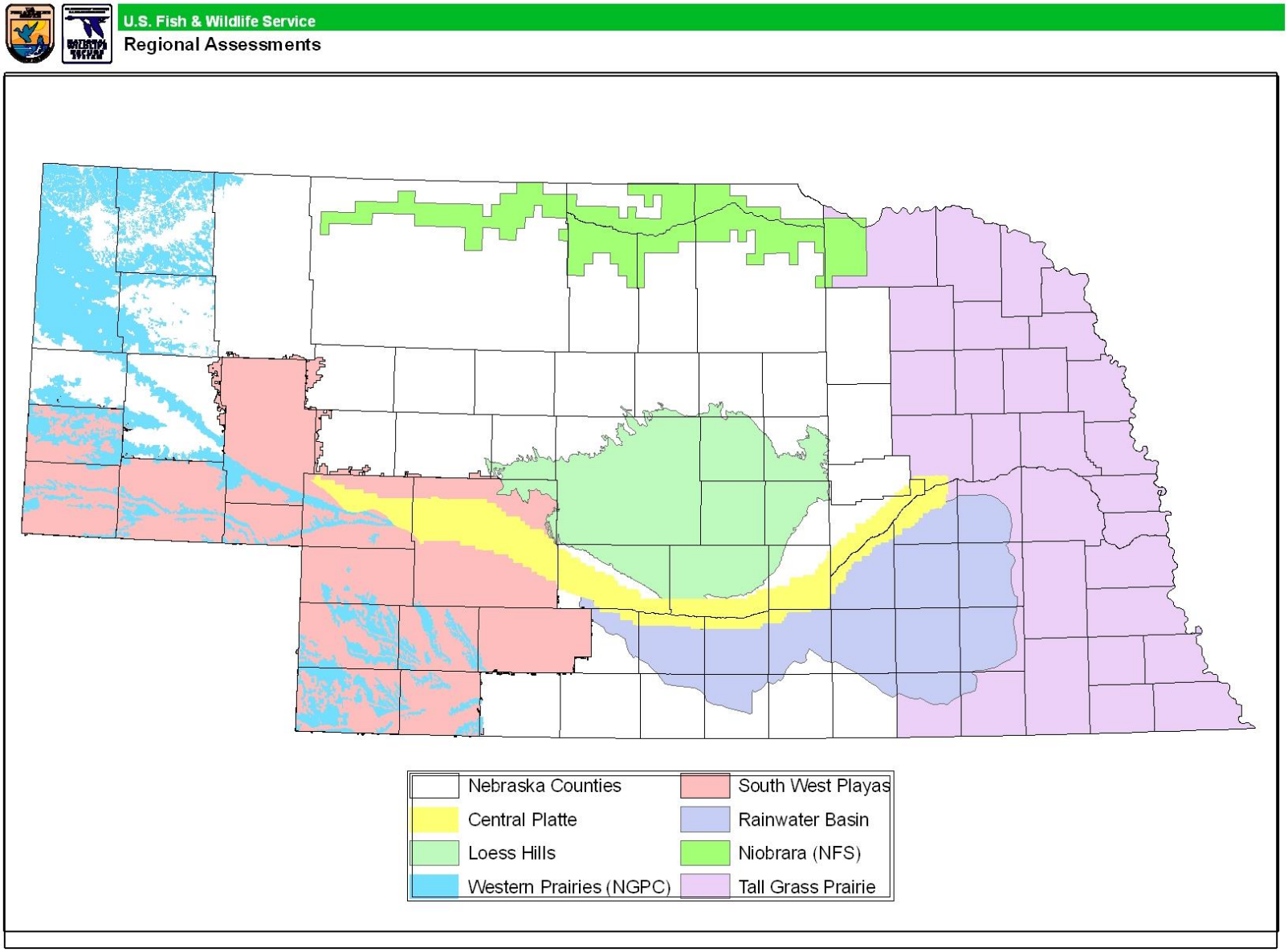


Table 6. Contribution of Features from Regional Datasets to Regional Masks for incorporation into the Final Nebraska Landcover

		Regional Masks					
		Developed	Wet Meadow	Wetland*	Forest/ Woodland	Sand Sage	Badlands/ Cliffs/ Outcrops
Contributing Datasets	Central Platte	X	X	X	X		
	Loess Hills	X	X	X	X		
	Niobrara		X		X		
	Rainwater Basin	X	X	X	X		
	SW Playas	X	X	X	X		
	Tallgrass Prairie	X	X	X	X		
	Western Communities			X		X	X

*Regional wetland features were incorporated into the final Nebraska landcover by updating the NWI datalayer for Nebraska to include these features.

Great Plains GIS Partnership Inventories

The five regional inventories which were developed by the Great Plains GIS Partnership cover the following regions: Tallgrass Prairie, Central Platte, Southwest Playas, Loess Hills, and Rainwater Basin. The Tallgrass Prairie region is delineated by the 35 eastern counties of Nebraska. The Central Platte region is defined as the area 10 miles either side of the outermost channel of the Platte River from Ogallala to Columbus. The Southwest Playa region is comprised of 13 counties south of the Platte River in the Panhandle in southwestern Nebraska. The Loess Hills region encompasses all or portions of 11 counties in central Nebraska intersecting Loess parental material. The Rainwater Basin region was defined by the STATSGO loess soils occupying all or portions of 21 counties in south central Nebraska.

Each of these datasets was developed separately but using consistent GIS protocols, allowing us to integrate these products at a statewide scale. The first step was to mosaic the complete CLU for each of the counties in order to create a seamless regional dataset. The CLU was used because polygons are delineated to a specificity that facilitates photointerpretation. The Land cover codes in the CLU layer were crosswalked to the appropriate land cover codes in the HABS classification. NWI data were then integrated into the regional dataset. We used FSA aerial imagery (2006) to photointerpret the entire dataset at 1:5000 scale. During the data refinement phase, we added, removed, and re-classified features to generate an accurate representation of current land cover conditions. The most common actions were addition of rural developed features, addition of agriculture features, addition of forest/woodland features, and the removal of wetland features due to urban and agricultural expansion. Finally, we identified upland forest/woodland and grassland features that coincided with SSURGO frequently-flooded soils data, and reclassified these as riparian canopy and wet meadow respectively (R1, R2).

In the Rainwater Basin, we conducted additional data collection and processing to identify wetland vegetation communities that are more refined than those used in the HABS model (Table 7). Fall 2004 color infrared (CIR) aerial photography was acquired and processed in eCognition software to map the vegetation communities on hydric soils. Hydrologic modifications (e.g. irrigation re-use pits, stock dams) were mapped by photo-interpreting the same 2004 imagery at 1:5000 scale.

Table 7. Rainwater Basin Wetland Community Crosswalk to HABS Land Cover Classes

RWB Wetland Community	HABS Association/Condition	HABS Code
Agriculture	Cropland	38
Cattail	RWB Late Succession	143
Grass	Grassland	71 or 77
Moist Soil	Moist-soil Unit	151
Pit	Pit	103
Reed Canary Grass	RWB Late Succession	143
Scirpus	RWB Late Succession	143
Stressed Agriculture	RWB Farmed	141
Trees	Forest/Woodland	61
Water Mudflat	RWB Early Succession	142
Wet Meadow	RWB Early Succession	142

Niobrara

We acquired from the Nebraska Forest Service (NFS) the Niobrara regional dataset, which encompasses the Niobrara River valley from Cherry County to the Missouri River (Figure 4). NFS used Definiens software and 2006 aerial imagery to develop their dataset which focuses on the forest/woodland components of the landscape. NFS should be contacted directly for a detailed description of their data development protocols. We extracted the woodland-related classes and crosswalked to our classification system as Ponderosa Pine, Eastern Red Cedar, and Forest/Woodland (Table 8). Any Forest/Woodland feature coinciding with SSURGO frequently-flooded soils was re-classified as Riparian Canopy (R1). We extracted all grassland features and reclassified as wet meadow those that coincided with SSURGO frequently-flooded soils (R2). We incorporated the woodland classes and wet meadow from this dataset into the final land cover.

Figure 4. NFS regional inventory coverage

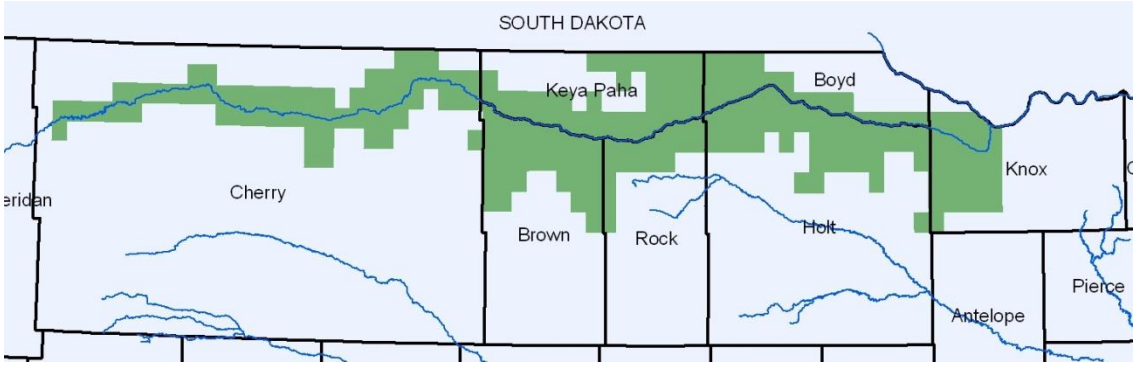


Table 8. NFS Crosswalk to HABS Land Cover Classes

NFS Class	HABS Association/Condition	HABS Code
Deciduous Forest	HABS ruleset (riparian or upland) (R1)	61 or 241
Eastern Red Cedar	Eastern Red Cedar	59
Ponderosa Pine	Ponderosa Pine	63
Grassland	HABS ruleset (wet meadow) (R2)	247

Western Communities

We acquired this dataset from the Nebraska Game and Parks Commission (NGPC) Natural Heritage Program (NGPC). NGPC developed this dataset to update information on native plant communities and wildlife habitats in western Nebraska to facilitate the development of the NGPC's Nebraska Natural Legacy Plan. The specific intent of the project was to identify, map, and give quality rankings to large blocks of privately owned native plant communities within the survey area in western Nebraska (Figure 5).

Large blocks of native vegetation were initially identified using 2002 Landsat imagery. Each block was inventoried via a combination of walking and/or roadside surveys conducted in 2004 and 2005. Distribution maps for the major plant community occurrences were developed for each survey area by correlating soil mapping units of the SSURGO database available from the Nebraska Department of Natural Resources (http://www.dnr.state.ne.us/databank/ssurgo2.html) to plant community distribution information gathered through roadside and walking field surveys. The NGPC Natural Heritage Program should be contacted directly for additional details about data development protocols.

We used only those features for which we subjectively determined that these data were more explicit than other available data layers. We extracted badlands, sandsage prairie, and wetland features and crosswalked to our classification system (Table 9).

Figure 5. Features extracted from the Western Communities regional inventory

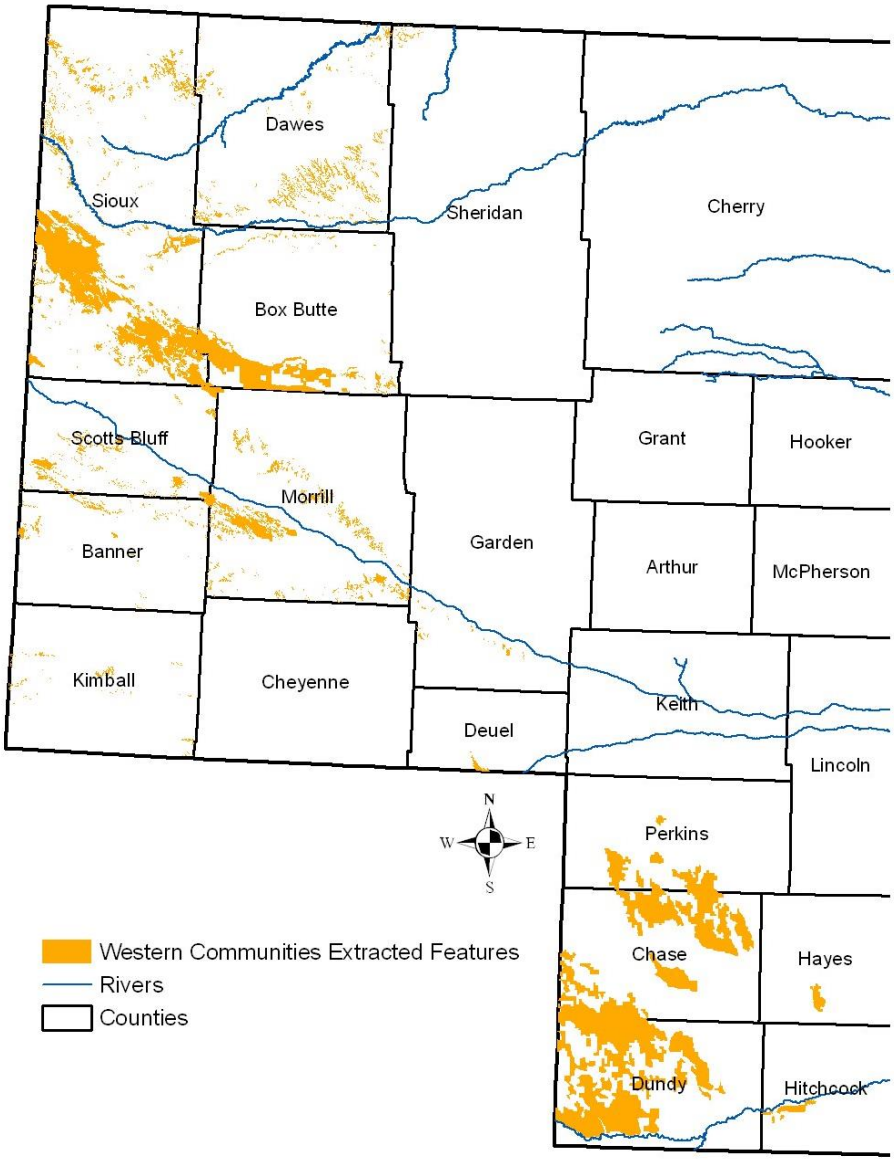


Table 9. NGPC Western Communities Extracted Features Crosswalk to HABS Land Cover Classes

NGPC Class	HABS Association/Condition	HABS Code
Badlands	Badlands/cliffs/outcrops	51
Rock outcrop	Badlands/cliffs/outcrops	51
Chalk-shale outcrop	Badlands/cliffs/outcrops	51
Alkaline meadow	Saline wetland	153
Sand sage	Sand sage	87
Sand sage – western mixed grass prairie transition	Sand sage	87

Final Land Cover and Intended Uses

The final Nebraska land cover maps over 49 million acres of habitats that influence wildlife population distribution and abundance (Figure 6). As expected, the Nebraska landscape is dominated by grasslands and agriculture (27 and 14 million acres, respectively) (Table 10). Roads and development (2 million acres) and woodlands (1 million acres) fragment the open landscape. Although very important to many wildlife species, wetlands today comprise a small fraction of the landscape (300,000 acres).

All land cover datasets inherently contain error. Land cover datasets record one snapshot in time, but the landscape can change very quickly. In addition, remote sensing and GIS mapping techniques sometimes lack precision for identifying particular types of habitats (e.g. shrublands comprised of small, scattered shrubs) or identifying very small landscape features (e.g. playa wetlands <1 ac in size). An informal preliminary accuracy assessment based on aerial photo comparison indicates that this land cover correctly classifies to broad landscape categories (i.e. cropland, grassland, woodland, developed, etc.) with 95% accuracy. Funding is being sought to conduct a formal accuracy assessment including field ground-truthing which would provide the detailed information necessary to assess the accuracy of fine-level classification to association and conditions. Unless this accuracy assessment is completed, we cannot quantify the types and extent of errors in the Nebraska land cover.

We offer these cautions in appropriate use and interpretation of the land cover:

- Due to inclusion of heterogeneous coverage from regional datasets in the Nebraska land cover, statewide accuracy is also likely heterogeneous. Statewide spatial models run using this dataset should be interpreted only with full understanding of the datasets that were used to build this land cover.
- The amount of upland woodlands is likely underestimated. Small woodland features like shelterbelts are frequently missed in the Ecosystems base layer, so portions of the state that have not had any additional land cover refinement likely contain significantly more forest/woodland than is mapped in the Nebraska landcover. In addition, a significant proportion of the acres generally classified as “Forest/Woodland” are likely Eastern Red Cedar.
- “Wet meadow” has a variety of definitions. In the Nebraska land cover, wet meadow is mapped primarily as a function of hydrology and is defined somewhat broadly. Although wet meadows may be correctly classified on this basis, wet meadow-associated plants and animals likely use a species-specific subset of these wet meadow features.

Additional questions should be directed to the Great Plains GIS Partnership Office, 203 W 2nd St, Grand Island, NE, 68801, 308-382-6468.

Figure 6. Nebraska Land Cover

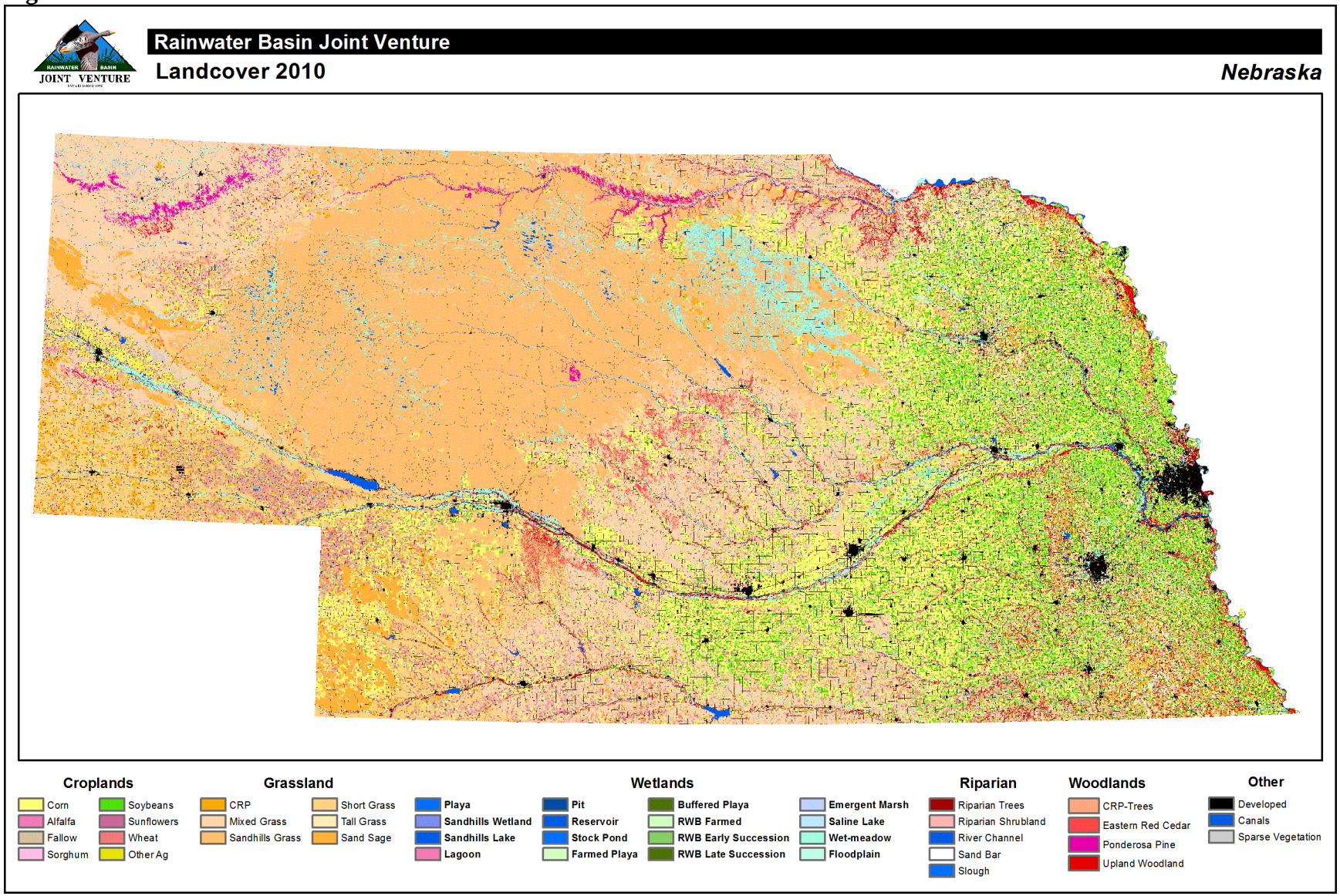


Table 10. Nebraska Final Land Cover Acres Comparison with Ecosystems Layer

Association	Condition	HABS Code	Base Layer (Ecosystems) Acres	NE Landcover V10 Acres	Change
CRP	Grass	31	0	1,025,417	1,025,417
CRP	Trees-upland	32	0	29,178	29,178
CRP	Trees-riparian	33	0	3,558	3,558
CRP	Wetland	34	0	9,696	9,696
CRP	Wetland-playa/nonfloodplain	35	0	178	178
CRP	Other	36	0	3,736	3,736
CRP		39	0	8,273	8,273
CRP Total			**0**	**1,080,037**	**1,080,037**
Other	Other roads	41	0	1,262,134	1,262,134
Other	Rural developed	42	0	490,514	490,514
Other	4-lane roads	44	0	108,262	108,262
Other	Urban/suburban	46	295,429	373,356	77,927
Other	Other	48	2,491	13,077	10,586
Other Total			**297,920**	**2,247,342**	**1,949,422**
Badlands/Cliffs/Outcrops		51	107,639	96,875	-10,764
Sparse Vegetation Total			**107,639**	**96,875**	**-10,764**
Forest/Woodland	Eastern Red Cedar	59	79,617	298,009	218,392
Ponderosa Pine	Many trees, little understory	60	167,152	110,486	-56,666
Forest/Woodland		61	272,211	859,600	587,389
Ponderosa Pine		63		86,467	86,467
Juniper		66	6,850	2,491	-4,359
Ponderosa Pine	Few trees, grassy understory	69	49,016	39,675	-9,341
Upland Woodlands Total			**574,846**	**1,396,727**	**821,881**
Mixed Grass		71	9,572,399	10,039,962	467,563
Sandhills Grasslands		73	11,846,162	11,536,055	-310,107
Shortgrass		75	2,272,251	2,916,928	644,677
Tallgrass		77	1,528,296	1,959,742	431,446
Sand Sage		87	154,075	641,831	487,756
Grasslands Total			**25,373,183**	**27,094,518**	**1,721,335**
Reservoirs Lakes Ponds		1	89	89	0
Reservoirs Lakes Ponds	Freshwater lake	101	7,117	87,268	80,151
Reservoirs Lakes Ponds	Lagoon	102	0	3,647	3,647
Reservoirs Lakes Ponds	Pit	103	23,040	47,326	24,286
Reservoirs Lakes Ponds	Reservoir	104	98,654	110,575	11,921
Reservoirs Lakes Ponds	Stock pond	106	13,433	115,734	102,301
Reservoirs Lakes Ponds Total			**142,333**	**364,638**	**222,305**
Playas		12	0	31,936	31,936
Playas	Farmed	121	0	10,942	10,942
Playas	Grassland/Buffered	122	0	3,469	3,469
Sandhills Wetlands		13	178	74,903	74,725
Rainwater Basin		14	0	712	712
Rainwater Basin	Farmed	141	0	11,120	11,120
Rainwater Basin	Early successional	142	0	20,727	20,727
Rainwater Basin	Late successional	143	0	11,565	11,565
Other Wetlands	Emergent marsh	152	0	98,387	98,387
Other Wetlands	Saline	153	0	16,279	16,279
Wetlands Total			**178**	**280,039**	**279,861**

Table 10. Nebraska Land Cover V10 Acres Comparison with Ecosystems Layer Cont.

Association	Condition	HABS Code	Base Layer (Ecosystems) Acres	NE Landcover V10 Acres	Change
Cropland		38	20,483,259	6,316	-20,476,943
Cropland	Alfalfa	201	534	600,466	599,932
Cropland	Corn	202	1,423	8,083,601	8,082,178
Cropland	Fallow	203	0	576,091	576,091
Cropland	Sorghum	206	0	162,615	162,615
Cropland	Soybeans	207	356	3,117,172	3,116,816
Cropland	Sunflowers	208	0	9,163	9,163
Cropland	Wheat	209	178	1,214,453	1,214,275
Cropland	Other	211	89	154,609	154,520
Cropland Total			**20,485,838**	**13,924,485**	**-6,561,353**
Riverine Systems		24	89	0	-89
Riverine Systems	Riparian canopy	241	247,036	563,548	316,512
Riverine Systems	Exotic riparian shrubland	242	0	5,337	5,337
Riverine Systems	Native riparian shrubland	243	0	68,231	68,231
Riverine Systems	River channel	244	154,609	128,455	-26,154
Riverine Systems	Unvegetated sandbar	245	0	35,939	35,939
Riverine Systems	Warmwater slough	246	0	712	712
Riverine Systems	Wet meadow	247	2,187,652	2,272,606	84,954
Riverine Systems	Floodplain marsh	248	0	20,638	20,638
Riverine Systems Total			**2,589,385**	**3,095,467**	**506,082**
Grand Total			**49,571,322**	**49,580,129**	

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Chapman, S.S., Omernik, J.M., Freeouf, J.A., Huggins, D.G., McCauley, J.R., Freeman, C.C., Steinauer, G., Angelo, R.T., and R.L. Schlepp. 2001. Ecoregions of Nebraska and Kansas (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,950,000).

Cowardin, L.M., V. Carter, F. Golet, and E. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service. 103 pp.

Appendix A. Nebraska Landcover Development HABS Ruleset Codes and Criteria

Code	Purpose	Spatial Criteria
R1	Distinguish upland forest/woodland and riparian canopy.	Forest/woodland intersects SSURGO frequently-flooded soils; riparian does not.
R2	Distinguish grassland and wet-meadow.	Wet-meadow intersects SSURGO frequently-flooded soils; grassland does not.
R3	Refine wet-meadow in the Sandhills	Wet-meadow in the Sandhills not occurring on SSURGO frequently-flooded or subirrigated soil is converted to sandhills grassland. Sandhills grassland occurring on subirrigated soil is converted to wet-meadow.
R4	Distinguish ponderosa pine and eastern red cedar	If located within Wildcat Hills or Pine Ridge, then Ponderosa Pine; otherwise, eastern red cedar.
R5	Refine shrubland classes	If intersects SSURGO frequently-flooded soils, then riparian shrubland. If upland shrubland within Shortgrass Prairie ecoregion, then Sand Sage. All other upland shrublands, Eastern Red Cedar.
R6	Refine open water classes	Open water pixels are assigned the wetland attribute of the SSURGO dataset water feature that they intersect.

Appendix B1. NWI Codes Crosswalk to Associated HABS Habitat Classes

	SYSTEM	CLASS	WATER REGIME MOD.	SPECIAL MOD.	HABS Spatial Criteria	ASSOCIATION	CONDITION
Palustrine	P	AB	C, E, B, A, J, W, Y	None, x, d	Does not Intersect floodplain*	15	152
	P	EM	C, E, B, A, J, W, Y	None, x, d	Does not Intersect floodplain*	15	152
	P	UB	C, E, B, A, J, W, Y	None, x, d	Does not Intersect floodplain*	15	152
	P	US	C, E, B, A, J, W, Y	None, x, d	Does not Intersect floodplain*	15	152
	P	AB	C, E, B, A, J, W, Y	None, x, d	Intersects floodplain*	24	247
	P	EM	C, E, B, A, J, W, Y	None, x, d	Intersects floodplain*	24	247
	P	UB	C, E, B, A, J, W, Y	None, x, d	Intersects floodplain*	24	247
	P	US	C, E, B, A, J, W, Y	None, x, d	Intersects floodplain*	24	247
	P	AB, EM, UB, US	C, E, J, G, U	None, x, d	Sandhills ecoregion	13	13
	P	AB, EM, UB, US	B, Y, F	None, x, d	Sandhills ecoregion	13	152
	P	AB, EM, UB, US	A, W	None, x, d	Sandhills ecoregion	13	247
	P	AB, EM, UB, US	H	None, x, d	Sandhills ecoregion	13	101
	P	AB	F, G, H, U	None, x, d, b	Does not Intersect floodplain*	15	152
	P	EM	F, G, H, U	None, x, d, b	Does not Intersect floodplain*	15	152
	P	UB	F, G, H, U	None, x, d, b	Does not Intersect floodplain*	15	152
	P	AB	F, G, H, U	None, x, d, b	Intersects floodplain*	24	248
	P	EM	F, G, H, U	None, x, d, b	Intersects floodplain*	24	248
	P	UB	F, G, H, U	None, x, d, b	Intersects floodplain*	24	248
	P	AB	Any	h	≤ 40 ac	1	106
	P	EM	Any	h	≤ 40 ac	1	106
	P	UB	Any	h	≤ 40 ac	1	106
	P	US	Any	h	≤ 40 ac	1	106
	P	AB	Any	h	> 40 ac	1	104
	P	EM	Any	h	> 40 ac	1	104
	P	UB	Any	h	> 40 ac	1	104
	P	US	Any	h	> 40 ac	1	104
	P	AB	K	None, x		15	151
	P	EM	K	None, x		15	151
	P	UB	K	None, x		15	151
	P	US	K	None, x		15	151
	P	FO	Any	Any	Intersects floodplain*	24	241
	P	SS	Any	Any		24	243
	P	SB	Any	Any		24	243

Appendix B1. NWI Codes and Associated HABS Habitat Classes (Continued)

	SYSTEM	CLASS	WATER REGIME MOD.	SPECIAL MOD.	HABS Spatial Criteria	ASSOCIATION	CONDITION
Lacustrine	L	AB	Any	None, d		1	101
	L	UB	Any	None, d		1	101
	L	US	Any	None, d		1	101
	L	AB	Any	x		1	103
	L	UB	Any	x		1	103
	L	US	Any	x		1	103
	L	AB	Any	h	≤ 40 ac	1	106
	L	UB	Any	h	≤ 40 ac	1	106
	L	AB	Any	h	> 40 ac	1	104
	L	UB	Any	h	> 40 ac	1	104

	SYSTEM	CLASS	WATER REGIME MOD.	SPECIFIC MOD.	Spatial Criteria (PLJV)	ASSOCIATION	CONDITION
Riverine	R	UB	G, H, B, F	None, x, h		24	244
	R	US	G, H, B, F	None, x, h		24	244
	R	SB	F, C, A	None, x		24	244
	R	US	C, A	None, x		24	245

*The floodplain was delineated by selecting frequently flooded soils from the SSURGO layer. Query completed using soil data viewer extension.

Appendix B2. NWI Wetlands and Deepwater Habitats Classification and Codes (Cowardin et al 1979)

System	R - Riverine						
Subsystem	1 - Tidal	2 – Lower Perennial	3 – Upper Perennial	4* - Intermittent	5** – Unknown Perennial		
Class	RB – Rock Bottom	UB – Unconsolidated Bottom	SB*** – Streambed	AB – Aquatic Bed	RS – Rocky Shore	US – Unconsolidated Shore	EM – Emergent
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble 3 Cobble-Gravel 4 Sand 5 Mud 6 Organic 7 Vegetated	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent

* **Intermittent** is limited to the **Streambed** Class
** **Unknown Perennial** is limited to **Unconsolidated Bottom**
*** **Streambed** is limited to **Tidal** and **Intermittent** Subsystems

Appendix B2 (cont). NWI Wetlands and Deepwater Habitats Classification and Codes (Cowardin et al 1979)

System	L - Lacustrine									
Subsystem	1 - Limnetic			2 - Littoral						
Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RS – Rocky Shore	US – Unconsolidated Shore	EM – Emergent	
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent	

System	P - Palustrine							
Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	US – Unconsolidated Shore	ML – Moss-Lichen	EM – Emergent	SS – Scrub-Shrub	FO – Forested
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	1 Moss 2 Lichen	1 Persistent 2 Nonpersistent 5 *Phragmites australis*	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen

MODIFIERS

In order to more adequately describe the wetland and deepwater habitats, one or more of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy. The farmed modifier may also be applied to the ecological system.

Water Regime			Special Modifiers	Water Chemistry			Soil
Nontidal	**Saltwater Tidal**	**Freshwater Tidal**		**Coastal Halinity**	**Inline Salinity**	**pH Modifiers for all Fresh Water**	
A Temporarily Flooded	L Subtidal	S Temporarily Flooded-Tidal	b Beaver	1 Hyperhaline	7 Hypersaline	a Acid	g Organic
B Saturated	M Irregularly Exposed	R Seasonally Flooded-Tidal	d Partly Drained/Ditched	2 Euhaline	8 Eusaline	t Circumneutral	n Mineral
C Seasonally Flooded	N Regularly Flooded	T Semipermanently Flooded-Tidal	f Farmed	3 Mixohaline (Brackish)	9 Mixosaline	l Alkaline	
E Seasonally Flooded/ Saturated	P Irregularly Flooded	V Permanently Flooded-Tidal	h Diked/Impounded	4 Polyhaline	0 Fresh		
F Semipermanently Flooded			r Artificial	5 Mesohaline			
G Intermittently Exposed			s Spoil	6 Oligohaline			
H Permanently Flooded			x Excavated	0 Fresh			
J Intermittently Flooded							
K Artificially Flooded							

Appendix B2 (cont). NWI Wetlands and Deepwater Habitats Classification and Codes (Cowardin et al 1979)

Other Water Regime Modifier codes not listed above:

W: Intermittently Flooded/Temporary

Y: Saturated/Semipermanent/Seasonal

U: Unknown