United States Department of Agriculture

Natural Resources Conservation Service

CEAP Conservation Insight
Conservation Effects Assessment Project

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# USDA Programs Help Meet Migrating Waterfowl and Shorebird Food Energy Needs on Rainwater Basin Wetlands in Nebraska

**Summary Findings**

The Rainwater Basin wetland complex (RWB) in Nebraska provides critical migration habitat for wetland-dependent birds. However, the historical loss of RWB wetlands has decreased the forage available for these birds. The Rainwater Basin Joint Venture (RWBJV) assessed the kilocalories accessible (food energy made available by flooding) to waterfowl and shorebirds on RWB wetlands in 2004 and 2012 based on wetland vegetation maps for the respective years.

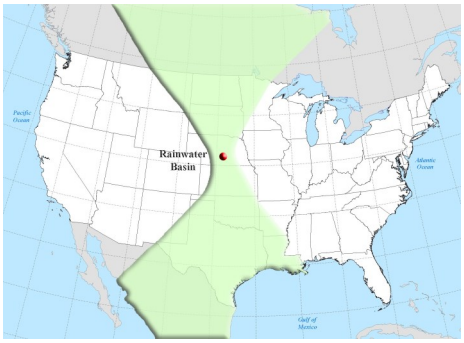
The 2012 accessible food energy for waterfowl on RWB wetlands was 1.3 billion kcal—0.13 billion kcal higher than in 2004. Wetlands Reserve Program (WRP) sites provided 0.13 billion kcal in 2012, or 10% of the total energy available. While waterfowl food resources increased from 2004 levels, the accessible food energy in 2012 was still 3.1 billion kcal below the 4.4 billion kcal that the RWBJV Waterfowl Plan estimated are needed to sustain the target migrating waterfowl population for the RWB.

The 2012 accessible food energy for shorebirds on RWB wetlands was 13.9 million kcal for small-bodied probers/gleaners, 29.4 million kcal for large-bodied probers, and 33.9 million kcal for swimmers. Those values decreased 0.1 million, 0.5 million, and 2.1 million kcal, respectively, between the years 2004 and 2012. WRP was responsible for providing 8–9% (1.2–2.6 million kcal) of the 2012 accessible kilocalories, depending on the shorebird foraging guild. Based on the estimated food energy needed to sustain target populations, the 2012 accessible kilocalories were sufficient to sustain the target swimmer population, but were short by 25.8 million kcal and 35.9 million kcal to sustain the target small-bodied prober/gleaner and large-bodied prober populations, respectively.

Vegetation management, WRP and Wetlands Reserve Easement wetland restoration, and Agricultural Land Easement cropped wetland restoration can produce additional waterbird food resources on NRCS easement wetlands. Flexibility in the enrollment options and management of NRCS wetland easements fosters landowner contributions to help meet waterbird habitat goals for the RWB.

## Background

The Rainwater Basin wetland complex (RWB), located in south-central Nebraska, provides important waterbird migration habitat in the Central Flyway, particularly during spring. The Rainwater Basin Joint Venture (RWBJV) Implementation Plan highlights the need for the RWB to have sufficient habitat to support approximately 8.6 million waterfowl and 500,000 shorebirds. While in the RWB, wetland-dependent birds replenish energy and nutrient reserves to continue migration and initiate nesting. However, 90% of the original 11,000 historical RWB wetlands have been lost or highly degraded, and virtually all of the remaining wetlands are hydrologically modified (Schildman and Hurt 1984, Smith 1998).




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

PHOTO: W. MEINZER, USFWS

The significant loss of RWB wetlands has decreased the region's ability to provide sufficient energy and nutrient resources for wetland-dependent birds (waterfowl, shorebirds, and other water birds). Energy and nutrient reserves acquired at migration staging areas are critical for successful reproduction and population recruitment on northern breeding grounds (Krapu 1981, Dubovsky and Kaminski 1994, Devries et al. 2008).

Croplands in the RWB region provide waste grain for waterfowl, but wetland seeds are necessary to compensate for waste grain's mineral and protein deficiencies (Loesch and Kaminski 1989, Pearse et al. 2011).

Conservation lands in the RWB, including the Natural Resources Conservation Service's (NRCS) Wetlands Reserve Program (WRP) easements (now Wetland Reserve Easements under the 2014 Farm Bill's Agricultural Conservation Easement Program—ACEP) help increase the amount of habitat and wetland foraging resources accessible to wetland-dependent birds.

**Assessment Partnership**

In 2004, the RWBJV, NRCS, Nebraska Game and Parks Commission, and U.S. Fish and Wildlife Service (USFWS) partnered to determine the amount of accessible forage, measured in kilocalories, RWB wetlands provide for waterfowl. Analyses were based on a 2004 vegetation map covering all historical RWB wetlands. Results are provided by Bishop and Vrtiska (2008) and summarized in NRCS (2008).

In 2012, the partnership examined changes in the RWB's migratory bird carrying capacity based on updated vegetation conditions. The 2012 accessible kilocalorie estimates described the contribution of WRP to the overall forage in the RWB. Also, comparisons between the 2004 and 2012 vegetation maps provided insight into the changes of vegetation communities on WRP and all RWB wetlands. The findings help guide management and programmatic planning for RWB wetlands to promote accessible forage resources for wetland-dependent birds.

This conservation insight summarizes the 2012 assessment approach and findings provided in more detail by Nugent et al. (2015). This insight summarizes estimates of the accessible forage resources for waterfowl and shorebirds on wetlands enrolled in WRP and across the RWB landscape, as well as how those resources changed between 2004 and 2012.

**Assessment Approach**

***Vegetation surveys.*** A total of 12,594 field survey points were located on conservation land wetlands, including 2,698 points on WRP sites, 248 on other long-term private conservation easements (e.g., easements held by Ducks Unlimited), 2,827 on state Wildlife Management Areas, and 6,821 on USFWS Waterfowl Production Areas (see Nugent et al. 2015 for full description of methods). Vegetation surveys were conducted between 27 August and 9 November, 2012. At each point, the percentage range of each vegetation cover type within a 1-$m^2$ sampling frame (Daubenmire 1959) was recorded. Cover types were chosen from a predetermined list of 37 species and groups of species selected based on their importance to wetland management and commonness.

PHOTO: STEVE DONOVAN, DUCKS UNLIMITED

Figure 1. Wetlands in the RWB provide important habitats for migrating waterfowl, as illustrated by this Wetlands Reserve Program restored wetland site in Clay County, Nebraska.

After surveys were completed, vegetation data were used to assign each survey point to one of nine map classes—Bare Soil/Mudflat, Cattail, Grass, Moist-Soil Species, Reed Canarygrass, River Bulrush, Water, Wet Meadow Species, or Woody Species. Map classes were chosen based on each class's unique importance to wetland wildlife and vegetation management.

***Vegetation map.*** To delineate the vegetation communities for the 2012 vegetation map, polygons were developed within the wetlands using eCognition Developer 8 (Trimble Germany GmbH, Munich, Germany). Three imagery sets (i.e., spring color infrared, mid-summer true color, and late-summer color infrared) were loaded into eCognition along with a shapefile of the 11,000 historical wetlands. Polygons were created with eCognition by grouping similar pixels based on imagery pixel values and neighborhood context. Similar groups of pixels were assumed to have similar dominant vegetation communities.

Polygons were then imported into ArcMap 10 (ESRI, Redlands, California), where they were combined with the vegetation survey data. Polygons with corresponding survey data were assigned as either training polygons used to create the vegetation map or testing polygons used to test the accuracy of the map. The polygons were then reloaded into eCognition, in which a supervised classification was conducted that assigned a map class to each polygon based on the properties of pixels contained within the training polygons. The parameters used for classification included the mean pixel value of each of the nine imagery bands, the standard deviation of each band, the maximum difference between imagery bands, and the brightness within each polygon.

The classified polygons were uploaded into ArcMap, where they were manually verified twice based on training polygons, aerial imagery, elevation, and surrounding vegetation communities. The map class Agriculture was also created and assigned to cultivated portions of hydric soils that showed no wetland signature. The map class Cropped Wetland was developed to represent portions of hydric soils embedded in crop fields that often flood; although cultivated, these areas still provide important habitat for wetland-dependent birds. The Annual Habitat Survey (AHS), based on spring aerial imagery, was used to integrate cropped wetlands into the vegetation map. Cropped wetlands were those features in the Agriculture map class that ponded water ≥25% of the time. Accuracy of the 2012 vegetation map was assessed by field testing polygons.

***Kilocalories accessible to waterfowl.*** The amount of kilocalories accessible to waterfowl in RWB wetlands is dependent on habitat type and ponded areas (Bishop and Vrtiska 2008, RWBJV 2013b). Vegetation was grouped into habitat types and assigned a kilocalorie value. The early successional habitat type was composed of the Bare Soil/Mudflat, Moist-Soil Species, Water, and Wet Meadow Species map classes and estimated to provide 250,000 kcal/ac (Bishop and Vrtiska 2008). Late successional habitats included the Cattail, Reed Canarygrass, and River Bulrush map classes as well as areas defined as irrigation reuse pits, and were estimated to produce 25,000 kcal/ac (Bishop and Vrtiska 2008). Cropped wetland habitat was assigned to the Cropped Wetland map class and estimated to supply 100,000 kcal/ac (Bishop and Vrtiska 2008). Upland habitats included Agriculture, Grass, and Woody Species and produce no kilocalories accessible to waterfowl.

Total potential kilocalorie production reflected the forage production potential regardless of whether areas were ponded to provide suitable foraging habitat. Total potential production in 2004 and 2012 was calculated using the total area of early successional, late successional, and cropped wetland habitats in the respective vegetation maps. The total acres of each habitat type were multiplied by the kilocalorie rate to determine the habitat type's total kilocalorie production for waterfowl.

Estimates of total potential kilocalorie production did not represent the amount of actual forage resources accessible because they do not take into account the areas that were ponded (i.e., accessible foraging habitat). To calculate accessible kilocalories, each year of AHS ponding data was combined with each vegetation map, producing eight maps using the 2004 vegetation and eight using the 2012 vegetation. The eight maps for each vegetation year were combined to produce the mean accessible kilocalories on RWB wetlands based on vegetation present in 2004 and 2012.

When calculating accessible kilocalories, the Agriculture map class was included in cropped wetland habitat and the Grass map class was included in late successional habitat because the precise areas of ponded water were included in the analysis and could extend beyond the routinely-ponded areas onto portions of the hydric soils that generally did not pond water.

***Kilocalories accessible to shorebirds.*** Kilocalories accessible to shorebird foraging guilds depends on kilocalorie rate and accessible habitat for each guild. The shorebird foraging guilds that use RWB wetlands include small-bodied probers/gleaners (e.g., Baird's sandpiper), large-bodied probers (e.g., lesser yellowlegs), and swimmers (e.g., Wilson's phalarope). The proportion of each wetland habitat type generally accessible to each foraging guild was outlined in the RWBJV Shorebird Plan (Table 1; RWBJV 2013a). The kilocalorie rate was 10,238 kcal/ac for all wetland habitat types. The accessible kilocalories produced by each wetland habitat type for each foraging guild was calculated by multiplying the area of the habitat type, proportion of the habitat type generally accessible to the guild, and 10,238 kcal/ac. Upland habitats (i.e., Agriculture, Grass, and Woody Species) do not provide consistent foraging habitat for these shorebird guilds and were not included in the analysis.

## Findings

***Vegetation surveys.*** On WRP wetlands, 4 of the 37 possible cover types were recorded at >25% of points: reed canary-grass, annual smartweed, ragweed, and other annual species (e.g., plains coreopsis). The prevalence of reed canary-grass was due to its ability to outcompete other species and its widespread distribution throughout the region (Stubben-dieck et al. 1995). Wetlands managed for moist-soil plants often contain smartweeds, ragweeds, and other desirable annual species.

Of the noxious weeds listed by the Nebraska Department of Agriculture, musk thistle was observed at seven points on two WRP properties, while phragmites was recorded at three points, each on separate WRP sites. Although landowners remove noxious weeds on WRP sites, these species readily spread and are difficult to eradicate. The low presence of noxious weeds on WRP properties demonstrates that while landowners are successfully containing these species, they are also difficult to completely eradicate and must be continuously monitored and managed to ensure control.

***Vegetation map.*** The accuracy of the 2012 vegetation map was 75% overall and 84% on surveyed properties. The map contained 134,265 individual polygons covering 79,575 ha. Figure 2 illustrates a portion of the vegetation map. A total of 9,567 ha of wetlands were on publicly owned or long-term (≥30-year) easement conservation lands, of which 1,545 ha were on long-term WRP sites. The Moist-Soil Species map class was the most common on long-term WRP sites (47%) and all conservation lands (42%), followed by Grass and Reed Canary-grass. The least common natural vegetation (i.e., not Agriculture or Cropped Wetland) map class on WRP sites was Water (<1%), due to the regional drought conditions in 2012, and on all conservation lands was Woody Species (<1%)

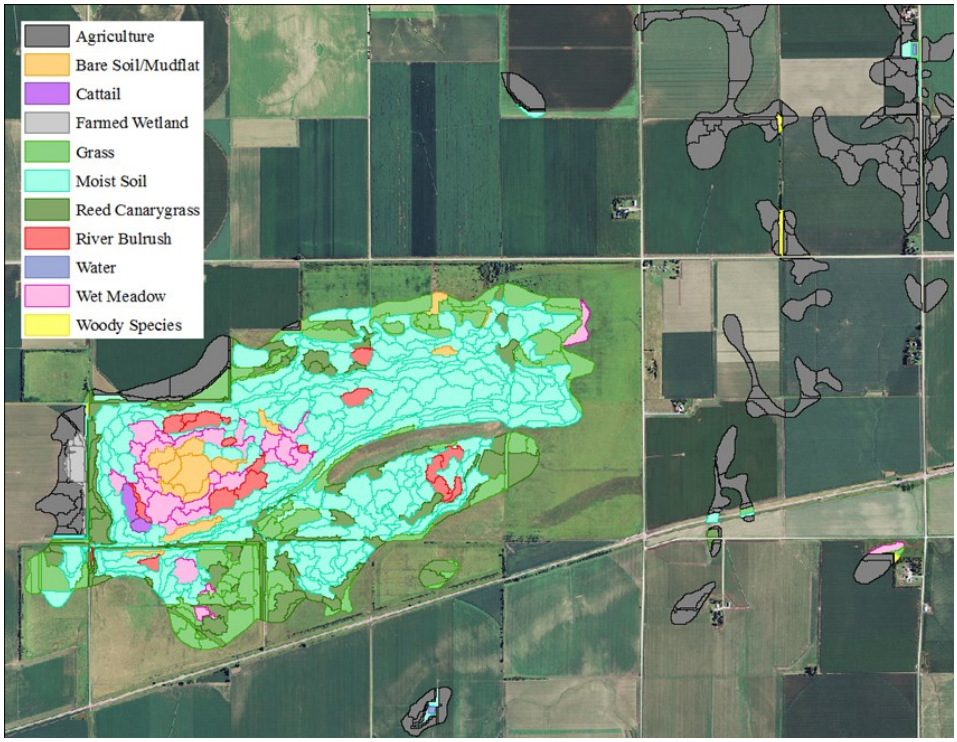



Figure 2. Mid-summer aerial imagery of wetlands in Clay County, Nebraska, representing a portion of the 2012 Rainwater Basin vegetation map.

Table 1. Percentage of wetland habitat types accessible for shorebird foraging guilds in the Rainwater Basin, Nebraska (RWBJV 2013*a*, Nugent et al. 2015).

| Habitat type | Small-bodied Probers/Gleaners | Large-bodied Probers | Swimmers |
|---|---|---|---|
| Early Successional | 5.0 | 10.0 | 10.0 |
| Late Successional | 0.0 | 1.5 | 1.5 |
| Cropped Wetland | 12.5 | 25.0 | 50.0 |

because land managers actively remove them and prevent their growth. In the entire 2012 wetland vegetation map, the Agriculture map class covered more than three-fourths of the area, illustrating the loss of historical wetlands to drainage and cultivation (Table 2).

Between 2004 and 2012, the desirable Moist-Soil Species map class increased 16% on WRP properties, which had the highest increase of moist-soil species of any of the conservation lands. However, undesirable reed canarygrass also increased 4% on WRP sites, while all other property types experienced a decrease of reed canarygrass. A significant change on WRP wetlands was the decreased area of Agriculture (15%) and Cropped Wetland (6%) due to easements acquired between 2004 and 2011 that were restored by 2012.

***Kilocalories accessible to waterfowl.*** The total potential kilocalorie production for waterfowl based on the 2012 vegetation map was 6.1 billion kcal, most of which were produced by early successional habitats (5.7 billion kcal). Based on the 2004 vegetation map, 5.9 billion kcal were potentially produced, which was 0.23 billion kcal less than in 2012. The increased total potential kilocalorie production since 2004 was caused by late successional and cropped wetland habitats being converted to early successional wetlands.

When habitat accessibility was taken into account, however, the available kilocalorie value was much lower. The mean accessible kilocalorie estimate based on the 2012 vegetation map was only 1.3 billion kcal, or 21% of the total potential kilocalories. Long-term conservation lands supplied about 60% of the accessible kilocalories, with an average of 0.77 billion kcal annually (Table 3). Of those, WRP wetlands supplied a mean of 0.13 billion kcal, or 10% of the accessible kilocalories. According to the RWBJV Waterfowl Plan (RWBJV 2013*b*), RWB wetlands should provide 4.4 billion kcal from wetland seeds to allow the target waterfowl population to acquire sufficient foraging resources. The 2012 mean kilocalorie accessibility was 3.1 billion kcal short of this goal.

Between 2004 and 2012, the mean kilocalorie accessibility increased 0.13 billion kcal regionwide. Kilocalorie accessibility on conservation lands also increased 0.13 billion kcal, and 0.05 billion kcal on WRP wetlands, because of the conversion from late successional and cropped wetland habitats to early successional and more total area in conservation. Kilocalorie accessibility increased less for other RWB wetlands on non-conservation lands (0.002 billion kcal).

**Table 2.** Area of each map class in the final vegetation map of wetlands in the Rainwater Basin, Nebraska. Also included are the percentage of the area of the entire map each map class covers and percentage of the area of natural vegetation (i.e., not Agriculture or Cropped Wetland) each of the non- cultivated classes covers (Nugent et al. 2015).

| Class | Area (ha) | % of Entire Map | % of Natural Vegetation |
|---|---|---|---|
| Moist-Soil Species | 7,059.1 | 8.9 | 39.5 |
| Wet Meadow Species | 1,305.5 | 1.6 | 7.3 |
| Bare Soil/Mudflat | 686.8 | 0.9 | 3.8 |
| Water | 468.5 | 0.6 | 2.6 |
| Cattail | 488.9 | 0.6 | 2.7 |
| Reed Canarygrass | 2,650.5 | 3.3 | 14.8 |
| River Bulrush | 678.5 | 0.9 | 3.8 |
| Grass | 3,974.2 | 5.0 | 22.2 |
| Woody Species | 575.9 | 0.7 | 3.2 |
| Cropped Wetland | 709.8 | 0.9 | --- |
| Agriculture | 60,977.3 | 76.6 | --- |

Table 3. Mean kilocalories accessible to waterfowl by early successional, late successional, cropped wetland, and all habitats combined on long-term Wetlands Reserve Program sites (WRP), other long-term private easements (Other), Wildlife Management Areas (WMA), Waterfowl Production Areas (WPA), and all conservation sites combined in the Rainwater Basin, Nebraska. Values are based on the vegetation in the 2012 vegetation map and the ponded areas determined by the Annual Habitat Survey (2004, 2006–2012; Nugent et al. 2015, Bishop et al., unpublished data).

| Habitat | WRP | Other | WMA | WPA | All |
|---|---|---|---|---|---|
| Early Successional | 128,643,725 | 14,920,666 | 209,590,107 | 384,430,955 | 737,585,453 |
| Late Successional | 4,650,463 | 725,728 | 5,629,884 | 16,521,950 | 27,528,025 |
| Cropped Wetland | 171,737 | 159,218 | 35,639 | 115,192 | 481,786 |
| Total | 133,465,925 | 15,805,612 | 215,255,630 | 401,068,097 | 765,595,264 |

***Kilocalories accessible to shorebirds.*** The 2012 accessible kilocalories for shorebirds on all RWB wetlands ranged from 13.9 –33.9 million kcal depending on the foraging guild (Table 4). Of the accessible kilocalories, conservation lands provided 43–50%, depending on the guild, with WRP providing 8–9% of available food energy. The 2012 accessible kilocalories were 3.4 million kcal more than the amount needed to sustain the target swimmer population but were 25.8 million kcal and 35.9 million kcal less than needed to sustain the target small-bodied prober/gleaner and large-bodied prober populations, respectively (RWBJV 2013a).

Between 2004 and 2012, the accessible kilocalories decreased by 0.1 million kcal for small-bodied probers/gleaners, 0.5 million kcal for large-bodied probers, and 2.1 million kcal for swimmers. The decreased accessible kilocalories were due to the loss of cropped wetland habitat between 2004 and 2012. For all of the shorebird foraging guilds, cropped wetland habitat provides a greater portion of suitable habitat than early successional. The gains in early successional habitat from 2004 to 2012 were often the result of a transition of cropped wetland habitat to more persistent wetland vegetation communities. On conservation lands, kilocalorie accessibility for shorebirds increased 1.2–2.4 million kcal, depending on the guild, of which 0.4–0.8 million kcal were on WRP wetlands. On conservation lands, the decrease in cropped wetland habi-

Table 4. Accessible kilocalories for shorebird foraging guilds (small-bodied prober/gleaner, large-bodied prober, swimmer) on long-term Wetlands Reserve Program sites (WRP), other long-term private easements (Other), Wildlife Management Areas (WMA), Waterfowl Production Areas (WPA), all conservation lands combined, and all regional wetlands in the Rainwater Basin, Nebraska. Values are based on vegetation in the 2012 vegetation map (Nugent et al. 2015).

| Conservation Area | Small-bodied Prober/ Gleaner [a] | Large-bodied Prober [b] | Swimmer [c] |
|---|---|---|---|
| WRP | 1,226,232 | 2,560,536 | 2,565,981 |
| Other | 157,207 | 335,824 | 344,807 |
| WMA | 1,909,499 | 3,977,786 | 3,978,657 |
| WPA | 3,626,213 | 7,697,233 | 7,706,357 |
| All Conservation Lands | 6,919,151 | 14,571,380 | 14,595,802 |
| All RWB Wetlands | 13,865,025 | 29,351,319 | 33,933,803 |

[a] e.g., semipalmated plover, Baird's sandpiper.
[b] e.g., lesser yellowlegs, long-billed dowitcher.
[c] e.g., Wilson's phalarope.

tat between 2004 and 2012 was outweighed by more area in conservation and late successional habitats being converted to early successional.

**Conservation Implications**

Additional accessible kilocalories must be provided by RWB wetlands to sustain target populations of waterfowl and shorebirds and to help ensure their healthy arrival on northern breeding grounds. Conservation strategies to attain the target accessible kilocalories must be employed to produce additional kilocalories and provide ponded habitat that allows wetland-dependent birds to access the food energy produced. With 99% of the RWB privately owned, private conservation easements, such as WRP and the new Wetlands Reserve Easements (WRE), are crucial to implementing those conservation strategies. The RWBJV has developed a ranking model for all properties overlapping wetlands in the RWB (Grosse and Bishop 2012). The tool assigns a value to each property reflecting its potential contribution to the RWB landscape and can be used to target future WRE enrollment.

To produce additional kilocalories, strategies can be implemented that convert late successional and cropped wetland habitats to early successional habitats and convert drained cultivated wetlands to hydrologically restored cropped wetlands. Cropped wetlands can be converted to early successional habitats through wetland restoration on newly enrolled sites, while late successional wetlands can be returned to early successional habitats through management actions involving disturbance such as disking, grazing, and herbicide treatments (Gray et al. 2013).

Grazing on WRP and WRE wetlands has the added benefit of allowing landowners to incorporate enrolled lands into their farm operations, thereby increasing their likelihood of engagement in wetland management. Flexibility of WRP and WRE management plans and Compatible Use Authorizations can increase the likelihood that landowners will enroll in these programs and remain active partners in the management of wetland sites. For example, when producers were allowed to pass their pivot irrigation systems through WRP sites under a Wetlands Reserve Enhancement Program pilot, enrollment in the region tripled.

Finally, converting drained cultivated wetlands to hydrologically functioning cropped wetlands could be achieved through the new Agricultural Land Easements (ALE). A pilot program being proposed by the RWBJV partners would restore the hydrology of enrolled wetlands, yet still allow producers to crop wetlands when weather conditions allow.

For the forage produced in RWB wetlands to be accessible to wetland-dependent birds, the wetland acres must be flooded during migration. To provide additional ponded acres, strategies such as wetland hydrology restoration, watershed restoration, and pumping can be used. Pumping water into wetlands provides additional ponded areas and is particularly important in years with below-average precipitation. Watershed restoration, such as removing abandoned irrigation reuse pits in a wetland's watershed, allows runoff from precipitation events and snowmelt to reach downstream wetlands, while wetland restoration allows these wetlands to again hold water. A new conservation practice is now available in the Environmental Quality Incentives Program to close abandoned irrigation pits.


PHOTO: STEVE DONOVAN, DUCKS UNLIMITED

Figure 3. When grazing of conservation easement lands is compatible with wetland and waterbird habitat restoration goals, both wildlife resources and agricultural operations can benefit.

By implementing these conservation strategies, conservation programs such as the WRP, WRE, and ALE can be effectively employed to help increase the accessible kilocalories for waterfowl and shorebirds in the RWB.

## References


Bishop, A.A., and M. Vrtiska. 2008. Effects of the Wetlands Reserve Program on waterfowl carrying capacity in the Rainwater Basin region of south-central Nebraska. U.S. Fish and Wildlife Service, Grand Island, Nebraska, USA.

Daubenmire, R.F. 1959. Canopy coverage method of vegetation analysis. Northwest Science 33:43-64.

Devries, J.H., R.W. Brook, D.W. Howerter, and M.G. Anderson. 2008. Effects of spring body condition and age on reproduction in mallards (*Anas platyrhynchos*). Auk 125:618-628.

Dubovsky, J.A., and R.M. Kaminski. 1994. Potential reproductive consequences of winter-diet restriction in mallards. Journal of Wildlife Management 58:780-786.

Gray, M., H.M. Hagy, J.A. Nyman, and J.D. Stafford. 2013. Management of wetlands for wildlife. Pages 121–180 in J.T. Anderson and C.A. Davis (eds.). Wetland Techniques, Volume 3. Springer, Secaucus, New Jersey, USA.

Grosse, R., and A. Bishop. 2012. Targeting the Wetlands Reserve Program using Geographical Information System technology in the Rainwater Basin region of south central Nebraska: Updated for 2012. Rainwater Basin Joint Venture, Grand Island, Nebraska, USA.

Krapu, G.L. 1981. The role of nutrient reserves in mallard reproduction. Auk 98:29-38.

Loesch, C.R., and R.M. Kaminski. 1989. Winter body-weight patterns of female mallards fed agricultural seeds. Journal of Wildlife Management 53:1080-1087.

Natural Resources Conservation Service. 2008. The Wetlands Reserve Program supports migrating waterfowl in Nebraska's Rainwater Basin Region. Conservation Effects Assessment Project (CEAP) Conservation Insight. www.nrcs.usda.gov/technical/NRI/ceap/.

Nugent, E., A. Bishop, R. Grosse, T. LaGrange, D. Varner, and M. Vrtiska. 2015. An assessment of landscape carrying capacity for waterfowl and shorebirds in Nebraska's Rainwater Basin. U.S. Fish and Wildlife Service, Wood River, Nebraska, USA.

Pearse, A.T., G.L. Krapu, R.R. Cox, and B.E. Davis. 2011. Spring-migration ecology of northern pintails in South-central Nebraska. Waterbirds 34:10-18.

Rainwater Basin Joint Venture. 2013*a*. The Rainwater Basin Joint Venture shorebird plan. Rainwater Basin Joint Venture, Grand Island, Nebraska, USA.

Rainwater Basin Joint Venture. 2013*b*. The Rainwater Basin Joint Venture waterfowl plan. Rainwater Basin Joint Venture, Grand Island, Nebraska, USA.

Schildman, G., and J. Hurt. 1984. Update of Rainwater Basin wetland survey. Survey of habitat work plan K-83, W-15-R-40. Nebraska Game and Parks Commission, Lincoln, Nebraska, USA.

Smith, L.M. 1998. Research needs for the Rainwater Basin of Nebraska: a hierarchical approach. Nebraska Game and Parks Commission, Lincoln, Nebraska, USA.

Stubbendieck, J., G.Y. Friisoe, and M.R. Bolick. 1995. Weeds of Nebraska and the Great Plains. Second edition. Nebraska Department of Agriculture, Lincoln, Nebraska, USA.


**The Conservation Effects Assessment Project: Translating Science into Practice**

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 wildlife is affected by conservation actions taken on a variety of landscapes, the wildlife national assessment complements the national assessments for cropland, wetlands, and grazing lands. The wildlife national assessment works through numerous partnerships to support relevant assessments and focuses on regional scientific priorities.

This assessment was conducted through a partnership between NRCS and the U.S. Fish and Wildlife Service, Rainwater Basin Joint Venture (RWBJV). Primary investigators on this project were Eleanor Nugent and Andy Bishop (RWBJV).

For more information: www.nrcs.usda.gov/technical/NRI/ceap/, or contact Charlie Rewa at charles.rewa@wdc.usda.gov.

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