4 Management Direction

The management direction for the Rainwater Basin Wetland Management District is to manage the district's resources in a holistic manner. There will be a focus on cooperation, coordination, and better exchange of information. An expanded district staff will work with partners to improve the waterfowl production areas across the landscape of the Rainwater Basin. The emphasis will be on adaptive management—as more information is known, management will be changed to improve effects on the environment.

Through integrated restoration, the district will work to restore ecological processes where appropriate and achieve habitat conditions that require reduced management over time. This will be accomplished while recognizing (1) the role of the district in the overall landscape, and (2) the capabilities of its staff and resources to complete the proposed management actions during the next 15 years. A high priority will be to monitor the effects of habitat management practices and to use research results to direct restoration and management. Another priority will be to increase opportunities for wildlife-dependent, compatible public use and visitor services.

4.1 GOALS, OBJECTIVES, STRATEGIES, AND RATIONALE

The goals and objectives in this section are the guidance that will enable the district to provide for its purposes and reach its vision. Strategies to carry out the objectives, to reach the district's goals, will provide for resource needs and public use.

- A goal is a descriptive, broad statement of desired future conditions that conveys a purpose, but does not define measurable units.
- An objective is a concise statement of what is to be achieved, how much is to be achieved, when and where it is to be achieved, and who is responsible to achieve it.
- Strategies are ways to achieve an objective.
- Rationale for the objectives includes background information, assumptions, and technical details used to formulate the objective. The rationale provides context to enhance comprehension and facilitate future evaluations.

NOTE: The overall guidance for use of prescribed fire and management of wildland fire is in the description of the fire management program (appendix L).

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Mallard Pair.

Wetland Goal

Restore, enhance, and maintain the hydrology and early successional vegetation conditions essential to the conservation of migratory birds.

Wetland Objective A

Within 15 years, restore, enhance, and manage the wetland plant composition to achieve a high level of preferred moist-soil and wet-meadow vegetation. Table 6 shows the shift in plant associations.

Wetland Objective B

During the next 15 years, manage wetland vegetation to create a vegetative mix of species of various heights, with spring (February–April) habitat conditions having 20–50% of the wetland vegetation between 6 and 12 inches tall.

Table 6. Current, preferred, and achievable plant composition at WPA wetlands.*

Associations	*Current Composition %*	*Preferred Composition %*	*Achievable Composition %*
Nonnative undesirable vegetation	19	<1	5–10
Native undesirable vegetation	18	10	10–20
Moist-soil community	44	65	55–65
Wet meadow	17	25	20
Trees	2	0	<1% in wetlands
Total	100		

(Source: Drahota et al. 2004.)
**Although the percentages are the collective total for all the federal wetlands, it is the district's intent that each wetland has a percent composition that falls close to the preferred composition. For example, no one WPA would have most of the trees that exist on district lands. During wet years, open-water areas reduce the acreage of moist soil, native, and nonnative communities; but the percentages should stay within the achievable composition for most communities during normal years.*

Wetland Objective C

During the next 15 years, improve water-pumping capabilities on wetlands that currently have water-pumping facilities; develop water-pumping facilities for 800–1,000 additional wetland acres; and increase pumping potential to allow more opportunities to supplement water during the fall and spring migration periods.

Wetland Objective D

Within 15 years, acquire from willing sellers fee-title ownership on 10 adjoining portions of wetlands to complete ownership to allow for better management of individual wetlands.

Wetland Objective E

Within 15 years, acquire permanent protection from willing sellers on 15 additional wetlands within the basin.

Wetland Objective F

During the next 15 years, develop baseline information on water quality and quantity of in-flowing water into WPAs for use in developing desired conditions or standards.

Wetland Objective G

Through the duration of the CCP, apply prescribed grazing at a rate, timing, and intensity that is appropriate for management needs.

Wetland Strategies

1. Annually apply grazing, fire, disking, haying and shredding on 35% of the wetland acres to create a vegetative mix of various heights.
2. Develop annual grazing plans that identify the objective and grazing method that will be used at each WPA.
3. Seasonally monitor and review the effects of grazing to determine if the objective is being met or if modifications need to be made.
4. Construct and maintain adequate boundary fences at 80% of the WPAs.
5. Develop livestock watering facilities for at least 10 WPAs to allow intense grazing treatments to reduce invasive plants and establish native plants.
6. Conduct 1,000–3,500 acres of prescribed burning in wetland habitats each year to encourage and promote the plant composition described in table 6.
7. Continue using IPM strategies to reduce noxious weeds and other invasive plants. Besides burning and grazing, use other management practices including disking, haying, flooding, and herbicide application.
8. Work with partners to increase supplemental water-pumping capacity at WPA wetlands, with a desired water depth of 2–18 inches during migration (October–April).
9. Replace antiquated water-pumping facilities with modern, energy-efficient systems.

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Gleason WPA (Kearney County).

10. Coordinate with partners to install additional water-pumping facilities and to improve water delivery in a manner that optimizes water distribution at WPAs within existing high-use areas, wetland complexes, and areas currently without water-pumping capability.
11. Delineate all WPA watersheds to determine actual hydrologic effects on each wetland, and assess the cost and feasibility of restoring each wetland.
12. Implement hydrologic improvements on 10 WPAs using one or more of the following practices: install sediment control structures; replace culverts; install water control structures; remove trees; fill water concentration pits; fill drainage ditches and drains; remove sediment and fill material; and construct dikes or berms.
13. Work with partners and private landowners within WPA watersheds to increase water quantity and quality received by implementing 120 (8 per year) of the following practices (RWBJV 1994):
    - Fill water concentration pits
    - Replace culverts
    - Install buffer areas
    - Restore grassland
    - Install sediment control structures
    - Install "Variable Flow Tailwater Recovery Systems"
    - Remove restrictions to natural runoff
    - Remove sediment and fill material
    - Fill drainage ditches and drains
14. Continue to encourage the drainage districts and county governments to abandon existing wetland drainage tiles associated with WPAs.
15. Work with partners to develop a monitoring program to document quality of water entering the wetlands after storm events.
16. Close a WPA to hunting when threatened or endangered species (such as whooping crane) occur at the WPA.

Wetland Rationale

Each spring, for a short period, a significant portion of the North American waterfowl population uses habitat of the Rainwater Basin. However, compared with historical conditions, the extent, distribution, and quality of remaining wetlands in the basin is reduced. These changes in habitat conditions likely have various adverse effects related to the life cycle requirements of waterfowl. Wetland vegetation and watershed management need to be done at optimal levels to meet the needs of all types of waterbirds. To increase the benefit of the basin's wetlands for spring migration, it is critical that a diversity of flooded and moist-soil wetland habitat is made available throughout the basin to provide more, natural wetland foods and reduce the risk of disease (Samuel et al. 2005, Smith et al. 1989, RWBJV 1993). The basin has a history of large mortality associated with avian cholera during spring migration (Gordon 1989, Samuel 1995, Samuel et al. 2005, Smith and Higgins 1990).

It is the historical nature of the basin's wetlands to provide resting and feeding habitats for prenesting survival and overall annual waterfowl production (Gersib et al. 1989a, LaGrange and Dinsmore 1988). Moist soil plants such as smartweed and barnyard grass are typical early successional plants that respond quickly to disturbed areas, especially on bare soil (Fredrickson and Taylor 1982). Baldassarre and Bolen (2006) stated that the feeding ecology of waterfowl is a complex interaction of nutritional needs, resource availability, habitat quality, and waterfowl behavior. Feeding ecology is further complicated during winter (November–April) when waterfowl are migrating, preparing for production, and facing increased energy demands due to environmental stresses (Kendeigh et al. 1977, Dubovsky and Kaminski 1994, Ballard et al. 2004). Although Nebraska has an abundance of agricultural fields, waste grains lack many nutrients found in natural foods found in wetlands (Baldassarre et al. 1983, Loesch and Kaminski 1989, Krapu et al. 2004, Baldassarre and Bolen 2006).

Reid et al. (1989) found that native or naturally occurring wetland plant seeds are necessary in a duck's diet to offset the protein and mineral deficiencies in waste grain. Ankney and MacInnes (1978), Krapu (1981), and Ankney and Afton (1988) showed a positive relationship between lipid reserves and clutch size for various waterfowl species. Failure to meet the nutritional need of waterfowl during winter and spring migration may result in reduced recruitment (the addition of members to the overall population). This is often called the "lipid limitation hypothesis" (Ankney and Afton 1988) and is supported by Ankney and Alisauskas (1991) as a limiting factor. Lipids are an efficient form of energy storage and are more efficiently catabolized than protein, causing Petrie and Rogers (2004) to conclude that these advantages alone explain why most studies conclude that ducks rely heavily on stored lipids during reproduction.

Heitmeyer and Fredrickson (1981), later confirmed by Kaminski and Gluesing (1987), first suggested a relationship between winter habitat conditions and duck recruitment in the following breeding season. Raveling and Heitmeyer (1989) linked increases in northern pintail populations to winter habitat conditions. LaGrange and Dinsmore (1988) went further to say those stopover areas close to breeding areas were crucial habitats for female mallards to acquire adequate nutrients. Many other authors have suggested the correlation between wintering and spring migration energetics and their implications during nesting (Krapu 1981, Rohwer 1984, Dubovsky and Kaminski 1994). This suggests that the basin's wetland habitat is important for prenesting survival and overall annual waterfowl production (Gersib et al. 1989a).

Food production in wetlands can be very impressive in terms of the number of seeds produced and the varieties. In a 1951 study by J.R. Singleton of the east Texas gulf coast, researchers found that salt marsh bulrush produced an average of 300 pounds (dry weight) of seeds per acre per year, and each acre produced about 5 tons of plant corms. Reinecke and others (1989) concluded that seeds provide the greatest biomass of food in moist-soil habitats, but tubers (Taylor and Smith 2005), roots, rhizomes, stems, leaves, and invertebrates can be important (Jorde 1981, Krapu 1981, Heitmeyer 1988, LaGrange 1985, Ballard et al. 2004, Bowyer et al. 2005). Anderson and Smith (1999) found managed moist soil wetlands had four to five times more ducks than unmanaged wetlands.

Reinecke et al. (1989) and Laubhan and Fredrickson (1992) synthesized seed production into metabolizable energy associated with moist soil plants, as well as daily energy requirements, allowing an estimate of duck use-days (DUDs) based on a wetland's vegetative community and seed production potential. Metabolized energy (ME) is described as a measure of available energy to waterfowl from their diet (Miller and Reinecke 1984). Kendeigh et al. (1977) describes ME as the total daily energy intake compared to the total food biomass required to supply energy needed for any individual or population. Wetland bioenergetics can be described as the relationship between seed biomass and gross energy value. The more energy a wetland can provide, the more bioenergetically efficient it is.

The average energy of moist-soil seeds is 2.5 kilocalories per gram (kcal/g). Ducks do not exploit moist-soil seeds in flooded environments when the seed mass is less than 45.1 pounds per acre (50 kilograms per hectare [kg/ha]). The minimum threshold for energy requirements of a 2.4-pound (1.1-kg) duck is 292 kcal/day (Reinecke et al. 1989). Prince (1979) and Reinecke and others (1989) proposed the calculation of DUDs as a desirable means for evaluating waterfowl habitat management. Haukos and Smith (1993) described DUDs as the number of ducks that could survive on a wetland for 1 day based on native seed availability. Cox and Davis (2002) and Fredrickson and Reid (1988) suggested that it takes larger ducks 2–3 days to replenish endogenous (produced within the body) fat reserves at 480 kcal/day in good habitat. For example, a mallard weighing 2.4 pounds (1.1 kg) would need 3 days of feeding, at a rate of 480 kcal/day, to replenish fat reserves following an 8-hour flight (figure 29, duck-use days).

Using Reinecke's energetics figures, a minimally suitable hectare of moist soil would yield 50,600 kcal/acre (equation 1) or 173 DUDs/acre (equation 2).

Equation 1: 45.1 lbs/acre (50kg/ha) × 2.5 kcal/g = 50,600 kcal/acre (125,000 kcal/ha)

Equation 2: $\frac{125{,}000\ \text{kcal/ha}}{292\ \text{kcal/day}}$ = 173 DUDs/acre (428 DUDs/ha)

As energy requirements go up (such as with weather, disturbance, and stress), the number of DUDs a wetland can provide would go down (Fredrickson and Reid 1988). The DUDs would also vary within vegetative stands since metabolizable energy can vary from 1.0 to 3.5 kcal/g, depending on what plant species are present (Sherfy and Kirkpatrick 1998). During periods when ducks need 480 kcal/day (see figure 30), only 260 DUDs/ha would be provided in the above example.

Based on recent findings from J. Drahota (personal communication) and Rabbe et al. (2004), the basin's wetlands that are dominated by moist-soil plant communities support about 1,779 DUDs/ha and wet meadow communities support 575 DUDs/ha (see figure 29). Conversely, undesirable stands such as cattail (115 DUDs/ha), reed canarygrass (102 DUDs/ha), and bulrush (*Scirpus* spp.) (23 DUDs/ha) plant associations cannot support endogenous or exogenous (produced outside the body) nutrient storage during periods of high energy demands. Drahota (2006) found that wetland management during a dry year increased seed production and the moist-soil plant association provided 8,739 DUDs/ha, compared to 3,250 DUDs/ha in a mixed moist-soil/river bulrush stand.

Estimation of duck use-days will improve when estimates of metabolized energy are available for all moist-soil plants that occur in the basin and when average seed production per stand can be estimated for a variety of environmental and management influences.

Native, undesirable plants such as cattail and river bulrush replace the high food-producing plants if a wetland is left undisturbed for a period of years (Reid et al. 1989). The result is a decline in seed production but an increasing amount of shelter and visual barriers for birds. Woody plants such as elm, cottonwood, and green ash can quickly invade a drying mud flat to convert a grassed wetland into a wooded wetland.

Nonnative undesirables such as reed canarygrass and Canada thistle spread quickly and can dominate or quickly turn a wetland into a monotypic stand of vegetation that is less beneficial and unattractive to waterfowl or other waterbirds (Lavergne and Molofsky 2004). Wet meadow species provide a food source but at a lesser degree (Reinecke et al. 1989, Rabbe et al. 2004).

The shallowness of the wetlands and their frequent flooding and drying make the basin's wetlands suitable for moist-soil plants. Moist-soil plants such as smartweed and barnyard grass are the typical early successional plants that respond quickly to disturbance, especially after a disturbance leaves bare mineral soil (Fredrickson and Taylor 1982).

Experience at the WPAs has shown that grazing, fire, haying, disking, and shredding create an interspersion of plant species. Annual district reports beginning in 1964 document the change in plant communities with various management practices used at the WPAs over

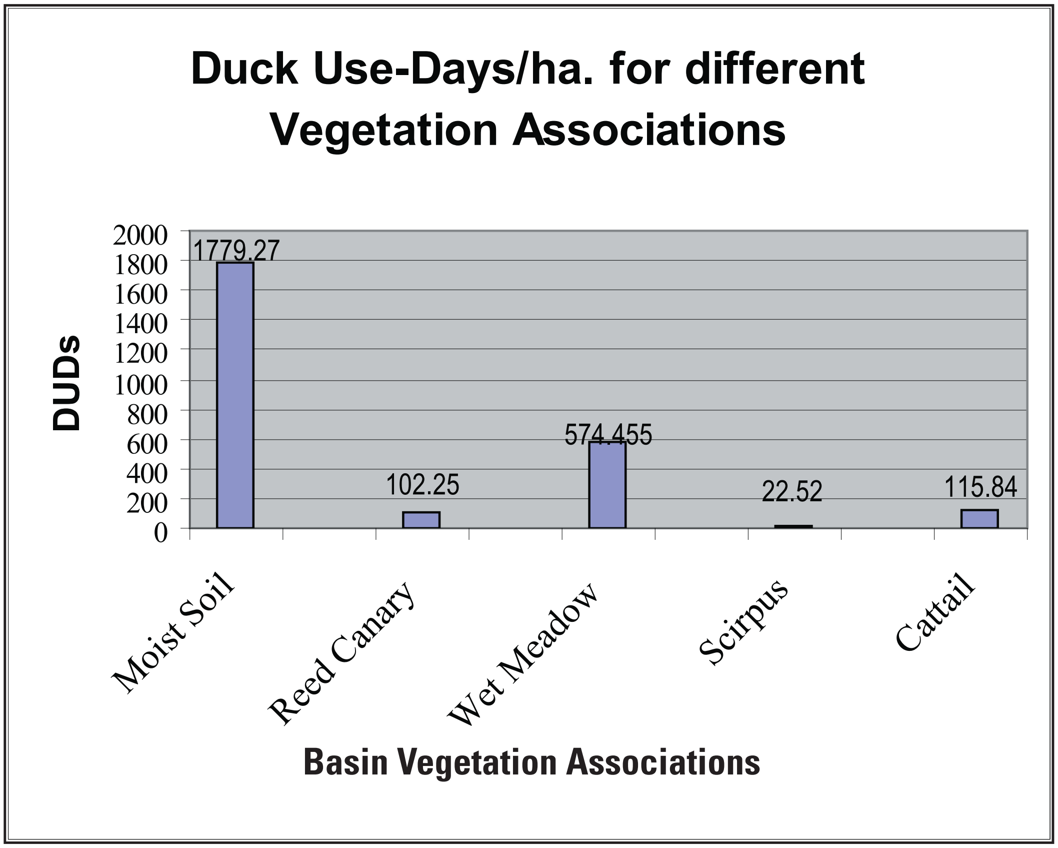

Figure 29. Rainwater Basin duck use-days.
(Calculated using metabolizable energy numbers found in Sherfy and Kirkpatrick [1998] and Checkett et al. [2002]; frequency of occurrence results were then used for each vegetation association as described in Drahota et al. [2004] to extrapolate DUDs for each community based on a daily energy requirement of 292 kcal/day.)

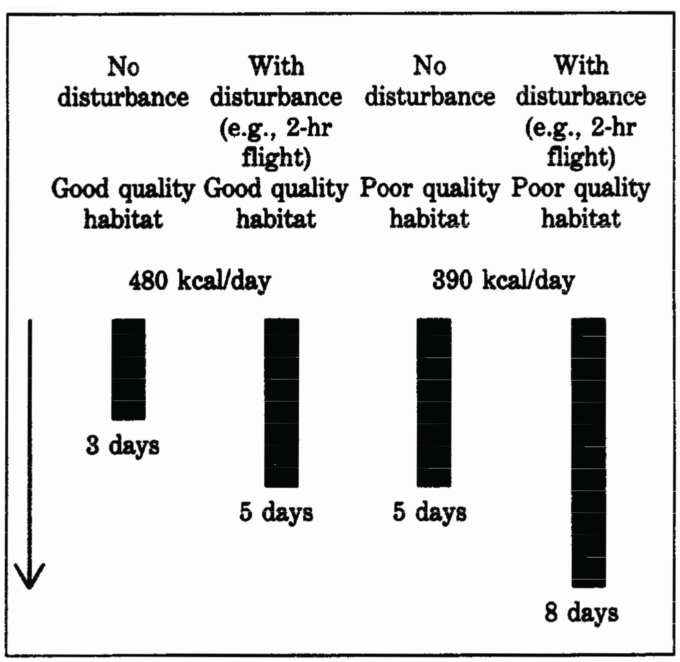

Figure 30. Time required for replenishment of endogenous fat reserves following an 8-hour migratory move.
(For a duck weighing 2.5 pounds. Taken from Fredrickson and Reid [1988].)

the years. Grazing and fire were absent from the WPAs between 1966 and the late 1970s. The reports describe increasing problems with (1) smooth brome on uplands, (2) reed canarygrass and trees in wetlands, (3) vegetation-choked wetlands, and (4) noxious weed (primarily musk thistle) spread. In the late 1970s, the herbicide Rodeo® was aerially applied to cattail-choked wetlands to create open water. After about 3 years of use, it was discontinued because the cost per acre was too high. In the early 1980s, fire and grazing were used but at a conservative rate, with haying being the primary management practice. The annual reports indicate that wetland and upland improvement occurred but not enough to change plant composition. In the mid-1990s, the district increased grazing on wetlands dominated with reed canarygrass, river bulrush, and cattail. The district found that a combination of fire followed by intense grazing was the most effective management tool for changing monotypic stands of vegetation into a diverse stand of seed-producing, moist-soil plants.

Grazing has been an integral part of the prairie wetland ecosystem. Most techniques of rangeland management were developed with the idea of increasing and sustaining livestock production by decreasing the inherent variability associated with grazing (Fuhlendorf and Engle 2001). However, this is not the approach used at the WPAs. Grazing treatments are used as a vegetation management tool. Wetland grazing can reduce perennial vegetation, increase diversity, and decrease stand density to result in more wildlife use, especially by migratory waterfowl.

Animal stocking rates of two to four animals per acre in river bulrush and cattail marshes reduced the vegetative cover by 25% (USFWS 1983–93). During drought and low-water periods, livestock trampling compacts the soil, which improves the pooling of water, and tills the surface to allow seed germination. High-intensity grazing also stimulates regrowth (Ermacoff 1968). Cattle should be removed from wetlands before August 10 to allow annual plants to produce seed heads (USFWS 1983–93) if moist soil plant communities are desired. Later grazing and multiyear grazing may be needed to reduce the frequency of occurrence of undesirable species before moist-soil plants can grow.

Livestock grazing generates revenue for use to offset the costs of fencing and control of invasive plants at the WPAs. In addition, grazing provides economic benefits to the local community.

Anderson and Smith (1998) suggest intense moist-soil management for existing wetlands should increase overall nutrition available to waterfowl and other wildlife. Noted moist-soil expert, Leigh Fredrickson (St. Louis, MO), confirmed this (personal communication). Fredrickson stated that increasing disturbance will increase seed production, reduce perennials, and reduce the woody component. The number of years after a disturbance occurs will also decrease the amount of seed produced. Millet seed production postdisturbance was about 50% less after 3 years and an additional 25% less after 4 years. Undesirable species like cattail and reed (*Phragmites* spp.) have a tremendous amount of belowground biomass—cattail is about 2.5 times more than aboveground biomass and reed (*Phragmites* spp.) is about 6.5 times more. The belowground biomass has to be reduced or eliminated to allow desirable species that are in the seed bank an opportunity to grow.

Effective migratory bird habitat must include a complex of habitat types that provide important food and cover resources (Reid et al. 1989). Historically within this area, wildland fire and grazing by free-roaming bison and elk herds kept wetland vegetation in an early successional stage. Today, natural disturbances have to be replaced with planned management including fire, grazing, haying, flooding, and disking. The frequency and intensity of their use depends on management objectives and various factors including vegetative composition, saturation of soils, and hydrologic patterns within the wetland. Weather events usually determine the timing of treatments. However, if production of moist-soil plant seed is desirable during the same growing season, treatments should be completed before August 10. Kantrud (2006) noted that further studies in wetland management need to occur due to the unknown effects of (1) fire suppression, (2) differential grazing regimes, (3) cultivation, (4) mowing, (5) changes in hydrology, (6) siltation, and (7) pesticides.

Kantrud (2006), after reviewing numerous waterfowl studies, surmised that reductions in height and density of tall emergent plants generally increases breeding duck use. In the basin, migratory habitat has been the focus after researchers found that the basin produces relatively few waterfowl annually (Evans et al. 1967). Kantrud also stated that most waterfowl worldwide favor feeding in shallow water areas where tall emergent plants do not block sunlight.

A variety of bird species depends on plants of various heights. Height variations create structure within habitats that can accommodate greater diversity and higher use by wildlife. Research done by Brennan (2006) et al. have shown that ideal waterfowl habitat, especially for ducks, is an interspersion of tall and short vegetation to create a hemi-marsh condition when spring runoff pools in wetlands. Reinecke et al. (1989) found moist-soil impoundments provide an interspersion of open water and vegetation; a diversity of water depths was attractive to various waterfowl species.

Solid stands of tall vegetation that are greater than 12 inches above the water make areas less attractive to waterfowl (Reid et al. 1989). They may provide an abundance of food, but much of it remains unused. Scattered areas of shorter wetland plants or bare, open water increases bird use of an area. Pederson et al. (1989) stated that, during winter, freedom from


Jeff Drahota/USFWS

White-rumped sandpipers at Johnson WPA (Phelps County).

harassment by predators, availability of food, and thermally protected habitats may be critical. This suggests that this type of habitat in early spring, migratory, staging areas could be similarly critical (Jorde et al. 1984). Brennan (2006) found the percent of emergent vegetation to be a positive indicator for waterbirds—intermediate levels of vegetation in wetlands have the highest species richness. The lower end of the range (6 inches) is provided as a guideline; however, most researchers have found that short vegetation increases the attractiveness to a wider range of species and provides broader benefits for these species (such as feeding, loafing, and breeding).

Wetlands that contain the mix of tall and short vegetation require less runoff or pumped water before the wetland becomes suitable for waterfowl use. Gersib et al. (1989a) noted the temporary and seasonal wetlands provided the highest feeding values to waterfowl due to seasonal fluctuations in hydrology that directly affect vegetative growth and seed production. In drier years, this becomes a critical factor in determining how much migration habitat will be available. The open-water areas will attract the birds and provide them better access to the higher food plants in the flooded, emergent-plant areas of these wetlands.

Although the intent is to have most of the wetlands fall within the category described in the objectives, a few wetlands (<20%) need to be managed for the two extremes: (1) those that have taller, denser stands of vegetation (not attractive to geese), and (2) those that are open or sparsely vegetated (attractive to geese and shorebirds). White and James (1978) found water depth and the presence of emergent vegetation to be important factors associated with niche partitioning for wintering waterfowl species. The open-water wetlands will benefit snow geese use (Traylor 2000, Drahota 2000) and provide hunting opportunities. Past use of this strategy in the basin has shown separation of snow geese populations from other species of waterfowl. This strategy is expected to reduce the potential or extent of avian cholera. Conversely, wetlands with dense stands of emergent vegetation provide winter habitat for resident species such as pheasant (Baxter and Wolfe 1973, Gabbert et al. 1999, Bakker 2003).

Although vegetation management is critical, water management is equally so. The Great Plains GIS office assessed the Rainwater Basin's wetland conditions in spring 2004 (a year drier than normal) and found that only 14% of the original, historical basins provided any habitat. Of that amount, 91% were in private ownership but only provided 55% of the available waterfowl habitat. Those in public ownership represented only 9% and provided 45% of the available waterfowl habitat. The low number of wetlands within the basin makes it critical that as many as possible contain optimal habitat for all types of waterbirds, and it is important that these water areas be distributed throughout the basin. Rainfall is not consistent throughout the area, therefore, multiple complexes throughout the basin guarantee that there will be some water areas where water pools when scattered rainfall occurs. As birds concentrate, they quickly deplete their food supply and expose the entire population to disease outbreaks.

Pumping water in the fall can provide habitat for early waterfowl migrants and increase invertebrate abundance in the fall. In addition, maintenance of this water through winter into spring will substantially increase invertebrate abundance (Anderson and Smith 2000). Increased invertebrate numbers will benefit female ducks that molt the first week of March (Jorde 1981) during feather replacement. During dry years, northern pintails with higher body mass survived better in wintering areas (Fleskes et al. 2002, Moon and Haukos 2006), suggesting that quality wetland habitats along the fall migration route play a role in winter survival. Overall, increases in suitable habitat in the breeding, migration, and wintering areas potentially correspond with mallard populations (Heitmeyer and Fredrickson 1981, Bergan and Smith 1993). Fall water pumping can benefit other species such as whooping crane (Richert 1999).


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New submersible pump at Harvard WPA (Clay County).

Pumping water can be a major expense especially when precipitation is limited or when needed to accomplish moist-soil management objectives (Anderson and Smith 1999). Water pumping should deliver 2–18 inches of water to accommodate foraging needs of shorebirds, waterfowl, and other waterbirds (Laubhan et al. 2006). Since 2000, water-pumping costs in the district have averaged about $14 per acre. Moist-soil management practices that use fall water pumping can swell clay soil, reduce soil cracking, and slow infiltration rates (Anderson and Smith 1999).

The district has 71 wells scattered over 36 WPAs. Only 35 of these have water-pumping capability and occur at 23 WPAs. Those 35 wells have the ability to deliver water to 2,230 wetland acres (approximately 20% of the total). Each year, WPA and WMA wetlands with pumped water provide core, migrational habitat on a consistent basis. In drier years, these wetland areas need to have water pumped to them to keep the birds from concentrating on a few small reservoirs and the Platte River. Jorde et al. (1983) found that mallards in Nebraska would move to riverine habitat during winter or cold periods. Therefore, pumping water into wetlands can contribute to the overall distribution of waterfowl within south-central Nebraska.

To increase the benefit of wetlands in the basin for spring migration, it is critical that water be available throughout the basin (RWBJV 1993). Since a significant portion of the entire North American waterfowl population passes through the region, it is even more critical that those populations are not placed at risk. Krapu et al. (1995) advises that waterfowl managers in the basin provide favorable conditions by maintaining well-distributed, wetland-roosting habitat. Supplementing water will increase available habitat, provide more natural foods, and reduce risk associated with crowding (Samuel et al. 2005, Smith et al. 1989).

Each water-pumping facility has a different level of efficiency (for example, the cost per acre-foot of water, gallons per minute, and level of maintenance). Less efficient wells can only be used when wet conditions exist and only when a little supplemental water is needed to reach a desirable habitat condition. Submersible, electrical wells require minimal maintenance and can increase the flexibility of the district's water management. For example, they can be turned on during the harshest part of the winter without fear of freezing or damage, allowing more basins to be ready in the event of an early spring migration. Submersibles also reduce the use of high-cost diesel and natural gas.

Pumping water to wetlands is dependent on various factors (RWBJV 1993). The cost of water pumping and the limited funds makes it necessary to focus water pumping to areas where it will have the most effect for the least cost. For some areas, the capability of the well is less than needed to flood the entire wetland. After a portion of the wetland is flooded, percolation and evaporation begins to equal the pumping capacity of the well.

Thirty-eight WPAs need further acquisition to complete ownership of the wetlands. Partially owned wetlands are not being managed to their full potential. Management treatments such as pumping water, prescribed fire, and grazing are limited or absent. Often the adjoining landowner has different uses or interests in their portion of a wetland. Acquisition will greatly expand the number of fully functional wetlands in Service ownership.

The RWBJV has used GIS technology to identify wetlands having the highest migratory bird value (Bishop 2005). That value is based on biological needs of waterfowl and shorebirds and the geophysical condition of the wetlands. This information will help the district and its partners target the right wetlands for the right conservation strategy—be it acquisition or enhancement of privately owned wetlands (Bishop 2005).

Natural wetland function occurs when there is a balance in the hydrology between the size of the wetland and the watershed. Alterations within the wetland and watershed change that hydrologic balance. This, in turn, changes the plant composition—often to a less preferred habitat community (Gersib et al. 1989a). In fact, Smith (1990) stated that hydrology is the most likely factor influencing plant community composition.

Much of what occurs in a WPA wetland is dependent on what happens hydrologically within its watershed. Working with private landowners not only addresses the district's hydrology objectives, but also assists landowners in meeting their needs. Pits within a watershed capture water before it reaches the wetland. That water is confined to a deep, smaller, artificial wetland that has little value for migratory waterfowl (Gersib et al. 1989a). The Great Plains GIS office inventoried water concentration pits in the district. There were 11,859 pits found, with 627 pits existing within WPA watersheds. Roads and culverts restrict or impound the natural runoff so one portion of the wetland becomes flooded while other portions receive a smaller portion—again affecting the vegetation and amount of surface water in the wetland. Restoration of watershed hydrology should increase the frequency, size, and duration of pooled water.

The Service's Partners for Fish and Wildlife Program assists the district by working with private landowners within the watersheds. Their work adheres to the practices outlined in the "Rainwater Basin Joint Venture Private Lands Program" criteria (appendix M). Using funds and expertise from various partners since 2000, 89 pits have been filled on privately owned property.

It is unknown what the full extent is and effects are of agricultural runoff in the basin's wetlands. Agricultural runoff can carry fertilizers, pesticides, and heavy silt loads to wetlands at the WPAs. Agricultural chemical exposure at WPAs can have two types of effects:

- direct effects—for example, toxic pesticides that affect nontarget species
- indirect effects—for example, habitat quality that is degraded from nutrient enrichment (Dewey 1986)

Gordon et al. (1997) reported some district wetlands had concentrations of mercury, copper, lead, iron, and zinc that exceeded water quality criteria developed by the U.S. Environmental Protection Agency (USEPA) and concluded that high pesticide and fertilizer use in the area was a likely cause. In addition, herbicides (atrazine for corn and glyphosate for soybean acres) and insecticides (organophosphates and pyrethroids) were applied to 93% and 36% of all corn acreages, respectively (NASS 2004). Many of these chemicals appear to cause serious degeneration and malformation of organs in wildlife, and could interfere with the normal function of hormonal systems in humans.

In aquatic systems, atrazine exposure can adversely affect periphyton (organisms attached to submerged plants that provide food for invertebrates) (Nelson et al. 1999), invertebrates (Dewey 1986, Dodson et al. 1999), and amphibians (Larson et al. 1998, Hayes et al. 2002). For example, Dewey (1986) found atrazine concentrations of 20 micrograms per liter decreased adult insect emergence by 90% and insect diversity by 60%. Leopard frogs in York County, Nebraska, had gonadal dysgenesis (degeneration of the reproductive organs) in 28% of the sample and testicular oocytes (abnormally occurring female eggs in a male) were found in a single male (Hayes et al. 2002). Insecticides frequently recommended for corn pests in Nebraska include the third-generation pyrethroid permethrin and fourth-generation pyrethroids including bifenthyrin, tefluthrin, gama cyhalothrin, lambda cyhalothrin, cyfluthrin, zeta cypermethrin, and esfenvalerate (UNL 2004). Recent studies by Go et al. (1999) and Kim et al. (2004) indicate that certain pyrethroid insecticides, including permethrin, may function as endocrine modulators in both wildlife and humans.

The Natural Agricultural Statistics Service (NASS) reported 95% and 76% of the district planted to corn receive applications of nitrogen and phosphorus, respectively (NASS 2004). In addition, nutrient-rich runoff can cause wetland eutrophication (overenrichment of a waterbody with nutrients, resulting in excessive growth of organisms and depletion of oxygen) and may result in decreased foraging potential for waterfowl (Gaiser and Lang 1998).

Soil erosion and sedimentation, especially during high flows, reduces the storage capacity of wetlands and forces some of the surface water to flood nonwetland areas (increasing percolation rates) (Stutheit et al. 2004). The buildup of sediment also allows less-preferred perennial plants to survive during the hotter, drier summer period (Reid et al. 1989). Sedimentation of only 0.2 inch (0.5 cm) caused a 92% reduction in seedling emergence of hydrophytic plants and a 99.7% reduction in total invertebrate emergence in northern prairie wetlands (Gleason et al. 2003). Roads, terraces, culverts, and tile drains also reduce, delay, or redirect runoff from wetlands.

Livestock runoff is of particular concern for at least 22 WPAs that have concentrated animal-feeding operations (CAFO) within their watersheds (USFWS 2006). Mindy Meade-Vohland (personal communication) suggested more confinement might exist as enclosures that were not detectable using remote sensing techniques. Of these CAFOs, five are major operations (larger than 40 acres in size) and are within the watersheds of Theesen, Jones, Cottonwood, McMurtrey, Funk, Sinninger, and Prairie Dog waterfowl production areas.

Runoff into the WPAs from CAFOs may directly affect beneficial uses (as defined by the Nebraska Department of Environmental Quality [NDEQ]) such as aquatic life, wildlife, agricultural and municipal water supply, and aesthetics. A recent court case involved feedlot discharge into Cottonwood WPA. In that case, the owner was charged with illegal discharge that violated aesthetic standards and exceeded ammonia standards. Nebraska's water quality standard (NDEQ 2006) states the following:

To be aesthetically acceptable, wetlands shall be free from human-induced pollution which causes: (1) noxious odors; (2) floating, suspended, colloidal, or settleable materials that produce objectionable films, colors, turbidity, or deposits; and (3) the occurrence of undesirable or nuisance aquatic life (e.g., algal blooms). Wetlands shall also be free of junk, refuse, and discarded dead animals.

In recent years, aesthetic violations are suspected to occur annually in association with four of the five WPAs with CAFOs (Funk, Theesen, Cottonwood, and McMurtrey WPAs). The biological integrity of wetlands is assumed to diminish when aesthetic violations occur.

Pollutants associated with CAFOs include pesticides, trace elements, salts, nutrients, cyanobacteria toxins, bacterial pathogens, hormones, and antibiotics (USEPA 2003). Studies indicate that heavy metals associated with livestock medicine may be above acceptable levels for waterfowl and other waterbirds. Schwarz et al. (2004) found water and sediments from a swine CAFO served as a source for high concentrations of nutrients, antibiotics, hormones, bacterial pathogens, and elemental contaminants (such as selenium, nickel, copper, and zinc). During large storms, contaminant flows can come from flooded wastewater treatment ponds and from runoff on fields fertilized with animal waste (Sharpley et al. 1999).

The district is working with Service contaminant specialists by providing staff time to collect data as outlined in a research proposal entitled "FY07 Environmental Contaminants Program On-refuge Investigations." This work will provide baseline information about water quality coming into and at the WPAs. Results from this study will define what kind of water quality tests should be conducted by the district.

The "Wetland Management District Ditch and Tile Maintenance Policy" in appendix N will apply to existing ditches or tiles that come onto the WPAs where there is no reservation of a drainage easement in the deed.

Upland Goal

Reestablish and maintain native grassland communities of the Rainwater Basin.

Upland Objective A

Within 15 years, restore, enhance, and manage the native grassland plant composition to achieve a high level of diversity. The accumulated, current, and desired percentages for Service lands are shown in table 7.

Upland Objective B

Through the duration of the CCP, apply prescribed grazing at a rate, timing, and intensity that is appropriate for management needs.

Upland Strategies

1. Use the "Rapid Assessment Vegetation Monitoring System" to document existing vegetation occurring with each plant community or association.
2. Harvest seed from the WPAs or other local, privately owned grasslands. Collect more than 80 species of grasses, forbs, and sedges from seed harvesting.
3. Use the seed mixes to reestablish native grassland at WPAs containing cropland or areas dominated by nonnative grasses.
4. Conduct 200–3,000 acres of prescribed burning in upland habitats each year to encourage and promote the plant composition shown in table 7.
5. Continue use of IPM strategies to reduce noxious weeds and other invasive plants.
6. Continue to remove trees to create an open grassland.
7. Develop annual grazing plans that identify the objective and grazing method that will be used at each WPA.
8. Seasonally monitor and review the effects of grazing and prescribed fires to determine if the objective is being met or if modifications need to be made.
9. Construct and maintain adequate boundary fences at 80% of the WPAs.
10. Develop livestock watering facilities for at least 10 WPAs to allow intense grazing treatments to reduce invasive plants and establish native plants.

Upland Rationale

Grassland plays a vital role in buffering runoff and in providing feeding, nesting, and shelter habitat for migrating and residential wildlife. Within the Rainwater Basin, agriculture and roads have replaced the tall-grass prairie in the eastern portion and the mid-grass prairie in the western portion of the basin. Steinauer and Rolfsmeier (2003) reported that more than 97% of tall-grass prairie that once covered the

Table 7. Current, preferred, and achievable plant composition at WPA uplands.

Associations	*Current Composition %*	*Preferred Composition %*	*Achievable Composition %*
Native grassland	64	>95	>80
Invasive grassland	27	<5	<19
Cropland	4	0	0
Trees*	5	<1	<1
Total	100		

(Source: Drahota et al. 2004.)

**Although the percentages are the collective total for all the WPA uplands, it is the district's intent that each upland unit has a percent composition that falls close to the preferred composition. For example, no single WPA would have more than 1% of the trees that exist on district lands. The native grassland association includes all grasses and forbs that historically occurred within the basin (refer to table 4 and appendix H for a list of plant associations that are recorded during transect sampling). Transect data collection determines the frequency of occurrence for all vegetative associations that occur in the stand. Dominant plant communities are determined by data analysis. Plant associations that have the most occurrences within the sample area are considered dominant.*

eastern one-third of Nebraska has been lost. Over the entire basin, less than 10% of the original grassland remains (personal communication with Ryan Reker, RWBJV, Grand Island, NE). Nearly all of the remaining grassland has been significantly altered by land use that promotes invasive cool-season plants such as smooth brome and Kentucky bluegrass.

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District staff use prescribed fire as a tool to manage uplands at the waterfowl production areas.

Grassland birds have experienced dramatic declines because of the loss of grasslands. The North American Breeding Bird Survey reports that 70% of the 29 species characteristic of North American prairies have experienced a decline in population. A portion of that decline is attributed to the small acreage of remaining grassland parcels and the increasing number of trees found within the grasslands (Bakker 2003). Cowbird parasitism is especially concerning (Bakker 2003) in the district due to planted shelterbelts and scattered volunteer trees that are numerous at the WPAs.

It is within the directive of the Service to manage areas according to their historical conditions for the benefit of multiple species of plants, animals, and insects (see habitat requirements in table 8). Because of the small amount of remaining native grassland, it is important to manage the uplands in this manner.

For most of the grassland bird species, the percentage of woody cover should be less than 5% of the plant community (McKee et al. 1998). Prairie chickens prefer less than 1% woody vegetation for lek sites (Merrill et al. 1999). McCarthy et al. (1997) found woody cover encroachment directly decreased adequate nesting cover for prairie chickens.

Burger et al. (1994) found prairie fragmentation directly affected predation rates on bobwhite quail, noting that nests found more than 60 meters from woody cover were three times more successful than those found less than 60 meters from woody cover. Therefore, tree and shrub removal is critically important for those WPAs that have a high percentage of trees or shrubs. Bakker (2000) recommends removing woodland habitat within or adjacent to grassland and acquiring or preserving grassland patches large enough (300–600 acres) to attract the majority of grassland-dependent species.

Native grassland responds better to natural ecological processes (including drought), which provides a more stable habitat to meet wildlife needs. It provides for a greater diversity of plants and animals.

Since the district reseeds areas with a high-diversity (80+ species), grassland seed mix, it is assumed that the species diversity of the established grassland will be greater than 50 species. High-diversity grassland is important for most of the native-grassland bird species (Bakker 2000). Native grassland management will benefit all of the species listed in table 9 (Bakker 2003); however, each has specific habitat requirements that are not the same. Grassland management treatments should provide a variety of grassland conditions that include short-vegetation grazed or hayed areas, medium-height vegetation with low thatch, tall vegetation with low thatch, and grass stands with heavy thatch (Bakker 2003, Sporrong 2001). High-diversity grassland can also be an important line of defense against invasive plant species. Kennedy et al. (2002) found that restoration and revegetation practices that included high-diversity seeding proved effective for exclusion of undesirable invaders.

Table 8. Habitat requirements for selected grassland birds.

Species	*Vegetation Height (inches)*	*Litter (inches)*	*Patch Size (acres)*	*Distance from Trees (feet)*
bobolink	10–18	1.3–3.6	100	150
burrowing owl	<5	minimal	10	>328
dickcissel	8–40	0.6	25	prevent woody encroachment
long-billed curlew	<12	minimal	104	avoids areas with high-density trees and shrubs
grasshopper sparrow	8–24	not available	20	164
sharp-tailed grouse	6–16	use areas that are idle for several years	150	>164
short-eared owl	12–24	2–8 years of residual cover	183	not available
upland sandpiper	1–24	1.0	250	328

(Sources: Grant 1965, Wiens 1973, Clark 1975, Duebbert and Lokemeon 1977, Redmond et al. 1981, Johnsgard 1983, Prose 1987, Renken and Dinsmore 1987, Messmer 1990, Haug et al. 1993, Herkert et al. 1993, Pampush and Anthony 1993, Helzer 1996, Hughes 1996, Madden 1996, Connelly et al. 1998, Clayton and Schmutz 1999, Helzer and Jelinski 1999, Dugger and Dugger 2002, and Laubhan et al. 2005.)

Table 9. Key grassland species found in the Rainwater Basin.

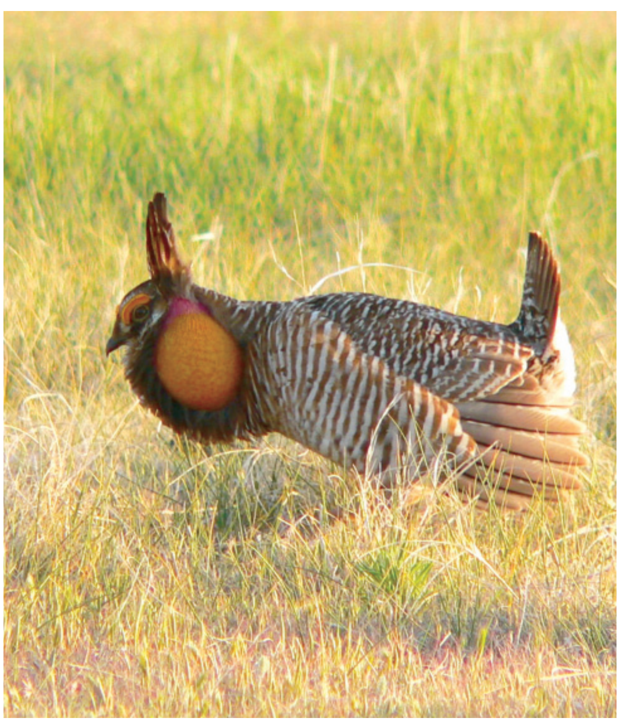
Grassland-nesting Species	*Partners in Flight (score is greater than 20 points)*	*USFWS Focal Species (2005)*	*BCC Bird Conservation Region 19* (2002)*	*Nebraska Tier 1 Species*
northern harrier	✓	—	✓	—
Swainson's hawk	✓	—	✓	—
upland sandpiper	✓	✓	—	✓
burrowing owl	—	✓	—	✓
short-eared owl	—	✓	—	✓
sedge wren	—	✓	—	—
lark bunting	✓	—	—	—
grasshopper sparrow	✓	✓	—	—
dickcissel	✓	—	—	—
bobolink	—	✓	—	—
eastern meadowlark	—	✓	—	—

(Source: Sharpe et al. 2001.)
**Designated by Birds of Conservation Concern, 2002; region 19 comprises central Nebraska, Kansas, Oklahoma, and Texas.*

USFWS

District staff mix 31,000 pounds of seed harvested during the summer. More than 100 species were collected.

Game birds also benefit from managed native grassland stands. Bakker (2003) noted that pheasant researchers found nesting success to increase with increasing distance from trees. Nesting success was lower in and near shelterbelts in South Dakota and Colorado (Trautman et al. 1959, Olson and Flake 1975, Snyder 1984). Heavy predation rates near shelterbelts, road ditches, and fencerows prevented successful nesting (Trautman et al. 1959). Gabbert et al. (1999) found that predation was significantly higher than severe winter mortality—suggesting that thermal cover provided by native grass stands will provide the highest winter survival rates for pheasants. Managing natural areas for grassland bird species involves providing the nesting habitat requirements and food resources essential for production and survival. These requirements include large, treeless patches that contain diverse vegetative structure (Renken and Dinsmore 1987, Johnson and Temple 1990, Volkert 1992, Helzer and Jelinski 1999, DeJong 2001, Herkert et al. 2003, Davis 2004, Fritcher et al. 2004). Management practices that favor grassland-nesting birds will benefit the grassland species of management concern shown in table 9 (Sharpe et al. 2001).



USFWS

Greater Prairie-chicken.

Grazing has been an integral part of the prairie ecosystem. Most techniques of rangeland management were developed with the idea of increasing and sustaining livestock production by decreasing the inherent variability associated with grazing (Fuhlendorf and Engle 2001). However, this is not the approach used at the WPAs. Grazing treatments are used as a vegetation management tool. Proper upland grazing can reduce undesirable species, maintain healthy grasslands, and promote heterogeneity (Fuhlendorf and Engle 2001).

Livestock grazing generates revenue for use to offset the costs of fencing and control of invasive plants at the WPAs. In addition, grazing provides economic benefits to the local community.

The district has mapped the uplands at the WPAs but not to the level of detail or accuracy needed to assess the status or future changes in uplands over a period of years. Currently, the district is not staffed to accurately measure the effect management tools, such as fire and grazing, is having on grassland communities. Measurements from vegetation transects will provide that information. Measurements taken during vegetation transect sampling will provide enough information to adequately address upland-monitoring needs. Without this data, it will be difficult to determine whether upland objectives have been met.

Water Rights Goal

Develop partnerships to protect the natural hydrology of WPA watersheds and ensure the necessary water rights are in place to protect future use of both ground and surface water.

Water Rights Objective A

Within 2 years of CCP approval, complete an inventory of existing district-owned water rights and monitor changing natural resource district regulations associated with groundwater use.

Water Rights Objective B

Through the duration of the CCP, work closely with partners to obtain all necessary water rights and to protect the integrity and hydrology of district wetlands.

Water Rights Strategies

1. Work with water rights experts at the regional office to develop and perform a formal review and determination of the legal status of existing water rights.

2. Work with partners to identify threats and possible solutions to the loss of surface water runoff to district wetlands.

Water Rights Rationale

State law entitles groundwater users to "reasonable and beneficial use of the groundwater." The increase of groundwater irrigation and drought conditions has caused a decline in groundwater throughout the district. The Nebraska Ground Water Management and Protection Act, amended in 2004, requires the Nebraska Department of Natural Resources to annually determine which river basins, subbasins, or reaches are considered fully appropriated. Fully appropriated basins will cause the respective natural resource district to (1) place a moratorium on new surface and groundwater uses, and (2) develop an integrated surface water and groundwater management plan. Only WPAs located in the Tri-Basin Natural Resource District are in fully or overappropriated basins. The Upper Big Blue Natural Resource District established the goal of holding its average groundwater level above the 1978 level. If the average groundwater level drops below a level 3 feet above the 1978 average level, groundwater users will be required to report annual groundwater use.

It is uncertain what future actions will be taken by the natural resource districts or what effect those actions may have on future use of groundwater to supplement wetlands. With water becoming scarcer, there is concern that neighboring lands will capture natural runoff before it reaches the district's wetlands. It is not clear if any legislation or regulations are in place to protect public wetlands from being dried up by diversion of surface water runoff.

Invasive Plant Species Goal

Reduce and control the spread of nondesirable, nonnative plant species within wetland and upland habitats for the benefit of native plant and wildlife communities.

Invasive Plant Species Objective A

Throughout the life of the CCP, continue to monitor and control invasive plant species in wetland and upland habitats by using the appropriate treatment for each situation.

Invasive Plant Species Strategies

1. Annually map and document treatment of nonpreferred plant communities throughout the district.
2. Develop an integrated pest management approach that will include chemical, biological (such as insects), mechanical, and physical (such as fire, grazing) treatments.
3. Treat known stands of state-identified noxious weeds. Other species that degrade wetland and upland habitats will be second priority.
4. Establish healthy stands of preferred, native plants that can compete with invasive plants.
5. Develop partnerships that will find new ways to efficiently control invasive plant species by combining resources of all partners.

Invasive Plant Species Rationale

Invasive, nonnative wetland and upland plants are a serious problem affecting thousands of acres of wildlife habitat along the Platte River and within the basin. Nonnative plants such as Canada thistle and reed canarygrass can outcompete with native flora—creating a monotypic stands if left undisturbed. Native species, such as cattail and river bulrush can do the same if left unmanaged.

In 2004 7,596 acres of undesirable plant communities (includes noxious weeds, cattail, reed canarygrass, bulrush, and invasive cool-season grasses) were mapped at the WPAs.

Vegetation management is key to providing optimal wetland and upland habitat for both migratory and resident wildlife. Healthy native plant communities are better equipped to withstand weed invasions (Kennedy et al. 2002). Long-term control requires the cooperation of public and private land managers throughout the basin. A joint effort by all partners is needed to conduct research on finding the best management practices to control or eliminate individual species.

Wildlife Diseases Goal

Work with partners to prevent or control the outbreak and spread of wildlife-borne diseases to protect human and migratory bird populations.

Wildlife Diseases Objective A

Through the duration of the CCP, continue to monitor WPAs for outbreaks of various wildlife diseases, especially avian cholera and influenza.

Wildlife Diseases Objective B

Respond in an appropriate manner to contain any disease outbreak that occurs.

Wildlife Diseases Strategies

1. Work closely with the NGPC and other state and federal specialists to monitor and control all wildlife diseases at the WPAs.
2. Maintain an up-to-date disease contingency plan.
3. Follow federal and state guidelines for monitoring and control of wildlife diseases.
4. Use partnerships to increase awareness and preparedness for the monitoring, detection, and control of wildlife diseases.
5. Where possible, use management practices such as supplemental water pumping to reduce the spread or effect of disease.

Wildlife Diseases Rationale

Avian cholera was first documented in the district in 1975. It has occurred in the district every year since. The level of outbreak fluctuates from year to year. Cholera mortality in 1998 was estimated at more than 100,000 birds, primarily snow geese, while the mortality in the past 5 years has been in the low hundreds. It is not known for certainty what environmental or physiological factors trigger an outbreak, but it appears to be associated with physiologically stressed birds that are concentrated on a limited number of wetlands (Smith and Higgins 1990). Avian cholera epizootics (diseases affecting large numbers of animals) were found to be inversely related to densities of semipermanent wetland basins. Avian cholera is widely distributed and poses a constant threat to migratory bird populations, especially where dense concentrations of birds occur.

There is a growing concern that an avian influenza pandemic could occur within the next few years. What remains unknown is the possibility that other diseases could reach outbreak proportions while birds are concentrated in the district. The best approach to take is to be vigilant and prepared.

Research and Science Goal

Encourage and support research that substantially contributes to the understanding and management of the Rainwater Basin wetland and grassland ecosystem.

Research Objective A

Through the duration of the CCP, support research that furthers the understanding of the ecology, wildlife populations, socioeconomics, and hydrology within the Rainwater Basin.

Research and Science Strategies

1. Complete baseline research that determines the watershed boundaries for the WPAs and the hydrologic events that affect wetlands. Determine what practices should be done to restore wetland hydrology.
2. Conduct an in-depth inventory of invertebrates, amphibians, reptiles, birds, and small mammals within the district.
3. Determine the baseline composition for each upland plant community using the "Rapid Assessment Vegetation Monitoring System."
4. Determine the socioeconomic effects associated with Service-owned lands: (1) property tax deficiencies, (2) increased local revenue generated from recreational opportunities provided by public access and uses, and (3) aesthetic values.
5. Conduct an invertebrate study to assess the effects of land and water management actions.
6. Identify the energetics contribution of the district to waterfowl and other migratory birds.

USFWS

A crew of district staff, Bureau of Reclamation employees, and summer interns map vegetation at all the waterfowl production areas.

7. Conduct or support contaminant research associated with nonpoint and point source pollution.
8. Work with partners to continue to identify needed research, obtain funding, and support the research process.
9. Conduct district data collection to support ongoing research.

Research and Science Rationale

Smith (1998) identified the current district research needs. The district is working with the RWBJV to accomplish those needs; however, district staff and resources are limited. Research done within the district can be divided into six categories: wetland inventory, bird inventory, habitat evaluation, bird biology, avian cholera, and hydrology.

Most of the early research involved wetland inventory. The first research assessed Clay and Fillmore counties (USFWS 1954). In the late 1960s, a more detailed inventory used soil data and field surveys to assess how many large wetlands had been drained or degraded (McMurtrey et al. 1972). Schildman and Hurt (1984) updated the McMurtrey data and found that 10% of the original wetlands and 22% of the original wetland acres remained. Raines et al. (1990) included small wetlands in their review; they noted the declining number of basins and that the frequency of degraded wetlands was increasing. An assessment in 2004 of land use in the district reported 14% of the historical wetlands have some wetland function (pooled water). Of that amount, 49% are classified as cropped wetlands (Bishop and Reker 2006).

Bird inventories started in the late 1950s with the Service counting numbers of greater white-fronted geese. Those counts were used through 1992 as a population index for the midcontinental population (Benning 1987, Solberg 1992). The district conducted aerial waterfowl surveys during spring migration (USFWS 1983–1993). The NGPC inventoried the basin for species of concern to assess the potential conflicts that may occur with the "Conservation Order for Mid-continent Light Geese" (COMLG) (NGPC 1997–1999). The Canadian Wildlife Service conducted two goose counts in 1999 to compare population numbers using the district with previous population estimates (Warner and Nieman 1999). In addition, the NGPC inventoried spring waterfowl numbers during a 4-year study that looked at effects on nontarget species during the COMLG (NGPC 2000–2003). Austin and Richert (2001) mapped and evaluated whooping crane habitat selection. Although less is known about populations of nonwaterfowl species, the wetlands provide habitat for a minimum of 200,000–300,000 shorebirds represented by over 30 species (LaGrange 2005). Jorgensen (2004) was able to summarize shorebird use in the district. Jorgensen (personal communication) is currently completing buff-breasted sandpiper research. Records of birds occasionally observed in the basin are found in "The Birds of Nebraska and Adjacent Plains States" (Johnsgard 1997).

Habitat evaluations in the basin are limited. Taylor et al. (1978) correlated landscape changes with pheasant numbers. Gersib et al. (1989a) looked at waterfowl densities and activity time-budgets for the basin's wetlands; they found that temporary and seasonal wetlands were the most valuable for spring-staging waterfowl. Gilbert (1989) sampled 47 wetlands in the basin and organized its plant communities in accordance with the dominant hydric soils that were present. Gersib et al. (1989b) also completed a functional assessment concluding that the basin's wetlands have a high probability of providing wildlife habitat, food chain support, long-term and seasonal nutrient retention, flood storage, and sediment trapping. The NGPC (1977–1999), the Service (USFWS 1977–1999), and Richert (1999) have documented whooping crane roost sites and habitat preferences for central Nebraska. Stutheit et al. (2004) provided a comprehensive review of wetland hydrology and function in the basin. Drahota et al. (2004) mapped and sampled vegetation communities at public areas. Brennan (2006) assessed local and landscape factors influencing migratory bird use.

Duck production research by Evans and Wolfe (1967) found the district's wetlands to be intermittent, producing 10,000 birds to flight stage annually. Their findings led managers to focus more on managing for spring migration habitat rather than nesting habitat. Krapu et al. (1995) looked at habitat, food, and nutrients in white-fronted geese and concluded that fat and protein contents increased for females during spring staging in the district. Cox (1998) looked at weight gain, nutrient reserves, and habitat use by white-fronted goose, snow goose, and northern pintail. Cox and Davis (2002) used telemetry techniques to assess northern pintail habitat use, movements, and survival during spring migration and found the smaller wetlands in the basin to be the most important habitat. Farmer and Parent (1997) found that the distance between wetlands influenced use by the pectoral sandpiper. Thus, higher wetland densities provided greater variability in food resources to maximize foraging opportunities and minimize energy expenditures (Farmer and Wiens 1999). Max Post van der Burg (2005) looked at factors affecting songbird nest survival and brood size.

Numerous avian cholera studies have been completed in the district. The first avian cholera outbreak in the district was reported in 1975 (Zinkl et al. 1977). Research conducted in the 1980s and '90s had little success pinpointing the cause of outbreaks and could not develop any strategies that minimized bird loss during outbreaks (Windingstad et al. 1984, Smith et al. 1989, Smith and Higgins 1990, Smith et al. 1990). However, it was determined that the bacteria can remain in the environment for several days after an outbreak occurs (Price and Brand 1984), which potentially jeopardizes the next migrants that stop at the wetland. Samuel (1995) listed those factors that can affect cholera outbreaks and survival of the bacterium in the environment. Cox (1999) found no correlation between a bird's body condition or size and its susceptibility to cholera.

Wetland hydrology appears to be the newest frontier for research in the basin. It is clear that the cumulative hydrologic impact within the hydric footprint and within the watershed can affect pooling duration, frequency, and flooded acres. Wetlands in the basin have the potential to recharge depleted groundwater resources—soil profiles support this due to the lack of visible chloride deposits in dry wetlands (personal communication with Warren Wood, Michigan State University).

Cultural Resources Goal

Identify and evaluate the cultural resources in the district and protect those that are determined to be significant.

Cultural Resources Objective A

Within 10 years of CCP approval, complete a comprehensive cultural resources survey and overview that identifies sensitive areas and helps to preserve historic records and information within the district to ensure protection of cultural resources and compliance with state and federal cultural resources protection laws.

Cultural Resources Rationale

Protecting significant sites, buildings, structures, and objects is the primary goal of the cultural resource work in the district. Cultural resources include the material evidence of past human activities: prehistoric, historic, and architectural in addition to any traditional cultural properties that may or may not have material evidence. A resource is considered significant if it is listed, eligible, or potentially eligible for the National Register of Historic Places.

Protection of significant cultural resources is primarily accomplished through compliance with section 106 of the National Historic Preservation Act. Any project that has the potential to affect structures older than 50 years or cause ground disturbance should be evaluated for its potential to impact cultural resources. Cultural resource personnel should be notified early in the planning process so that alterations of plans can be made if necessary and delays can be avoided.

Surveys are the best tool available to determine the location of cultural resources on the district. Through surveys, both historic and prehistoric sites are identified and key information is gathered that helps for planning, research, and educational outreach. Although small surveys have been done, usually as a part of the section 106 process, large-scale surveys are needed to better understand the distribution and nature of the resources.

A cultural resource overview is needed for the district. This comprehensive study will describe the nature and extent of past cultural resource investigations, the types of resources known on the district, and the interpretive context for these resources. The document will outline specific threats to the resources and the ability of future work to address regional research questions. It will also serve as a planning tool to help encourage consideration of cultural resources during project planning.

Long-term and past employees, in addition to local residents and members of regional historical societies, can be a wealth of information concerning the history of the district and the location of specific resources. District staffs, especially maintenance personnel, often remember alterations to historic structures and know the location of unrecorded archaeological resources.

The extent and condition of historical records, maps, artifacts, and photographs at the district is unknown. This type of historical documentation can provide valuable insight into the development and changes at the district through time. A comprehensive inventory of these items is needed.

Cultural Resources Strategies

1. Notify state and federal cultural resources personnel (for example, the State Historic Preservation Office) early in planning processes so alterations of plans can be made if necessary and delays can be avoided.
2. Notify all district staff of known cultural resource locations to facilitate management and protect the resource. Identify district areas that have not been surveyed but have a high potential for cultural resources.
3. Notify cultural resource staffs (state and federal) when previously unrecorded cultural resources are found in the district.
4. Develop partnerships and work with state and federal cultural resource staffs to develop a comprehensive inventory and compilation of the cultural resources within the district.
5. Conduct cultural resource-related interviews with district staff and local residents.
6. Locate individuals with knowledge on the general history, location of sites, or alterations to various buildings and structures within the district and document this information to preserve historic records.
7. Obtain assistance from state and federal cultural resource staffs, as well as from state universities and private organizations, to carry out an analysis as to how to best stabilize and store cultural resource items for future reference and educational purposes.

VISITOR SERVICES GOAL

Provide quality wildlife-dependent recreation and educational opportunities by instilling an understanding of basic ecological processes, purpose of the Rainwater Basin Wetland Management District, and mission of the Service for persons of all abilities and cultural backgrounds.

Visitor Services Objective A

Over the next 15 years, continue to provide safe and quality hunting and trapping opportunities at WPAs.

Visitor Services Objective B

Within 5 years, fund and hire a full-time outdoor recreation planner (ORP) to develop demographic, attitude, and expectation profiles of wildlife-dependent recreational users, which will determine a long-term plan for providing quality public use opportunities.

Visitor Services Objective C

Through the duration of the CCP, work with partners to provide demonstrations, written information, and other methods of communication that inform the public about the benefits of management actions and increase and improve education, outreach, and recreational opportunities within the district. Development will be guided by the arrival of the proposed ORP and the creation of a future visitor services plan.

Visitor Services Strategies

1. Construct and maintain at least one additional handicap-accessible blind at a WPA in the eastern portion of the district.
2. Maintain parking areas and access points to meet visitor needs.
3. Continue to construct and maintain adequate parking facilities on at least 95% of the WPAs.
4. Increase the amount of signage (such as boundary, regulation, and directional) at the WPAs.
5. Post 50% of the WPAs with entrance signs that include the WPA's name.

6. Provide adequate law enforcement coverage of all hunting and trapping seasons to ensure compliance with laws and regulations while providing for public safety and welfare.
7. Establish mechanisms to work collaboratively with USGS–BRD economists, state universities' departments of agriculture and resource economics, other agencies, national and worldwide travel agencies, outfitter groups, and nongovernmental organizations to obtain the necessary data to determine travel trends to the district.
8. Work with USGS–BRD economists and state universities' departments of agriculture and resource economics to better understand the values and needs of local, national, and international visitors to the district.
9. Within 5 years of designation and funding of a full-time ORP, expand the quality and quantity of wildlife- and habitat-oriented events and programs within the district.
10. Develop a visitor services plan.
11. Designate five WPAs that will become focus areas, representing other WPAs in the district. An ORP position will facilitate integration of environmental education and interpretation for counties in the district.
12. Within 5 years of designation and funding of a full-time ORP, install kiosks that have interchangeable interpretive panels at focus WPAs.
13. Develop a watchable wildlife brochure that identifies the district's WPAs and state areas, as well as seasons that offer exceptional wildlife observation and photography opportunities.
14. Develop a partnership with Nebraska's visitors bureau and other similar agencies to develop and include in their existing publication and websites information about the district and wildlife observation and photography opportunities.
15. Within 3 years of developing an outreach partnership, create an outreach plan that increases the awareness of the district's assets both within and outside the Service.

Visitor Services Rationale

The WPAs are open to the public for hunting, fishing, and trapping during legal seasons. Photography, environmental education, and interpretation are allowed year-round during daylight hours.

The COMLG, approved in 1999, allows for light-goose-hunting during the spring migration. To provide refuge areas during the migration, some public areas are closed to hunting and the entire district is on a day-closure schedule (hunting allowed Saturday, Sunday, Wednesday, and Thursday). Closed WPAs include Bluestem, Clark, Eckhardt, Funk, Hultine, Lindau, Massie, Nelson, Prairie Dog, Springer, Verona, and

USFWS

A district intern assists a young bird watcher.

Wilkins. Closure provides safe haven for waterfowl during periods of significant public use (Delnicki and Reinecke 1986). Hunting pressure and disturbance often discourage waterfowl use on preferred wetlands (Jessen 1970, Raveling et al. 1972, Koerner et al. 1974, Raveling 1978).

The district staff does not have training or responsibilities directed toward education, outreach, or public use in general. The district has always hired personnel with expertise in managing wetlands and grassland. Nearly all the work done by the district to encourage public use has focused on hunting. That work has mostly been limited to placement of boundary signs and maintenance of parking lots. Although spring and fall water pumping is done for the health of waterfowl populations, it also increases hunting opportunities.

In the last decade, informational kiosks have been constructed at 4 of the 59 WPAs. Funk WPA has a viewing and hunting blind that is accessible to people with disabilities, and there are interpretive signs. At Massie WPA, the neighboring community of Clay Center has collaborated with the district to construct and maintain an observation blind.

Although the district periodically gets requests from schools and Scout groups to provide environmental education programs, the district often declines because of lack of staff, expertise, and materials.

Partnership Goal

Promote and develop partnerships with adjacent landowners, public and private organizations, Native American tribes, and other interested individuals to protect, restore, enhance, and maintain a diverse and productive ecosystem.

Partnership Objective A

Continue to provide strong support and active participation in the RWBJV partnerships to promote activities and projects that are mutually beneficial.

Partnership Objective B

Develop more community-based partnerships that involve local individuals, groups, or organizations in the protection, management, enhancement, and enjoyment of the basin's wetlands.

Partnership Strategies

1. Provide representation on joint venture work groups and committees such as the private lands work group, acquisition work group, public lands work group, and technical committee.
2. Set priorities for Service funding and support for projects (land protection, staff, and equipment) that accomplish district objectives and use partner contributions.
3. Work with NGPC to more efficiently manage public lands that are near each other through coordinated exchange of staff, cooperators, equipment, and facilities.
4. Pursue partnerships to develop a field bird guide that is specific to the basin.
5. Pursue partnership funding for an ORP.
6. Develop a list of high-priority and innovative projects that overlap between district and other joint venture partner needs.
7. Foster a working relationship with individual producers to enhance and maintain habitat conditions at the WPAs.
8. Develop, coordinate, and maintain working relationships with state and local law enforcement authorities and fire departments to protect district properties and trust species.
9. Develop, coordinate, and maintain working relationships with cooperating agencies and joint venture partners who conduct prescribed burns.
10. Through the Partners for Fish and Wildlife Program and other partners, develop, coordinate, and maintain working relationships with joint venture partners who also deliver private lands projects.

Partnership Rationale

The basin has a mix of wetland types. Because of their large size and water permanence, some wetlands are best for public ownership. The other wetlands will remain in private ownership and will require a partnership approach to restore or enhance them. The value of each WPA for waterfowl is dependent on its proximity to a complex of other wetlands. A WPA that is adjacent to other wetlands will be of more value to waterfowl than one that is isolated from other wetlands. It is important that the district work with its neighbors and conservation partners to improve the basin-wide landscape for the benefit of migratory birds, other wildlife, and the human environment.

Working together has been characteristic for the neighbors, agencies, and organizations in the Rainwater Basin. Partnerships have flourished because each group recognizes that it cannot "do it" alone. The RWBJV (described in chapter 1, section 1.4) is a partnership organization made up of government and conservation organizations, as well as landowners.

The RWBJV's goal is to

> *Restore and maintain sufficient wetland habitat in the Rainwater Basin area of Nebraska to assist in meeting population objectives identified in the North American Waterfowl Management Plan.*

The joint venture's objectives are in line with those of the district. The RWBJV commonly joins with nontraditional partners to (1) restore and protect additional wetlands, (2) provide reliable water to at least one-third of the protected wetlands, and (3) enhance existing wetlands.

Ducks Unlimited has identified the Rainwater Basin as a conservation priority for their organization. They are actively involved in wetland restoration and acquisition. Much of the restoration work done by Ducks Unlimited has occurred on NGPC and district lands. In recent

USFWS

This combine used to harvest native grasses was purchased through a three-way partnership—the district, NGPC, and Pheasants Forever.

years, they have acquired lands that are being restored and planned to be transferred to NGPC or district ownership. The U.S. Department of Agriculture's (USDA) Wetland Reserve Program has restored and protected wetlands throughout the basin. The Nature Conservancy has helped protect 1,765 acres that are currently under the Service's management. Another 466 acres are under the management of the NGPC.

Socioeconomics Goal

Obtain a better understanding of the social and economic contribution WPAs make to the people and communities within the Rainwater Basin.

Socioeconomics Objective A

Develop an economic impact analysis within 5 years of CCP approval to determine how the district's existence and management activities affect the local and state economies.

Socioeconomics Objective B

Within 5 years of CCP approval, evaluate the aesthetic and environmental benefits of the district's existence and management activities to the state and local communities.

Socioeconomics Strategies

1. Through joint venture partnerships, work collaboratively with USGS–BRD economists or state universities to develop an economic impact analysis of district management actions and the recreation that the WPAs provide.
2. Work with RWBJV partners, university and USGS–BRD ecologists, sociologists, and landscape architects to develop an environmental and aesthetical impact analysis of WPAs in the district.

Socioeconomics Rationale

The WPAs provide a service to communities and to those who visit the areas. Wetlands improve water quality, recharge groundwater, control erosion, and provide flood control. Wetlands provide habitat for many species of wildlife and offer recreational opportunities. However, it is not known to what extent the district's wetlands provide these services and benefits.

The basin is intensively farmed and many of the local citizens see wetlands as a detriment to farming operations. The loss of cropland due to seasonal flooding has caused many landowners to drain or fill the wetlands, which removes the benefits they may provide to the community. An accurate assessment of the wetlands' economic and social worth will help increase public understanding of the value of protecting wetlands.

Operations Goal

Safely and efficiently use funding, staffing, infrastructure, and partnerships to achieve the purpose and objectives of the Rainwater Basin Wetland Management District.

Operations Objective A

Within 10 years of CCP approval, build and maintain Service-owned facilities that serve as an office, visitor contact center, maintenance shop, equipment storage, and housing for researchers, volunteers, and seasonal employees.

Operations Objective B

Within 2 years of CCP approval, construct adequate storage facilities for heavy and farm equipment currently stored at McMurtrey and Cottonwood WPAs.

Operations Objective C

Through the duration of the CCP, continue to maintain adequate housing facilities for researchers and volunteers.

Operations Objective D

Through the duration of the CCP, continue to maintain existing roads and dikes at the WPAs.

Operations Objective E

Through the duration of the CCP, continue to maintain equipment and vehicles at or above Service standards.

Operations Objective F

Within 5 years of CCP approval, strive to obtain additional funding for necessary staffing to address the needs of the district.

Operations Strategies

1. Work with partners and the regional office to obtain funding and secure a suitable site for the construction of a Service-owned facility.
2. Prioritize the building and maintenance schedule based on funding projects in the Service Asset Maintenance Management System (SAMMS). Identify an office/visitor center as the top priority construction project.
3. Schedule equipment and vehicle replacements to achieve industry standards when normal life expectancy is reached.
4. Seek mutual agreements to maintain roads that provide access to the WPAs.
5. Work with partners and the regional office to obtain funding to fill four additional positions: outdoor recreation planner, law enforcement officer (park ranger), maintenance worker, and refuge operations specialist.
6. Seek to close minimum-maintenance roads that dissect four WPAs.

Operations Rationale

The district is operating out of the same building it leased in the late 1970s. At that time, the number of properties managed and the amount of equipment and staff were significantly less than what exists today. The building was constructed as a metal warehouse. Before leasing it, a portion of the warehouse was converted to office space. In the mid-1990s, more office space was needed and the shop area was reduced to allow for three additional offices.

Since the property was first leased, the work accomplished by the district has drastically changed. Staff has changed with the addition of a wildlife biologist, two Partners for Fish and Wildlife biologists, two permanent fire specialists, and three seasonal firefighters. With more staff has come more office and field equipment. The current building is not adequate to store the additional fire engines and equipment. Heavy equipment and some of the vehicles have to be stored at two other locations: McMurtrey WPA and Cottonwood WPA. Both areas are more than 40 miles from the office/shop.

The office portion of the building has desks crowded together with limited space for filing cabinets, computers, and books. The conference room is a small room, partitioned off from the storage room, located above the offices. Because the office is contained within the warehouse, the ventilation system draws shop fumes (welding, vehicle exhaust, and chemicals) into the office area.

The facility is located within an older industrial park. The immediate neighbors include an older trailer park, auto repair shops, grain elevator, and outdoor storage yard. The location of the facility and its appearance are not inviting to the public. Visitors are primarily delivery persons and a few cooperating landowners. The visitor contact portion of the office also serves as the mailroom and photocopying room. Staff vehicles fill the small parking lot and some parking occurs on the street. Although a security fence protects the storage yard, theft and vandalism still occur.

Storage facilities for vehicles and heavy equipment are lacking. Nearly all the equipment remains exposed to extreme weather conditions.

Temporary quarters for researchers and volunteers are old, surplus mobile homes. Mice infest the mobile homes, which are located on a site that does not have potable water. In addition, the temporary quarters are located 40 miles from the office, making it difficult to arrange work schedules between volunteers and staff. In recent years, arrangements with The Nature Conservancy have allowed their rural office/home to house fire crew and volunteers. Numerous opportunities to have research studies and prescribed fires conducted in the district have not happened because the district lacks housing.

Two dual-function officers provide law enforcement operations. However, their primary responsibility is land management. The time allocated toward law enforcement is not adequate to address game violations and vandalism.

4.2 STAFF AND FUNDING

The district has a staff of 12 full-time employees. Table 10 lists these positions along with four new positions that are needed for full implementation of the CCP. Projects required to carry out the CCP are funded through two separate systems, as follows:

- The Refuge Operations Needs System (RONS) is used to document requests to Congress for funding and staffing needed to carry out projects above the existing base budget.
- The SAMMS is used to document the equipment, buildings, and other existing properties that require repair or replacement.

Lists of the RONS and SAMMS projects required to carry out this CCP (including maintenance of structures and equipment to a safe and productive standard for the 15 years of the CCP) are in appendix O.

4.3 STEP-DOWN MANAGEMENT PLANS

The final CCP for the Rainwater Basin Wetland Management District will be a broad umbrella plan that (1) outlines general concepts and objectives for habitat, wildlife, visitor services, cultural resources, partnerships, and operations; and (2) guides district management for the next 15 years. Step-down management plans provide greater detail for carrying out specific actions authorized by the CCP. Table 11 presents step-down management plans that are anticipated to be needed, along with their current status and next revision date.

4.4 MONITORING AND EVALUATION

Adaptive management is a flexible approach to long-term management of biotic resources. Adaptive management is directed, over time, by the results of ongoing monitoring activities and other information. More specifically, adaptive management is a process by which projects are carried out within a framework of scientifically driven experiments to test the predictions and assumptions outlined within a CCP.

To apply adaptive management, specific survey, inventory, and monitoring protocols will be adopted for the district's WPAs. The habitat management strategies will be systematically evaluated to determine management effects on wildlife populations. This information will be used to refine approaches and determine how effectively the objectives are being accomplished. Evaluations will include participation by appropriate partners. If monitoring and evaluation indicate undesirable effects for target and nontarget

Table 10. Current and proposed staff for Rainwater Basin Wetland Management District, Nebraska.

Staff Group	*Current Positions*	*Additional Proposed Positions (Unfunded Staff)*
management	refuge project leader, GS-13 deputy project leader, GS-12 refuge operations specialist, GS-9	refuge operations specialist, GS-9
biological	wildlife biologist, GS-11 biological technician (wildlife), GS-7	no additional positions
visitor service	none	outdoor recreation planner, GS-11
administrative	administrative support assistant, GS-8	no additional positions
maintenance	maintenance worker, WG-8 biological technician (wildlife), GS-6	maintenance worker, WG-7
fire management	prescribed fire specialist, GS-9 supervisory range technician, GS-7	no additional positions
law enforcement	none	park ranger, GS-9
Partners for Fish and Wildlife	fish and wildlife biologist, GS-9 fish and wildlife biologist, GS-9	no additional positions

GS =General schedule position.
WG=Wage grade position.

Table 11. Step-down management plans for Rainwater Basin Wetland Management District, Nebraska.

Step-down Management Plan	*Completed Plan (year approved*	*New or Revised Plan, (completion year)*
disease contingency plan	2006	2013
fire management plan	1998	2009
habitat management plan	—	2010
habitat management plan (annual)	2007	2008
integrated pest management plan	2003	2008
law enforcement plan	—	2010
prairie dog management plan	2003	2011
safety plan	2004	2009
visitor services plan	—	2012
water management plan	2007	2008

species or communities, alterations to the management projects will be made. Subsequently, the CCP will be revised.

4.5 PLAN AMENDMENT AND REVISION

This CCP will be reviewed annually to determine the need for revision. The Service will revise this CCP if and when significant information becomes available. This CCP will be supported by detailed step-down management plans to address the completion of specific strategies in support of the district's goals and objectives. Revisions to this CCP and the step-down management plans will be subject to public review and compliance with the NEPA. At a minimum, this CCP will be evaluated every 5 years and revised after 15 years.