United States Department of Agriculture
Natural Resources Conservation Service

CEAP Conservation Insight

September 2008

The Wetlands Reserve Program Supports Migrating Waterfowl in Nebraska's Rainwater Basin Region

Summary Findings

- Wetland habitats of the Rainwater Basin (RWB) region of south-central Nebraska provide critical food resources to mid-continental migrating waterfowl.
- Less than 20 percent of historic RWB wetland habitat remains in this highly agricultural region.
- Over 3,000 acres of wetland habitat have been restored in the RWB through the Wetlands Reserve Program (WRP).
- Bio-energetic modeling reveals that nearly 12 percent of the wetland-derived food available to waterfowl migrating through the RWB is provided by WRP wetlands.
- Despite the presence of WRP wetlands, approximately 44 percent more wetland-derived waterfowl food energy is needed in the RWB to meet all energy requirements of the estimated 12.4 million waterfowl that migrate through this area (2.6 million in fall; 9.8 million in spring).

Recommendations

- Continued management of WRP wetlands in early successional habitat can maximize production of food resources for migrating waterfowl in the RWB.
- As irrigation practices in the RWB shift from gravity systems to center-pivot systems, irrigation tailwater pits can be eliminated to restore and enhance the hydrology of down-slope wetlands.
- Decision support tools developed by the Rainwater Basin Joint Venture can maximize the value of future WRP enrollments for migrating waterfowl habitat.

Background

The Rainwater Basin region (RWB) consists of a 6,150 mi^2 area of loess plains in south-central Nebraska (figure 1). The area is characterized by rolling plains formed by deep deposits of wind-blown silt with a high density of claypan playa wetlands. More than 200,000 acres of wetlands once existed in this region. As a result of agricultural and other development, only 17 percent of the original playa wetland area remains, most with hydrologic alterations. Siltation and colonization by invasive plant species (e.g., reed canary grass, narrow-leaved cattail, river bulrush) continue to threaten remaining wetland habitats in the RWB.

Despite historic wetland loss and degradation, the remaining playa wetlands in the RWB provide critical fall and spring habitat for migrating waterfowl. The RWB is located at the focal point of an hourglass where the Central Flyway narrows as millions of ducks and geese travel north from their wintering grounds during spring migration (figure 2). Wetlands in the RWB provide essential food resources and staging areas for northbound birds while they wait for northern wetlands to thaw.

This seasonal congregation of waterfowl includes up to 90 percent of the mid-continental population of greater white-fronted geese, approximately 50 percent of mid-continent mallards, and 30 percent of the continental breeding population of northern pintails. An increasing number (>1.5 million) of lesser snow geese also migrate through the area. On average, a total of 9.8 million waterfowl move through the RWB during spring migration. Although fall migration patterns in the Central Flyway are less constricted, approximately 2.6 million waterfowl still migrate through the RWB in the fall.

In response to the critical importance of the RWB wetlands to migrating waterfowl, state and Federal wildlife agencies have managed to secure protection of 31,700 acres of playa wetlands in the RWB since the 1960s. Since much of the surrounding landscape is active cropland, these wetlands are intensively managed in early successional wetland vegetation to maximize their value to migrating waterfowl.

The Wetlands Reserve Program (WRP) provides technical and financial assistance to eligible landowners to restore, enhance, and protect wetlands through

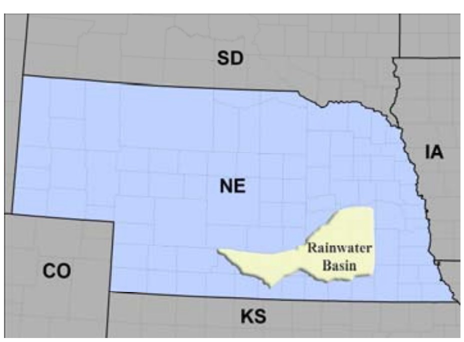

Figure 1. The Rainwater Basin region encompasses parts of 21 counties in south-central Nebraska.

Figure 2. The Rainwater Basin is located at a focal point of Central Flyway spring waterfowl migration.

30-year or perpetual conservation easements. The goal of the program is to achieve the greatest wetland functions and values, including optimum wildlife habitat. The program has filled a unique conservation niche in the RWB landscape by enabling complete hydrologic restoration of enrolled basins and engaging private landowners in wetland management with NRCS assistance. The program provides substantial benefit to migrating waterfowl as WRP tracts are actively managed to optimize waterfowl habitat value, and the juxtaposition of WRP tracts complements wetland habitats on adjacent public properties.

Evaluation Partnership

In 2007, a partnership was formed among the NRCS, Rainwater Basin Joint Venture (RWBJV), Playa Lakes Joint Venture, and Farm Service Agency to evaluate the effects of the Conservation Reserve Program and the WRP on priority birds of the Great Plains region. This partnership was formed in support of the Wildlife Component of the Conservation Effects Assessment Project (CEAP). Part of the evaluation, conducted by the U.S. Fish and Wildlife Service (USFWS) Habitat and Population Evaluation Team (HAPET) and Nebraska Game and Parks Commission (NGPC) on behalf of the RWBJV, was an assessment of the contribution of WRP wetlands in the RWB to support migratory waterfowl. This *Conservation Insight* provides a synopsis of the WRP evaluation; full details are available from the final project report, which is posted at ftp://ftp-fc.sc.egov.usda.gov/NHQ/nri/ceap/RWB_WRP_Final%20Report.pdf

Assessment Approach

To assess the benefits of WRP to migratory waterfowl populations, a bio-energetics model was developed to measure landscape forage capacity in the context of the energetic requirements of waterfowl that depend on the RWB region during migration. Elements of the bio-energetics model used in this assessment include the following:

1. Data sets used to estimate landscape carrying capacity:
   a. A geospatial data layer representing acres of primary foraging habitat.
   b. Findings from literature that allows the conversion of acres of each primary foraging habitat to a caloric measure of food energy available to waterfowl using the region.
2. An estimate of the food energy requirements of waterfowl using the region.

Data from a combination of traditional surveys and existing literature were used to estimate number of individuals, average residency time, and caloric requirements by species. This information made it possible to estimate the caloric requirements of waterfowl using the region during migration. Table 1 lists the waterfowl populations assessed.

Two landscape scenarios were considered in quantifying the benefit of WRP wetlands to migrating waterfowl energetic carrying capacities in the RWB:

1. Landscape configuration containing current WRP wetlands as implemented in the RWB.
2. The RWB landscape where all WRP easements were treated as active cropland (landscape without WRP).

The difference in energetic carrying capacity between the two scenarios represents the WRP contribution. Assumptions underlying this approach are that—

- all WRP parcels were once actively cultivated agricultural lands before enrollment,
- complete hydrologic restoration has been conducted on WRP wetlands to the extent of the hydric soil footprint, and
- WRP wetland basins are being actively managed to maintain the vegetation community in an early successional stage.

A five-step process was used to create and compare the scenarios in this assessment. Each is briefly described below.

Step 1: Delineate wetland boundaries on WRP easements in the RWB.
As of December 2007, there were 71 WRP easements (4,955 acres) on playa wetlands in the RWB. Easement boundaries were established in a GIS by USFWS and NGPC private lands biologists who coordinated with NRCS in delivery of these WRP projects. The NRCS Soil Survey Geographic (SSURGO) hydric soil footprint was intersected with the WRP easement boundary to delineate the wetland and upland components of individual WRP tracts. Results were visually assessed and compared with site-specific project information to ensure that hydric soils accurately reflected the extent of restoration completed at each site.

Step 2: Create geospatial land cover representing habitats in the RWB.
Using a combination of remote sensing (RS) and GIS techniques, a seamless land cover data layer was created for the RWB region. These data were used to determine the energetic carrying capacity of the landscape for waterfowl. This

Table 1. Waterfowl populations considered in the bio-energetics model developed for the Rainwater Basin

Species	Population Included
Mallard	Mid-continent
Northern pintail	Traditional Survey Area[1]
Blue-winged teal	Traditional Survey Area
American green-winged teal	Traditional Survey Area
Northern shoveler	Traditional Survey Area
American wigeon	Traditional Survey Area
Gadwall	Traditional Survey Area
Light geese (lesser snow goose/Ross's goose)	Mid-continent
Canada goose	Great Plains
	Western Prairie
	Tall Grass Prairie
Greater white-fronted goose	Mid-continent

[1] Traditional Survey Area is taken from the U.S. Fish and Wildlife Service and Canadian Wildlife Service's Waterfowl Breeding Population and Habitat Survey.

analysis revealed that approximately 75 percent of the 3.9 million-acre RWB landscape is under cultivation; grassland habitats make up approximately 20 percent of the region; and 3 percent of the area is covered by woodland/forest communities, confined generally to the drainages associated with the Blue River system. River-associated wetlands comprise about 2 percent of the landscape. Today RWB wetlands make up less than 1 percent of the total landscape.

The Rainwater Basin supports approximately 30 percent of the mid-continental breeding population of northern pintails.

Step 3: Define waterfowl energetic forage value of habitats in the RWB.
To estimate waterfowl forage capacity in the RWB, acreage in each habitat type was converted to energetic potential. In the RWB, waterfowl acquire energy primarily from waste grain and seeds produced by different wetland vegetation communities. A combination of field and laboratory research was used to estimate the caloric food energy that each acre of the various primary waterfowl forage habitats can provide (table 2).

Waterfowl foraging efficiency declines as resources are depleted. Studies suggest a threshold of 20 kg/acre of dry seed mass at which point waterfowl no longer forage efficiently (Reinecke et al. 1989). The amount of energy waterfowl can derive from 1 gram of seed is described as true metabolizable energy (TME). TME is represented as kcal of energy per gram of forage (kcal/g). This value is central to a bio-energetic model as it allows grams of seed per acre to be represented as energy (kcal) per acre. This conversion allows a bio-energetic model to relate available forage to waterfowl energetic requirements. For example, Kaminski et al. (2003) determined the average TME for moist soil seeds to be 2.47 kcal/gram. Thus, 1 acre of early succession RWB wetland habitat can provide approximately 250,000 kcal of energy compared to late succession habitats, which can provide approximately 25,000 kcal of energy (table 2). Other habitat types provide substantially less available waterfowl food energy per acre (table 2).

Landscape foraging capacity was estimated by multiplying the acres of each primary forage habitat type (from the GIS land cover) by the corresponding energy-per-acre constant in table 2. The sum of the energy these habitats provide is the energetic estimate for the region (table 3).

The RWB landscape contains approximately 2.6 million acres of suitable primary foraging habitats (table 3). These habitats provide approximately 237 billion kcal of energy. Wetland habitats provide approximately 6.5 billion kcal of energy, while agriculture foraging habitats provide approximately 230.5 billion kcal of energy (table 3). Although agricultural habitats provide the vast majority of potential food energy, corn and soybeans cannot provide all the dietary requirement of waterfowl (Loesch and Kaminski 1989, Krapu et al. 2004).

Step 4: Determine energetic foraging requirements by species utilizing the RWB.
The initial steps determined the RWB landscape's potential waterfowl food energetic carrying capacity. The next step involves developing waterfowl population-based energy demands. Wildlife managers in the RWB manage

Table 2. Important waterfowl forage habitats and associated energetic value estimates for the Rainwater Basin region

Habitat Type	Total Food Available[1]	Food - Forage Threshold	Food Available	True Metabolizable Energy[2]	Energy/Acre
	Kg/acre	*Kg/acre*	*g/acre*	*kcal/g*	*kcal/acre*
Wetland - early succession (Managed)	121	101	101,214.6	2.47	250,000
Wetland - late succession (Unmanaged)	30	10	10,121.5	2.47	25,000
Farmed wetland- early succession	61	40	40,485.8	2.47	100,000
Reservoir, Stock dam	30	10	10,121.5	2.47	25,000
Corn	61	40	40,485.8	3.67	148,583
Soybeans	24	4	4,048.6	2.65	10,729

[1]From Smith and Haukos (1993), Krapu et al. (2004), Rabbe et al. (2004), and Cox and Davis (2005).
[2]From Reinecke et al. (1989).

habitats to maintain waterfowl body condition during fall migration and seek to provide sufficient energetic resources so waterfowl can increase lipid reserves during spring migration, enhancing reproductive potential.

An average of 2.6 million waterfowl migrate through the RWB in the fall and 9.8 million waterfowl use the region in spring. These migrants will require 24.1 billion kcal to meet their energetic requirements. To meet the nutritional requirements that cannot be extracted from waste grain, 39 percent or 9.5 billion kcal should come from wetland-derived food sources.

Step 5: Conduct GIS analysis to determine landscape carrying capacity. Existing land cover that includes WRP early successional wetland cover was compared with the scenario that includes WRP sites treated as agriculture (corn). As currently implemented, WRP tracts contain approximately 1,950 acres of upland and 3,050 acres of wetland. These land cover features were included in the analysis.

Findings

WRP wetlands increase wetland forage. The presence of WRP wetlands increases overall forage capacity in the region by 30 million kcal (table 4). Although total forage availability is only slightly greater, the presence of WRP wetlands increases wetland-based forage by 763 million kcal (table 4). Thus, WRP in the RWB has increased wetland acreage by 8 percent, and more importantly, resulted in a 13-percent increase in wetland-based forage available to waterfowl. Stated another way, nearly 12 percent of the wetland-derived forage available for migrating waterfowl in the RWB is being provided by WRP wetlands.

Analysis of the 2004 land cover suggests that a total of 237 billion kcal of energy are available from primary foraging habitats in the RWB Region (table 4). In the fall, individual migratory birds will require 2.0 billion kcal of energy during their residency in the RWB, while in the spring approximately 22.1 billion kcal are needed. In total, 24.1 billion kcal will be consumed by migratory waterfowl using the RWB during a normal fall and spring migration.

Additional early successional wetland habitat is needed. On the surface, these data would suggest that migrating waterfowl forage resources are not limiting in the RWB. However, when dietary selection and nutritional requirements of waterfowl are considered, wetland habitats *are* limited. Waste grain is high in caloric energy but lacks important protein and minerals. Waterfowl rely on wetland habitats to acquire these dietary components. In the RWB, waterfowl would need approximately 9.5 billion kcal from wetland-derived food sources during the annual migration (fall and spring). Before delivery of the WRP, the RWB region could provide less than 5.8 billion kcal of energy from wetland habitats (table 4). Even with the 13 percent increase in wetland-derived forage available in WRP wetlands, the RWB is still about 3 billion kcal short of meeting the wetland dependent forage requirements for all migratory waterfowl that use the region, likely causing birds to arrive on the breeding grounds in poorer condition and negatively impacting population recruitment.

Maintaining wetlands in early successional vegetation in the RWB is important to maximize migrating waterfowl food production value. With the assistance of NRCS, landowners in the RWB have demonstrated a commitment to managing WRP wetlands to maintain early successional conditions.

Wetland habitat conditions vary substantially in response to weather patterns, affecting the waterfowl food available in any given year (table 5). To account for climactic variation, additional habitat and a focus on hydrologic restoration are required. The WRP and other conservation programs play an important role in providing these flooded habitats.

The RWBJV is using these results to evaluate the appropriate acres of habitat that should be protected, restored, and enhanced across the landscape to ensure annual suitable habitat for migratory waterfowl. The RWBJV is also in the

Table 3. Potential energy available to waterfowl from primary foraging habitats in the Rainwater Basin region

Wetland Habitats	Acres	Suitable Acres	Energy/Acre[1]	Available Energy
			kcal/acre	*kcals thousands*
Wetland - early succession	21,857	21,857	250,000	5,464,236
Wetland - late succession	10,456	10,456	25,000	261,403
Farmed wetland	7,902	7,902	100,000	790,213
Reservoir, Stock Dam (5% of total area considered suitable)	23,858	1,193	25,000	29,823
Total	**64,210**	**41,544**		**6,545,675**
Agriculture Habitats	**Acres**	**Suitable Acres**	**Energy/Acre**	**Available Energy**
			kcal/acre	*kcals thousands*
Soybeans	1,078,548	1,078,548	10,724	11,566,351
Corn	1,476,609	1,476,609	148,253	218,911,689
Total	**2,554,941**	**2,555,157**		**230,478,039**
Total All Habitats	**2,619,151**	**2,596,701**		**237,023,714**

[1]From table 2.

process of updating its implementation plan, using foraging habitat as the principal factor limiting waterfowl during spring migration. One potential new habitat goal would be to deliver sufficient habitat so adequate acres would be flooded as a result of 'average' precipitation conditions. Based on the estimate that 40,215 acres of wetland habitat currently exist in the RWB, 162,500 additional acres of early succession wetland acres would be needed to meet waterfowl forage requirements in an average year. In addition to greater wetland restoration efforts, management of wetlands in early successional vegetation will be required to provide sufficient forage habitat.

Management of irrigation water can enhance wetland habitat.

Over 70 percent of the RWB region is under agriculture cultivation, with 65 percent under irrigation (22.5 percent gravity, 77.5 percent center-pivot). Before the advent of pivot irrigation, nearly all of this land was gravity irrigated. Often associated with gravity irrigation is the use of tailwater recovery pits that catch runoff and allow the producer to maximize groundwater use for cultivation of crops. These pits catch not only irrigation runoff but also natural precipitation, typically preventing surface water from reaching down-slope wetlands. A recent GIS inventory of irrigation tailwater recovery pits documented 10,217 pits in the RWB, many of which are no longer used for gravity irrigation. Surveys indicate that at full saturation, 44 percent of the surface water in the RWB is stored in irrigation tailwater recovery pits and 56 percent is contained in wetlands. This helps to illustrate the effect that offsite hydrologic modifications can have on RWB wetland function. With the conversion to pivot irrigation systems that no longer use irrigation reuse pits, a tremendous opportunity exists to restore wetland function through off-site hydrologic restoration by redirecting water from unused recovery pits to wetlands, making wetland habitats containing surface water available on a more regular basis.

Table 4. Land cover and waterfowl forage estimates pre- and post-WRP implementation in the Rainwater Basin region

RWB Pre-WRP				
Wetland Habitats	**Acres**	**Suitable Acres**	**Energy/Acre**	**Available Energy**
			kcal/acre	*kcal (x 1000)*
RWB Early Succession	18,807	18,807	250,000	4,701,750
RWB Late Succession	10,456	10,456	25,000	261,403
RWB Farmed	7,902	7,902	100,000	790,213
Lake	23,858	1,193	25,000	29,823
Total	**60,535**	**38,358**		**5,783,188**
Agriculture Habitats	**Acres**	**Suitable Acres**	**Energy/Acre**	**Available Energy**
			kcal/acre	*kcal (x 1000)*
Soybeans	1,078,548	1,078,548	10,729	11,571,469
Corn	1,481,501	1,481,501	148,583	220,125,801
Total	**2,560,729**	**2,560,049**		**231,697,269**
Total Pre-WRP	**2,621,264**	**2,598,599**		**237,480,458**

RWB Post-WRP				
Wetland Habitats	**Acres**	**Suitable Acres**	**Energy/Acre**	**Available Energy**
			kcal/acre	*kcal (x 1000)*
RWB Early Succession	21,857	21,857	250,000	5,464,236
RWB Late Succession	10,456	10,456	25,000	261,403
RWB Farmed	7,902	7,902	100,000	790,213
Lake	23,858	1,193	25,000	29,823
Total	**64,210**	**41,544**		**6,545,675**
Agriculture Habitats	**Acres**	**Suitable Acres**	**Energy/Acre**	**Available Energy**
			kcal/acre	*kcal (x 1000)*
Soybeans	1,078,548	1,078,548	10,729	11,571,469
Corn	1,476,609	1,476,609	148,583	219,398,963
Total	**2,554,941**	**2,554,941**		**230,970,432**
Total Post-WRP	**2,619,151**	**2,596,485**		**237,516,107**

Table 5. Estimates of various wetland habitats containing surface water in response to climate conditions and associated migrating waterfowl food availability in the Rainwater Basin region

		Wetland with surface water (acres)					
Year	Annual Precipitation	Farmed	Early successional	Late successional	Lacustrine	Available food energy	% of RWB wetland forage requirement met
						billion kcal	
2004	Average	1,400	4,100	2,100	1,200	1.3	13.0
2006	Dry	120	1,400	500	1,200	0.4	4.3
2007	Wet	2,500	6,400	2,500	1,200	2.0	20.6

From RWBJV aerial photo interpretation.

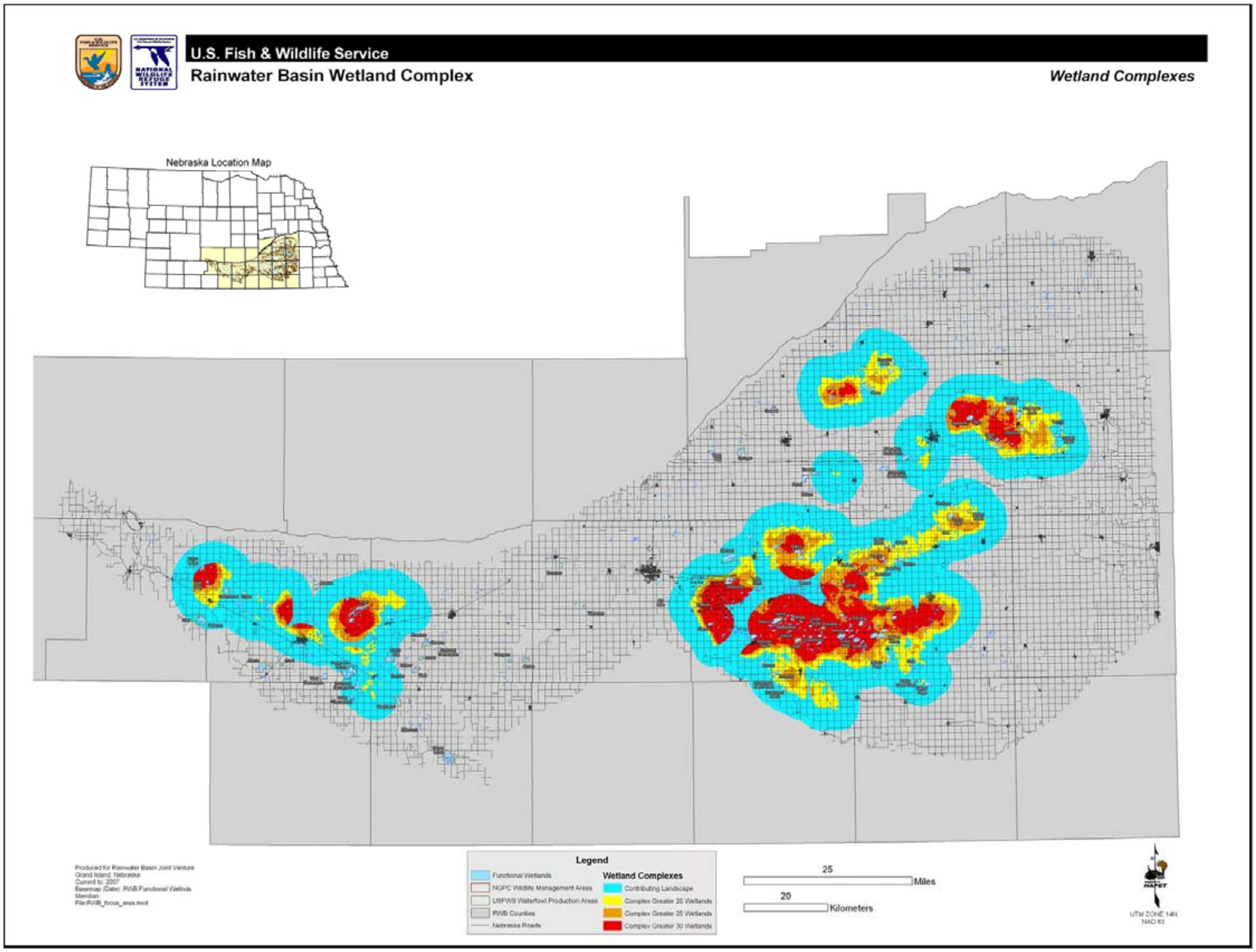

Figure 3. Wetland restoration priority focus areas associated with wetland complexes in the Rainwater Basin region used in the Rainwater Basin Joint Venture Decision Support Tool.

Wetland complexes are important. Wetland complexes containing a variety of wetland types receive greater waterfowl use than isolated wetlands (Gersib et al. 1989, Brennan 2006). HAPET has developed spatial models that identify areas on the landscape that have the potential to provide the highest quality wetland habitats for migratory waterfowl in the RWB. The product of this analysis has been integrated into Decision Support Tools (DST) to guide wetland conservation actions. Focus areas that have a high density of functioning wetlands with optimal wetland juxtaposition between wetland types should be higher in priority for wetland acquisition, restoration, and management activities (figure 3).

The RWBJV and HAPET also developed a USDA conservation-program-based spatial model that can be used to evaluate every hydric soil footprint based on potential program eligibility. A portion of the analysis also used the NRCS-Nebraska WRP criteria to estimate the rank a wetland would receive for enrollment in the WRP. This model can be used to conduct an initial assessment to determine the programs for which different RWB wetlands may be eligible. These types of tools help the RWBJV and its partners to deliver conservation projects, including WRP wetland restoration, in areas that provide the highest quality waterfowl habitat.

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The Conservation Effects Assessment Project: Building the Science Base

The Conservation Effects Assessment Project (CEAP) is a multi-agency effort to build the science base for conservation. Project findings will help to guide USDA conservation policy and program development and help farmers and ranchers make informed conservation choices.

One of CEAP's objectives is to quantify the environmental benefits of conservation practices for reporting at the national and regional levels. Because fish and wildlife are affected by conservation actions taken on a variety of landscapes, the wildlife national assessment draws on and complements the national assessments for cropland, wetlands, and grazing lands. The wildlife national assessment works through numerous partnerships to capitalize on relevant studies already underway, and it focuses on regional scientific priorities.

This assessment was conducted through a partnership among NRCS, Rainwater Basin Joint Venture, Playa Lakes Joint Venture, U.S. Fish and Wildlife Service Habitat and Population Evaluation Team, and Nebraska Game and Parks Commission.

Primary investigators on this project were Andrew Bishop (USFWS) and Mark Vrtiska (NGPC).

For more information:
www.nrcs.usda.gov/technical/NRI/ceap/