4 Management Direction

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Pied-billed Grebe

This CCP takes an integrated approach that optimizes the biological potential for migratory birds and finds a balance with reducing cropland, while ensuring depredation is minimized.

The management direction in this chapter meets the purposes, vision, and goals of the refuge. Objectives and strategies to carry out the goals will provide for ecosystem and 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;
  - who is responsible to achieve it.
- Strategies are ways to achieve an objective.
- Rationale for each objective includes background information, assumptions, and technical details used to formulate the objective. The rationale provides context to enhance comprehension and facilitate future evaluations.

Development of refuge goals and objectives involved multiple sources of information:

- a review and interpretation of national plans
- a review of existing scientific literature
- an evaluation of habitat conditions
- the personal knowledge of planning team participants

Management Summary

Upland habitat management will be geared toward providing tall and dense nesting cover on a high percentage of the uplands for nesting birds, especially waterfowl. Rejuvenation of decadent grasslands and the control of invasive plant species will be emphasized. This will be accomplished through an active management program of grazing, prescribed burning, haying, farming, reseeding, invasive plant control, and habitat monitoring.

- Cropland acreage will be reduced.
- No new shelterbelts will be planted. Existing shelterbelts will be allowed to die out to increase the size of grassland blocks for nesting migratory birds. In addition, selected shelterbelts will be removed and the disturbed sites seeded to grass.

- Invading Russian-olive trees will be removed or controlled where they are threatening the productiveness of grassland-nesting migratory bird species.

The refuge will acquire areas approved by the Migratory Bird Conservation Commission when the land becomes available from willing sellers.

Both Mud and Sand lakes will be managed to provide a wetland category preferred by overwater-nesting birds and waterfowl. The five subimpoundments (figure 9) will be managed as shallow-water, seasonally flooded wetlands—used by waterfowl breeding pairs and broods, nesting black terns and pied-billed grebes, and foraging waterbirds and shorebirds. Drawdowns will be accomplished, depending on the amount of flow in the James River; water can only be moved out of the units when there are low flows in the river. Siltation problems within Mud and Sand lakes will be addressed.

The refuge will manage its wildland fire program according to the steps outlined in appendix J.

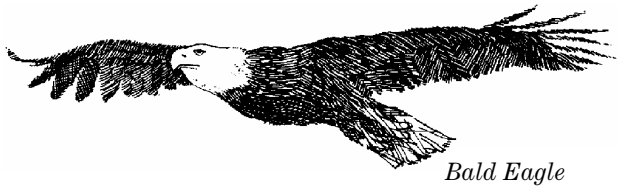
Neil Powers/USFWS

Prescribed fire is a tool to rejuvenate grassland.

The section 7 biological evaluation for threatened and endangered species can be found in appendix K.

Wildlife-dependent recreational activities will be expanded and improved on and off refuge lands.

- The building of an education center will allow visitors a quality experience and provide a focus point for public use. This new education center, larger than the current headquarters facility, will meet current demand for educational materials and activities, as well as for special events.
- Support facilities for hunting and fishing opportunities will be improved.
- The Columbia and Hecla day use areas will continue to be managed for public activities. Improvements such as updated signing, interpretive kiosks, and expanded trails will be made to each site.
- On-site tours, school field trips, and educational activities will be promoted and associated facilities will be improved.
- Off-site programs will promote visitation to the refuge.



Bald Eagle
© Cindie Brunner

MANAGEMENT DIRECTION

The biological diversity goal will be met through the following objectives and strategies. Expected habitat conditions are shown in figure 10.

BIOLOGICAL DIVERSITY GOAL

Promote the natural biological diversity of the area and, through management of refuge habitats, provide for the greatest number of native fauna and flora species within the capabilities of the Sand Lake National Wildlife Refuge.

Threatened and Endangered Species Subgoal

Provide for the protection and welfare of any threatened or endangered plants and animals that may occur on the refuge.

Threatened and Endangered Species Objective: Provide nesting and roosting habitat for bald eagles during the course of the year. Make special efforts to protect and provide for the well-being of any threatened or endangered species, such as the whooping crane, that is found to be present.

Strategy

— Allow riparian zone trees, especially cottonwoods, to grow except where affected by habitat management activities.

Waterfowl and Grassland-nesting Birds Subgoal

Provide sufficient habitat (wetlands and grasslands) for the production and maintenance of waterfowl and grassland-nesting, nongame bird species.

Waterfowl and Grassland-nesting Birds Objective: Maintain or develop a minimum of 8,000 acres of nesting habitat for waterfowl and grassland-nesting nongame birds within 10 years of CCP approval.

Strategy

— Maintain upland habitats through applied management such as grazing, haying, and prescribed fire.

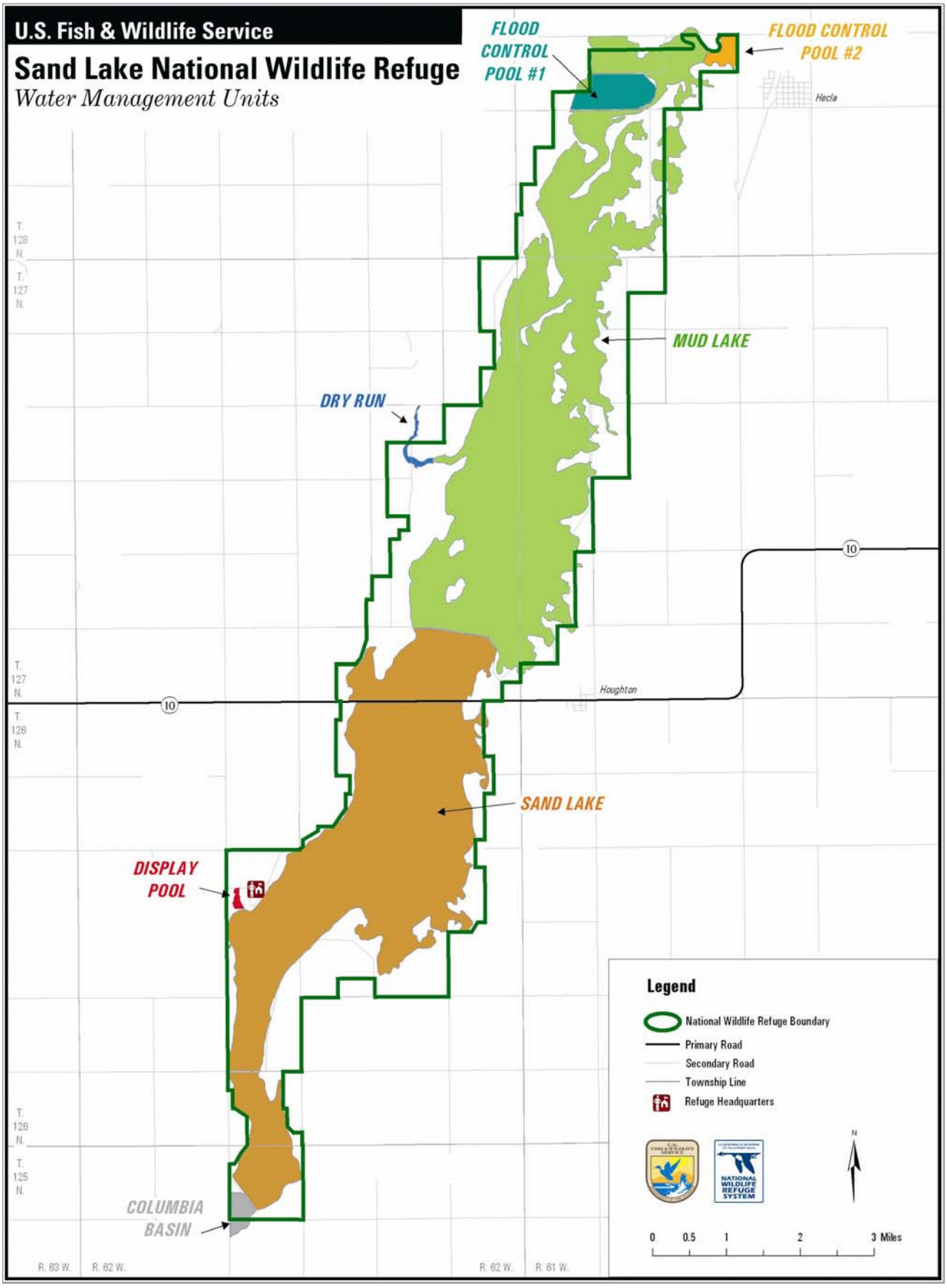


Figure 9. Water management units at Sand Lake National Wildlife Refuge, South Dakota

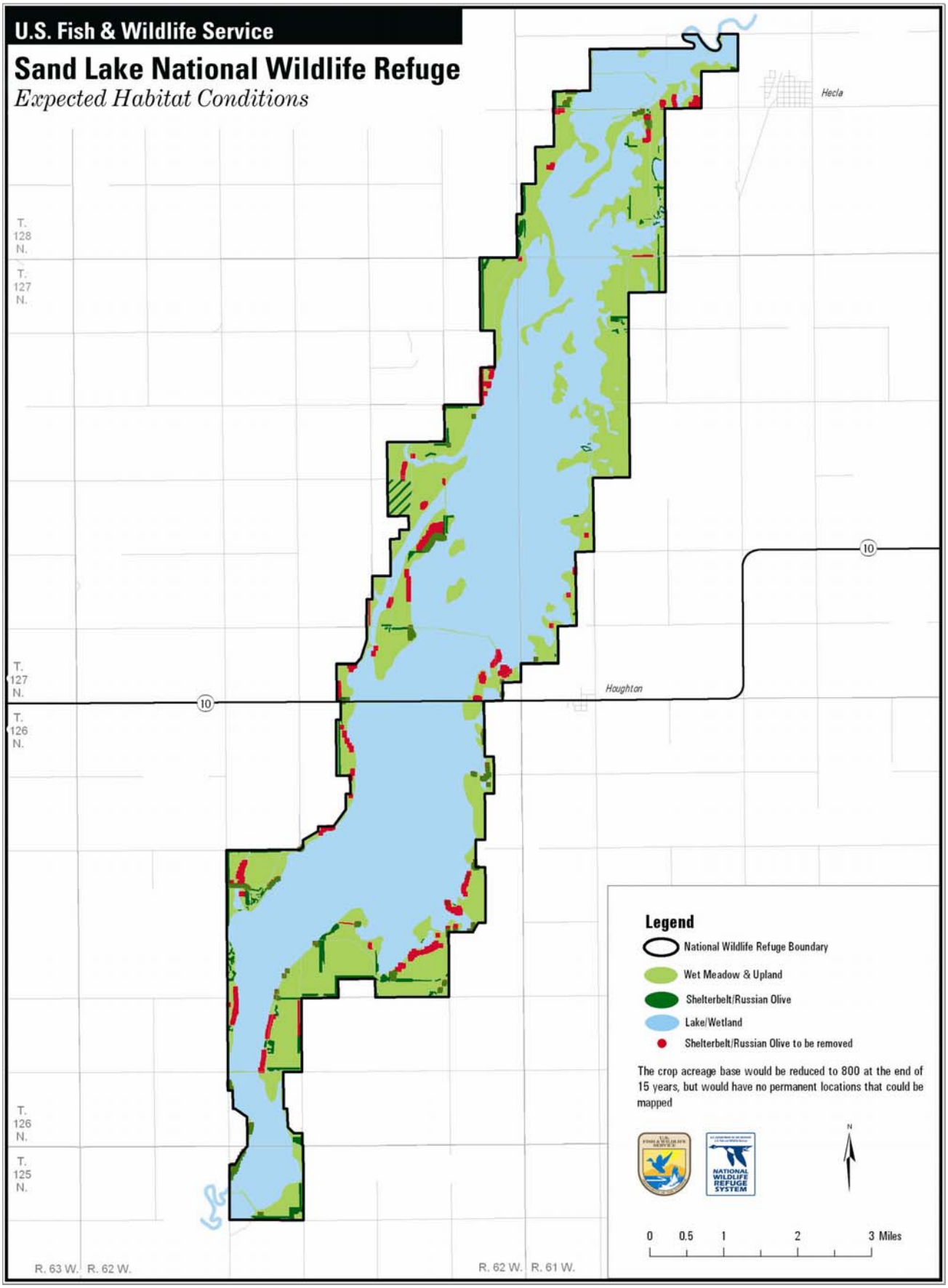


Figure 10. Expected habitat conditions at Sand Lake National Wildlife Refuge, South Dakota

Colonial Birds Subgoal

Provide and manage wetland habitats as nesting areas for the tremendous variety of colonial bird species using the refuge.

Colonial Birds Objective: Manage the emergent vegetative zones through water level manipulations to provide nesting and roosting habitat for the hundreds of thousands of colonial-nesting birds that use the refuge. Maintain 750 acres of emergent vegetation south of Highway 10 within the traditional nesting area.

Rationale

Overwater colonial-nesting birds rank high on the hierarchy of wildlife priorities of the refuge (table 2). This objective describes the deepwater/dense-emergent category of wetland habitat preferred as overwater nest sites by a high percentage of colonial-nesting birds found on the refuge, as follows:

- Franklin's gull (Burger 1974, Guay 1968)
- White-faced ibis (Ryder and Manry 1994, Zeiner et al. 1990)
- Black-crowned night-heron (Davis 1993)
- Eared grebe (Dechant et al. 2002)
- Western grebe (Short 1984)
- Forster's tern (Gorenzel 1977, McNicholl 1979)

Table 2. Priority ratings of bird groups relative to habitat management on Sand Lake National Wildlife Refuge, South Dakota

Priority Rating	*Bird Group*
1	Waterfowl
2	Colonial-nesting birds
3	Grassland-nesting passerine birds
4	Shorebirds
5	Other marsh and waterbirds
6	Raptors
7	Woodland-nesting passerine birds
8	Resident species

By managing areas of Sand and Mud lakes (see impoundment objectives in the wetland habitat section) for overwater-nesting birds, habitat for other wetland birds will naturally be provided in areas of different depth.

- Deepwater/sparse-emergent habitat will be provided along the edges of deepwater/dense-emergent areas and in areas of variable depth.
- Shallow-water/emergent habitat will be provided along the marshy edges of Sand and Mud lakes and in the northern part of Mud Lake.
- Open-water/submergent habitat will be provided in the deeper, center part of Sand Lake and in the deeper pockets of Mud Lake.
- Shallow-water/sparse habitat will be provided along the lake edges and shorelines.

The location and amount of each habitat type will vary with the natural wetland cycles. As emergent vegetation gradually decreases, the habitat type will change. This can happen gradually over time or within several years if water levels are extreme.

In addition, water levels in the subimpoundments are intended to vary like natural wetlands. The success and timing of such management actions are subject to dynamic weather patterns.

Plant communities in prairie wetlands are continually changing because of short- and long-term fluctuations in water levels and salinity. Prairie wetlands have evolved under these fluctuating conditions. The process of cycling with wet and dry periods makes prairie wetlands productive. For instance, exposure of mud flats during drought periods is necessary for the germination of many emergent macrophytes and facilitates the oxidation of organic sediments and nutrient releases that maintains high productivity.

Within the framework of a dynamic wetland system, management of the subimpoundments is directed toward waterfowl (foraging, breeding pairs, and broods), shorebirds, and wading birds. This objective sets an upper and lower threshold of emergent vegetation, because an interspersion of emergent vegetation and wetland openings is preferred by both dabbling and diving ducks and their broods (Kantrud 1986).

Interspersed emergent vegetation also benefits other marsh-dwelling birds and mammals (Seabloom 1958, Vogl 1973, Weller and Spatcher 1965). Such conditions may also result in avian communities of greater species diversity or richness (Weller 1978, Weller and Spatcher 1965). In addition, Voigts (1976) found maximum invertebrate abundance occurring where beds of submerged vegetation were interspersed with stands of emergent vegetation.

A lower invertebrate biomass threshold is part of the subimpoundment objective. Invertebrate abundance is quantified relative to biomass in June, because that is when invertebrate biomass is known to peak in most wetlands (Euliss and Mushet 2003).

Abundance of aquatic macroinvertebrates is positively related to waterfowl use (Kaminski and Prince 1981, Schroeder 1973, Swanson and Meyer 1973) and early growth of ducklings (Chura 1961, Perret 1962, Sugden 1973). Aquatic invertebrates also are important food resources for shorebirds (Eldridge 1987), amphibians (Clark 1978, Deutschman 1984), and other marsh birds (Weller 1981).

Shallow water conditions during some portion of the year are also favorable. Deep water may reduce the availability of invertebrates to feeding waterfowl (Laperle 1974, Murkin and Kadlec 1986) and shorebirds. Optimum foraging depths for dabbling ducks, shorebirds, and wading birds are 2–9.8 inches, 0–9.8 inches, and 3–23.6 inches, respectively (Jasmer 2000). Diving ducks can also exploit food resources in shallow water (Fredrickson and Reid 1988).

© John Jave

Young eared grebes keep watch from their mother's back.

Strategy

— Manipulate water levels in the major impoundments.

When emergent cover is in optimal condition, conventional water strategies will be applied. This consists of moving spring runoff through the refuge as quickly as possible, until water levels have fallen to full-pool elevation (1,287.52 feet above sea level). Full-pool elevation will be maintained through the nesting season (May 15–August 1). Refuge staff will continue to coordinate with upstream dam managers to minimize negative impacts to overwater nesters.

Control of water levels to manage wetland habitats is dependent on the flows of the James River. Conditions on the river can change quickly and need to be continually evaluated.

After multiple years of high water, cattail stands often need to be reestablished through managed drawdowns. The best time to reestablish cattail in Sand Lake is during low-flow years, when water levels can be drawn down during the summer months.

In Mud Lake, drawdowns will be limited by the level in Sand Lake, but conditions should be sufficient to reestablish cattail during low-flow years.

The coordinated release of water from Dakota Lake National Wildlife Refuge, just north of Mud Lake, may also be an option if the releases benefit both refuges or if the benefits to Sand Lake National Wildlife Refuge override the benefits to Dakota Lake National Wildlife Refuge. The managers at both refuges will determine this. These releases may be needed to reflood part of Mud Lake after a drawdown or to address a botulism problem in Mud or Sand lakes.

If the wetland experiences only shallow flooding, emergent vegetation may eventually expand through vegetative propagation to dominate the entire wetland. The resultant buildup of litter and organic material from emergent species can reduce water depth or eliminate shallow water areas (Hammond 1961; Ward 1942, 1968). Decreased waterfowl use is commonly associated with the decreased habitat variation in stands of tall, emergent hydrophytes, which typically form monotypes in the absence of disturbance.

General references (Kozlowski and Ahlgren 1974, Wright and Bailey 1982) indicate that burning of marsh vegetation releases nutrients and opens the canopy and detrital layer. Reduction in the height and density of tall, emergent hydrophytes by fire generally benefits breeding waterfowl. Such benefits are an increase in pair density probably related to increased interspersion of cover and open water, which decreases visibility among conspecific pairs (Kantrud 1986). Grazing by cattle also may remove much organic matter and create open water areas where submersed plants flourish (Schultz 1987).

Prolonged deepwater flooding reduces emergent macrophytes due to extended inundation and the expansion of muskrats and their consumption of macrophytes (Euliss et al. 1999). Drawing the wetlands down early in the summer when mud temperatures are too cool to allow cattail germination helps discourage cattail invasions. Alternately, allowing the subimpoundments to drain naturally will expose the mud flats in midsummer and likely encourage cattail proliferation.

The James River is embedded within an agricultural landscape where cultivation of wetland catchment areas has likely increased

the intensity of runoff events and decreased the time available for infiltration.

Although all major dams constructed on rivers have a finite life span due to natural sedimentation processes, human-caused influences on sedimentation rates have great potential to fill prematurely Mud and Sand lakes, degrading their wetland functions.

Increased sediment in water generally reduces the depth of the photic zone, reducing the light available for primary production by aquatic macrophytes and algae (Ellis 1936, Robel 1961). Sediment depths of 0.1 inch can significantly reduce species richness, emergence, and germination of wetland macrophytes (Jurik et al. 1994, Wang et al. 1994).

Because of the negative impacts on aquatic vegetation from sediments, water quality functions may be altered (Gleason and Euliss 1998). Such loss of standing vegetation structure and algal biomass generally makes wetlands less productive for invertebrates (Euliss and Grodhaus 1987, Krecker 1939, Krull 1970, Neill and Cornwell 1992). Aside from their obvious role in the feeding ecology of waterfowl and other birds, invertebrates provide critical food chain support for a wide variety of other organisms and play significant roles in nutrient cycling and overall wetland productivity (Murkin and Batt 1987).

In 2000, the USGS estimated the vertical accretion rate of sediment near the Mud Lake dike to be 0.5 inch per year, with sedimentation rates greater than 0.8 inch per year during the 1990s when river flows were especially high (Gleason et al. 2003).

At the current rate of sedimentation, the projected loss of water depth over the next 20 years would prohibit manipulation of water levels in Mud Lake. Lacking the ability to cycle vegetation and create an interspersion of cover and water, current wildlife objectives would not be met. Once Mud Lake fills with sediment, sedimentation rates are expected to escalate in Sand Lake as well.

If Mud Lake basin continues to fill with silt at its current rate, it could lose most of its original wetland volume. Methods to restore the basin will need to be evaluated within the context of economics and the postrestoration potential to provide targeted functions. Future work should assess current sedimentation rates in Sand Lake to project the life span of this impoundment.

Maintenance of the topographic relief of the basins of Mud and Sand lakes is essential to maintaining the functions and biological diversity of the wetlands. Management of the upper basin may be the most practical alternative to reducing sediment in these lakes.

Conservation practices that target sustained agricultural production and long-term wetland management can be quite effective in slowing overland input into the James River, as follows:

- fencing out riparian zones
- creating greenways
- establishing grassed waterways and vegetative buffer strips
- implementing the Natural Resources Conservation Service's (NRCS) best management practices

The NRCS has already implemented the wetland reserve and conservation reserve programs on scattered lands along the James River. However, based on lack of significant enrollment in these programs, a new approach may be necessary to achieve coordinated effort among landowners to address effectively runoff issues along the James River.

One approach may include an entirely new program designed specifically for protection of the James River basin. Economic incentives could be used to facilitate landowner implementation of the program. Partners will be needed to develop such a large-scale program and could include the James River Watershed District, soil conservation districts, state and federal agencies, and other conservation organizations.

This approach could also involve a presentation of existing programs with a coordinated effort among multiple state and federal agencies. This outreach effort could be directed toward property owners on the James River floodplain to ensure that they are made aware of their options. Region 6's Partners for Fish and Wildlife Program will be one avenue for promoting new and existing programs to private landowners.

The U.S. Department of Agriculture (USDA) has the conservation reserve enhancement program (CREP), which has great potential although it has not yet been implemented in South Dakota. Based on observations in other states, the CREP program may prove to be a valuable tool to achieve the desired James River environmental goals.

In addition, the possibility of land easements or purchases could be made available. Perpetual protection of the floodplain is preferable to a temporary solution. However, consideration should be given to the fact that perpetuity clauses may inhibit landowner participation.

Water could be moved in and out of the five subimpoundments opportunistically, as flows in the James River and water levels in Mud and Sand lakes allow.

When management action is necessary and water elevations in the main pools are not conducive to take advantage of gravity flow, a 16-inch Crisafulli pump could be used to move water into or out of these subimpoundments. This will add significantly to the cost, will be time consuming, and must not violate restrictions placed on the refuge's water rights. However, it could create the desired habitat conditions when other management alternatives are not available.

Most of the subimpoundments are smaller areas separated from the main pools by an embankment. Water could be diverted into or out of the subimpoundments by gravity flow. Because of their smaller size and isolation from the main pools, it will be possible to provide some water level control, thereby influencing the plant and invertebrate communities, as well as the productivity of the subimpoundments.

Plant and invertebrate production could be maximized through carefully planned drawdowns and subsequent reflooding events. Drawdowns of the subimpoundments will be accomplished in different years to provide a diversity of habitat conditions during any given year. The need for rejuvenation of plant and invertebrate communities within each unit and the ability to move water out of the unit will largely determine when drawdowns could be conducted.

Resident Wildlife Subgoal

Contribute to habitat requirements for regional populations of resident wildlife including fish, reptiles, amphibians, mammals, and nonmigratory birds.

Red Fox
Bob Savannah/USFWS

Resident Wildlife Objective: Work with the South Dakota Cooperative Research Unit and the South Dakota Heritage Program on nongame wildlife issues.

Strategy

— Work with the South Dakota Cooperative Research Unit and the South Dakota Heritage Program on inventories and development of habitat management techniques to support resident, nongame wildlife species.

Deer Management Objective: Continue working cooperatively with SDGFP to meet winter food requirements for white-tailed deer.

Strategy

— Allow the refuge's share of the farm program crop to remain in the field and available during winter months.

Grassland Habitat Subgoal

Restore, maintain, and provide quality habitat for the life requirements of a diversity of migratory birds and other wildlife species.

Directly connected to this subgoal, the refuge's farm program serves two purposes:

First and foremost, it has tremendous value as a habitat management tool. Farming is used to reclaim decadent grasslands and monotypic stands of undesirable grass species (brome and bluegrass), and to combat invasive plant infestations.

In addition to its use as a habitat management tool, farming provides direct benefits to wildlife.

Over the next 15 years, the scope of the farm program on the refuge will be reduced. However, a base acreage of approximately 800 acres will be maintained to address these needs.

Grassland Block Objective: Manage at least 8,000 acres of grassland habitat with a minimum of 80 percent of the grassland habitat managed in blocks of at least 160 acres within 15 years of CCP approval.

Rationale

With the United States' grasslands listed as critically endangered, i.e., greater than 98 percent declines (Noss et al. 1995), larger blocks of contiguous grassland will benefit grassland-dependent species.

An extensive, 8-year study in Manitoba, Saskatchewan, and Alberta, Canada found hatching rates of waterfowl were generally higher in larger patches of habitat (Howerter 2002). In Minnesota's tall-grass prairie, nest-depredation rates were lower

on large (321–1,201 acres) versus small (40–79 acres) grassland blocks (Johnson and Temple 1990).

By creating larger grassland blocks, more favorable habitat is created for grassland birds of special concern that are known to nest on the refuge (table 3). Of these 15 species, 9 use grassland growth forms in the tall- or medium-height category (Dechant et al. 1998b–d, 1998f, 1999a–c, 1999e, 1999f). These nine species, along with the more abundant savannah sparrow, bobolink, sedge wren, and clay-colored sparrow (Dechant et al. 1998a, 1998e, 1999d; Swanson 1998), have the greatest capacity to indirectly benefit from the management of tall, dense vegetation for nesting waterfowl (table 4, next page).

Table 3. Grassland birds of special concern with known nesting activity on Sand Lake National Wildlife Refuge[1], South Dakota

	PIF[2] Priority Species[3]		USFWS[2]	Audubon	TNC[2]	SDNHP[2]
Species	*Northern Mixed-Grass Prairie*[4]	*Prairie Potholes*[5]	*Birds of Conservation Concern*[6]	*Watchlist*[7]	*"Unlucky 13"*	*Rare Bird Species*[8]
American bittern		X	X			
Chestnut-collared longspur	X	X	X		X	
Dickcissel			X	X		
Grasshopper sparrow		X	X			
Le Conte's sparrow	X	X	X			X
Loggerhead shrike			X			
Marbled godwit	X	X	X	X		
Nelson's sharp-tailed sparrow	X	X	X	X		X
Northern harrier		X	X			
Sharp-tailed grouse		X				
Short-eared owl		X	X	X		
Swainson's hawk	X	X	X	X		X
Upland sandpiper		X	X			
Willet	X	X	X			
Wilson's phalarope	X	X	X	X		

[1]*Source: U.S. Fish and Wildlife Service 1996b, Meeks and Higgins 1998.*
[2]*PIF=Partners in Flight; TNC=The Nature Conservancy; SDNHP=South Dakota Natural Heritage Program; USFWS=U.S. Fish and Wildlife Service.*
[3]*Based on input from the breeding bird survey (Sauer et al. 2001) and other sources.*
[4]*Physiographic area S37 (Partners in Flight 2002a).*
[5]*Bird conservation region 11 (Partners in Flight 2002b).*
[6]*U.S. Fish and Wildlife Service 2002.*
[7]*National Audubon Society 2002.*
[8]*South Dakota Ornithologist's Union 2002.*

Eight of these 13 species (table 4) avoid woody vegetation (Dechant 1998a, 1999f; Wildlife Habitat Management Institute 1999); 7 of the 13 are area sensitive (Dechant et al. 1998b, 1998d, 1999a, 1999d, 1999f; Swanson 1998); and 6 of the 13 experience brood parasitism by brown-headed cowbirds (Dechant et al. 1998a–b, 1998f, 1999d–e; Swanson 1998).

Vegetative Structure and Composition Objective: Manage habitat blocks of DNC so that, in 7 out of 10 years, the habitat blocks would have a mean vegetative visual obstruction reading (VOR) of 11 inches, a litter depth of 0.5–2.5 inches, and a habitat composition of 50 percent forbs and 0 percent trees during late spring (May 25–June 15).

Introduced, Cool-season Grasses Objective: Manage habitat blocks of introduced, cool-season grasses so that, in 7 out of 10 years, habitat blocks would have a mean vegetative VOR of 7 inches, a litter depth of 0.5–2.5 inches, and a habitat composition of 5 percent forbs and 0 percent trees during late spring (May 25–June 15).

Seeded Natives Objective: Manage habitat blocks of seeded native grasses so that, in 7 out of 10 years, habitat blocks would have a mean vegetative VOR of 11 inches, a litter depth of 0.5–2.5 inches, and a habitat composition of 10 percent forbs and 0 percent trees during late spring (May 25–June 15).

Table 4. Species benefiting from grassland management of Sand Lake National Wildlife Refuge[1,2], South Dakota

Species	*Avoids Woody Vegetation*	*Area Sensitive*	*Brown-headed Cowbird Brood Parasitism*
American bittern[3]			
Bobolink	X	X	X
Clay-colored sparrow			X
Dickcissel			X
Grasshopper sparrow	X	X	X
Le Conte's sparrow	X		X
Northern harrier	X		
Savannah sparrow	X	X	X
Sedge wren[3]			
Sharp-tailed grouse		X	
Short-eared owl	X	X	
Upland sandpiper	X	X	
Wilson's phalarope	X	X	

[1]Grassland birds that use grassland growth forms in the tall- or medium-height categories for nesting, which can benefit most from active management for nesting waterfowl. The Nelson's sharp-tailed sparrow also uses grassland growth forms in the tall and medium categories, but was not included due to a lack of information.
[2]This is not an all-inclusive list.
[3]This species would benefit from grassland management, but does not avoid woody vegetation, is not area sensitive, and is not affected by cowbird parasitism.

Rationale (for the above vegetation, grasses, and natives objectives)

Grasslands are categorized as DNC, introduced cool-season grasses, and seeded native grasses. Vegetative structure differs greatly between the three habitat types; therefore, it was necessary to set grassland objectives specific to each habitat type. Despite the quantitative differences between objectives, all three objectives are similar in that they describe the maximum height-density of vegetation that can realistically be achieved for that habitat type within the constraints of climate and soil type.

Refuge grasslands are managed for tall dense cover because it is attractive to ducks. Several studies have reported high nest success in dense cover (Cowardin et al. 1985, Duebbert and Lokemoen 1976, Higgins and Barker 1982, Kirsch et al. 1978, Livezey 1981, Schranck 1972).

In addition to benefiting waterfowl, moderate to tall vegetation is also favored by many other grassland-nesting birds (Dechant et al. 1998a–f, 1999a–f; Swanson 1998).

As the refuge was specifically established to improve and maintain habitat for nesting waterfowl and other migratory birds, managing grasslands in the tall–dense category aligns well with the refuge's mandates and wildlife priorities (table 3).

A majority of the lands surrounding the refuge are annually managed as cropland or nonresidual grasslands, which provide some habitat in the other categories of short–sparse and medium height density. Therefore, managing grasslands in the tall–dense category of vegetation provides a vegetation class that is not well represented in Brown County.

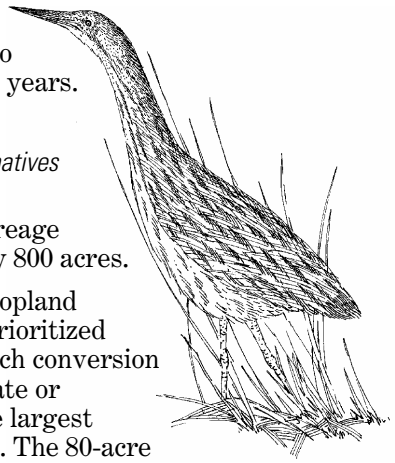
In the process of applying treatments to habitat in greatest need of management, blocks of grassland that conform to the short–sparse and medium height density vegetation categories will be created, thereby providing a diversity of vegetative structure within any given year.

Forb composition varies with treatment type and time since last disturbance. Forb coverage typically is 20–40 percent of the vegetation in the year following a habitat treatment, and gradually decreases to 10 percent within 5–6 years.

Strategies (for the above vegetation, grasses, and natives objectives)

— Reduce tilled acreage to approximately 800 acres.

Conversion of cropland to grassland is prioritized according to which conversion projects can create or contribute to the largest grassland blocks. The 80-acre block of cropland adjacent to Goose Corner (cropland block A-99a) was converted to grassland in 2004.



American Bittern
© Cindie Brunner

Cropland blocks A-94 (202 acres) and A-99 (57 acres), which are adjacent to Goose Corner and Hanson's Point, also have been identified as priority areas for conversion to grassland. Conversion of these three cropland blocks will create a 339-acre contiguous block of grassland and reduce the total cropland acreage from 1,217 acres to approximately 800 acres.

— Use farming as a tool to rejuvenate DNC, fight colonization of invasive plants, prepare ground for native grass seeding, and reduce use of non-selective broadleaf herbicides over the long term.

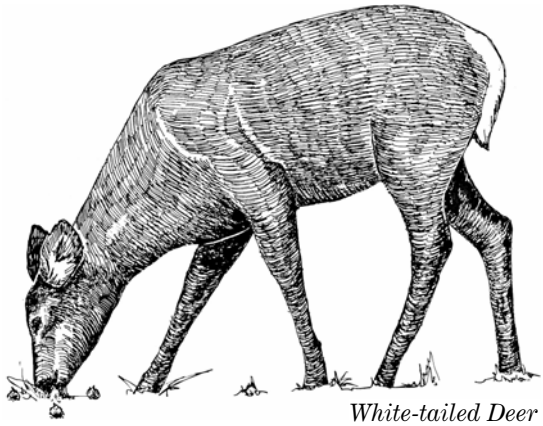
The focus of the farming program will change. Short of a more effective tool to control invasive plants on the James River floodplain, tillage holds the most promise and will be aggressively applied. By using the 800-acre farm model described under the invasive plant strategy below, the refuge will have the opportunity to renovate 3,000 acres of decadent, invasive plant-infested habitat blocks during the life of this CCP. The future of farming beyond 15 years will be determined by how effective the refuge is at improving upland habitat through use of this tool and others, and by success in developing a management strategy with SDGFP and the public to deal with the deer depredation issue.

— Prepare a management plan in cooperation with SDGFP that deals with wildlife depredation, invasive species management, and upland grassland restoration. The public, in particular local landowners, will be part of this management planning process.

The farming program will provide critical habitat for white-tailed deer during severe winters. Continuation of some level of farming on the refuge will provide for flexibility in management options while working cooperatively on the deer depredation issue with the SDGFP. By recognizing and acting on the fact that the Service has a stake in deer management on and near the refuge, it will preserve credibility with the SDGFP, refuge neighbors, and the public.

Thousands of acres of cattails provide thermal cover used extensively by the regional deer herd. There is seasonal movement into the James River corridor that appears directly related to winter severity. A study conducted by South Dakota State University between 1992–94 documented movements as far as 132 miles (Kernohan et al. 1994). Local landowner tolerance for whitetails relates directly to deer density and damage to crops, particularly during summer months (Naugle et al. 1994).

Depredation of crops on private lands adjoining the refuge has been, and will continue to be, a concern. The partnership previously described will address this issue.



White-tailed Deer
Tom Kelley/USFWS

— Control invasive plants.

The future of the refuge and the value of its grassland habitats will be shaped largely by how effective management is in combating the invasion of Canada thistle. Canada thistle is a pervasive pest for which there is no known control measure available for effective, one-time use on the refuge.

Canada thistle reduction will remain the highest priority until sufficiently controlled. Refuge staff will collaborate with other agencies and specialists to incorporate new control methods as they become available.

Prescribed fire will continue to be used as a tool to control exotic cool-season grasses such as quackgrass, smooth brome, and Kentucky bluegrass in reseeded native grass areas. In addition, grazing, mowing, and haying will continue to be used to fight invasive plants.

Additional exotic species such as purple loosestrife and spotted knapweed will be prevented from colonizing through a rigorous program of monitoring and complete eradication of initial patches.

It is estimated that no less than 3,000 acres of uplands and wetlands are heavily infested with Canada thistle. In the past, an average of 800 acres was treated annually using the Service's integrated pest management (IPM) program. Current control measures within the integrated pest management program include prescribed fire, chemical application, haying, grazing, biological agents, and rotary mowing. Despite aggressive efforts to control Canada thistle using these control measures, infestations continue to increase.

Grasslands that are infested with Canada thistle will be completely renovated by converting those areas to cropland and replanting them to grassland once the infestation is controlled. This strategy is based on the premise that Canada thistle will not grow in fields planted with genetically modified varieties of "Roundup® ready" corn or soybeans that are sprayed with the nonselective herbicide, Roundup®. By maintaining these no-till crops in production for several years, the percentage of viable Canada thistle seed in the upper soil layer should be significantly depleted and the germination potential of Canada thistle probably reduced.

Grassland areas that are heavily infested with Canada thistle are the best candidates for conversion to farmed acreage. Meanwhile, farmed acreage deemed to be free of viable invasive plant seed will be replanted to a grass and forb mixture. The farmed acreage will then shift to other weedy grassland areas in need of renovation. Such an approach will provide a cost-effective alternative to control methods such as chemical application or mowing. These control methods, which often contribute to degraded grassland habitat, will likely need to be used only on small areas of infestation within new seeding. As a result, this approach should provide for reestablishment of a more diverse plant community and higher quality habitat for migratory birds.

Averaged over the next 15 years, rotation of approximately 800 acres of cropland will improve control of Canada thistle on an estimated 3,000 acres of upland grassland. Under this CCP, 200 acres per year could be reasonably converted to deal with invasive plants. This will involve "breaking out" (i.e., sod preparation) of 200 acres of invasive plant-infested grassland and planting another 200 acres of retired cropland to a grass/forb mixture. For those 200 acres of invasive plant-infested grasslands identified annually, the rotation will progress as shown below.

Year 1	Till areas dominated by invasive plants and fallow
Year 2	Plant with "Roundup® ready" crop variety
Year 3	Rotate field into different "Roundup® ready" crop variety
Year 4	Prepare seedbed with "Roundup® ready" soybeans
Year 5	Replant to grasses and forbs

In any given year, 200 acres of upland will be in fallow, 600 acres will be in cropland, and 200 acres will be replanted to grasses and forbs. Several key factors will create the dynamic in which this invasive-plant reduction program will be applied, including the following:

- The speed at which Canada thistle is encroaching on farmable uplands
- The time required to significantly reduce the amount of viable invasive plant seed in the upper soil layer
- Funding and staff constraints
- The robustness and growth of the invasive plant problem in other areas such as marsh edges, fence lines, and tree belts, i.e., size of the local source of invasive plant seed
- The ability of the refuge to find interested cooperators as the size of farm fields shrinks
- Annual budgetary constraints associated with the cost of the grass/forb seed mixture and herbicides

Adjustments may need to be made to the extent of the overall invasive plant reduction program and to the acreage slated for cropland retirement in any given year. Regardless of the annual retirement rate, the acreage base of cropland will be reduced to 800 acres at the end of 15 years.

— Use DNC and native grasses to improve waterfowl and grassland bird production.

The value of grassland habitats will be shaped largely by how effectively habitat blocks of decadent DNC and smooth brome are reclaimed. As infestations of Canada thistle expanded, renovation of grassland blocks was minimized to avoid breaking sod. Without renovation, these stands of tame grass lost their vigor and became root-bound. In addition, use of herbicides to control Canada thistle has degraded the plant diversity within these established grasslands. Much of the desirable broadleaf forb component has been exterminated.

The degraded condition of 2,136 acres of smooth brome and decadent DNC within manageable habitat blocks demands attention. There are also 495 acres of reseeded native grasses that may need to be renovated in the future, should those areas become overrun with invasive species such as smooth brome.

Areas of cropland appropriate for conversion to dense nesting cover or native grass will be identified through development of a step-down plan. As concern for native species restoration continues to increase, some DNC may be converted to native grass where appropriate.

Historically, native grass has established better on the east side of the refuge, which is dominated by sandy and loamy soils of the Hecla–Hamar–Ulen association (USDA 1993). Native grasses seem to thrive better in these soils, which are less likely to harden or compact during dry conditions than the silty and sodium-affected silty soils of the Great Bend–Beotia association on the west side of the refuge (USDA 1993).

The DNC establishes more aggressively and is more resilient to silty soils and, therefore, may be favored over native grass on the west side of the refuge. Staff will continue to expand their knowledge of restoration techniques including site-specific seed mixes, site preparation, planting, and postplanting methods to improve their ability to successfully establish native grasses and forbs. Additional information is needed on the use of DNC and native and tame grasses by nesting waterfowl and grassland birds to improve management decisions.

— Provide some degree of water development for livestock if grazing were to be used as a tool for management of established grassland blocks.

The construction of a small dugout in each grazing unit is probably the most viable option to meet any short-duration livestock-watering needs.

— Remove selected shelterbelts.

Further fragmentation is not likely to benefit the upland wildlife species of highest priority. As a result, new shelterbelts or tree rows will not be planted. The majority of shelterbelts will be allowed to die out naturally.

In the past, shelterbelts were planted on the refuge, largely by homesteaders and the CCC (figure 6). Shelterbelts in agricultural areas provide substantial benefits for 29 species of birds (Johnson and Beck 1988). Avian communities were dominated by edge and generalist species in planted woodlands in eastern South Dakota (Bakker and Higgins 2003) and farmstead shelterbelts in Minnesota (Yahner 1982).

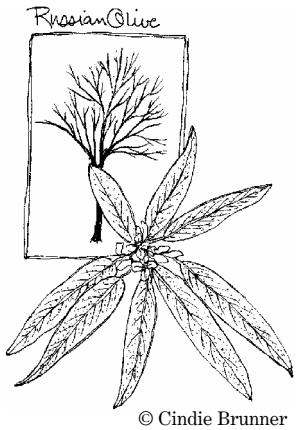
However, providing edge habitat such as shelterbelts to maximize local wildlife diversity may not always be a desirable objective if it is detrimental to habitat specialists or rare species that are dependent on extensive stands of undisturbed habitat (Hair 1980, Harris 1984). Shelterbelts decrease the size of grassland blocks and increase the amount of edge habitat, which can allow greater invasion by exotic species, predators, and brood parasites (Hagan and Johnston 1992).

An extensive, 8-year study in Manitoba, Saskatchewan, and Alberta, Canada found that duck-hatching rates increased with distance from a habitat edge (Howerter 2002). Habitat loss and fragmentation on the breeding grounds of grassland birds are known to contribute to poor reproductive success (Best 1978; Gates and Gysel 1978; Johnson and Temple 1986, 1990).

In Minnesota's tall-grass prairie, nest depredation and brown-headed cowbird brood parasitism on grassland birds decreased farther from woody edges (Johnson and Temple 1990). Grassland birds that nested in remnants of tall-grass prairie near wooded edges produced fewer young than birds that nested far from wooded edges (Johnson and Temple 1986).

Due to the high expense of tree removal, most of the current shelterbelts and tree rows will not be actively removed. A few select shelterbelts dividing large grassland blocks with high wildlife potential will be removed when funds allow. For example, the tree row bordered by habitat block SN-16 on the north and D-50 on the south is a high priority for removal as it is dissecting two large grassland areas on Hanson's Point.

— Reduce volunteer Russian-olive trees.



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Historically, Russian-olive trees were planted in the shelterbelts. The trees produce a heavy crop of persistent fruit every year that is a favored food of more than 40 kinds of birds and mammals (Borell 1951). However, the species is considered invasive because the seeds are widely dispersed by wildlife (particularly birds), remain viable for up to 3 years, and can germinate even on well-vegetated soils (Pearce and Smith 2001).

"Volunteer" Russian-olive trees are invading lowland areas and wetland (figure 6). As a result, Russian-olive woodlands threaten to displace native riparian vegetation (Olson and Knopf 1986a), as they have in many South Dakota marshlands (Olson and Knopf 1986b). In addition, Russian olives may depreciate waterfowl-nesting habitat, as waterfowl may avoid wetlands rimmed by dense stands of Russian olive (Olson and Knopf 1986b).

Volunteer Russian-olive trees in undesirable locations will be removed by cutting the trees

and painting or spraying the stumps with an herbicide to prevent regrowth. This control method is most effective (Olson and Knopf 1986b), although repeated aerial application of 2,4-D or 2,4,5-T for 1–2 years has also been found effective for large trees (Bovey 1965).

Removal priority will be given to volunteer Russian-olive trees that are adjacent to or encroaching on valuable wetlands or larger habitat blocks. Russian-olive trees within shelterbelts will be allowed to remain. Volunteer olive trees adjacent to the shelterbelts, which likely originated from seed trees within the shelterbelts, will be removed.

— Proactively manage predators.

To enhance nesting success, waterfowl nest predators will be removed from selected areas during the nesting period via trapping. Priority will be given to the predator exclosure, which provides the greatest potential for human manipulation of waterfowl-nesting success. Intensive predator management will be implemented inside the exclosure using Conibear traps. The integrity of the exclosure near the outside boundary will be maintained by removing predators.

In addition, Mud Lake Island has the potential for enhanced nesting success with management, but it will only be managed as time and resources permit.

— Monitor and react to wildlife disease issues.

Avian populations will be monitored for mortality due to avian botulism, West Nile virus, avian chlamydiosis, and other potential wildlife diseases. In the case of a disease outbreak, infected carcasses will be collected and properly disposed. Freshly-collected specimens will be sent for testing to confirm the cause of death.

Personal protective equipment will be used by refuge staff when contact with sick or dead birds and other wildlife presents a human-health risk.

If the threat of chronic-wasting disease increases, refuge staff will cooperate with the SDGFP to assess the impact on the refuge population of white-tailed deer. The refuge will continue to make use of the most current information to stay informed of current wildlife disease threats.

— Monitor habitat using adaptive resource management.

Adaptive management requires an ongoing commitment to evaluate and monitor the effects of habitat management strategies and incorporate new knowledge into updated plans and objectives. An upland monitoring plan that is consistent with the requirements of adaptive resource management, as well as the goals and objectives of this CCP, is being developed.

This habitat-monitoring plan emphasizes monitoring on three levels:

- Refuge monitoring determines whether habitat objectives are being met
- Habitat block monitoring determines which habitat blocks are in greatest need of treatment
- Treatment monitoring assesses vegetative response to treatments and determines whether treatment objectives were met

Through treatment monitoring, the future application of successful treatments can be validated and methods that were not successful in meeting treatment objectives can be modified. In addition, monitoring vegetative response to habitat treatments will produce the most reliable information, as site-specific effects are more informative than data gleaned from research conducted elsewhere.

— Improve technological support, especially using the geographic information system (GIS).

Technological support of management actions will be improved. Spatial and GIS data will be collected and analyzed with the assistance of the habitat and populations evaluation team in Bismarck, North Dakota and the area GIS coordinator for North Dakota and South Dakota. Selected staff will be responsible for maintaining and sharing these databases.

To use fully the potential of spatial databases in refuge management, selected staff will become familiar with the use of global positioning systems (GPS), Trimble GPS Pathfinder Office, ERDAS Imagine geographic imaging, Environmental Systems Research Institute (ESRI) ArcView and ArcGIS, and Microsoft Access, or use the expertise of others to analyze spatial data. Additional technological advances including the use of spreadsheets, Microsoft PowerPoint, and statistical software will be increasingly used.

— Acquire remaining land within the legislated boundary of the refuge.

The boundary of the refuge was established on September 4, 1935, by executive order of President Franklin D. Roosevelt. Of the 23,103 acres encompassed within that original legislative boundary, 21,498 acres have been acquired.

In an effort to provide a wider buffer zone around the edge of the wetland habitat and to establish larger tracts of habitat for grassland-dependent wildlife species, purchase of the final 1,605 acres of privately owned land within the legislated boundary will be strongly considered when that land becomes available for purchase.

Wetland Habitat Subgoal

Maintain a diversity of quality wetland habitat that meets the needs of wetland-dependent wildlife species.

Impoundment Objectives:

- Manage the Mud Lake impoundment for 30–50 percent emergent vegetation within the area from Mud Lake dike to 2 miles north of the dike, with a mean vegetation height of 19.7 inches above water, a mean vegetative VOR of 11.8 inches, and a water depth of 7.9–19.7 inches.
- Manage the Sand Lake impoundment to provide 30–60 percent emergent vegetation within the area from State Highway 10 to 2 miles south of the highway, with a mean vegetation height of 19.7 inches above water, a mean vegetative VOR of 11.8 inches, and a water depth of 7.9–19.7 inches.

Rationale

Overwater colonial-nesting birds rank high on the hierarchy of wildlife priorities of the refuge (table 2). This objective describes the deepwater/dense-emergent category of wetland habitat preferred as overwater nest sites by a high percentage of colonial-nesting birds found on the refuge, as follows:

- Franklin's gull (Burger 1974, Guay 1968)
- White-faced ibis (Ryder and Manry 1994, Zeiner et al. 1990)
- Black-crowned night-heron (Davis 1993)
- Eared grebe (Dechant et al. 2002)
- Western grebe (Short 1984)
- Forster's tern (Gorenzel 1977, McNicholl 1979)

Bill Schultze/USFWS

Forster's Tern

By managing the specified areas of Sand and Mud lakes for overwater-nesting birds, habitat for other wetland birds will naturally be provided in areas of different depth.

- Deepwater/sparse-emergent habitat will be provided along the edges of deepwater/dense-emergent areas and in areas of variable depth.
- Shallow-water/emergent habitat will be provided along the marshy edges of Sand and Mud lakes and in the northern part of Mud Lake.
- Open-water/submergent habitat will be provided in the deeper, center part of Sand Lake and in the deeper pockets of Mud Lake.
- Shallow-water/sparse habitat will be provided along the lake edges and shorelines.

The location and amount of each habitat type will vary with the natural wetland cycles. As emergent vegetation gradually decreases, the habitat type will change. This can happen gradually over time or within several years if water levels are extreme.

Strategies

— Maintain consistent water elevations.

When emergent cover is in optimal condition, conventional water strategies will be applied. This consists of moving spring runoff through the refuge as quickly as possible, until water levels have fallen to full-pool elevation (1,287.52 feet above sea level). Full-pool elevation will be maintained through the nesting season (May 15–August 1). Refuge staff will continue to coordinate with upstream dam managers to minimize negative impacts to overwater nesters.

— Manage drawdowns.

Control of water levels to manage wetland habitats is dependent on the flows of the James River. Conditions on the river can change quickly and need to be continually evaluated.

After multiple years of high water, cattail stands often need to be reestablished through managed drawdowns. The best time to reestablish cattail in Sand Lake is during low-flow years, when water levels can be drawn down during the summer months.

In Mud Lake, drawdowns will be limited by the level in Sand Lake, but conditions should be sufficient to reestablish cattail during low-flow years.

The coordinated release of water from Dakota Lake National Wildlife Refuge, just north of Mud Lake, may also be an option if the releases benefit both refuges or if the benefits to Sand Lake National Wildlife Refuge override the benefits to Dakota Lake National Wildlife Refuge.

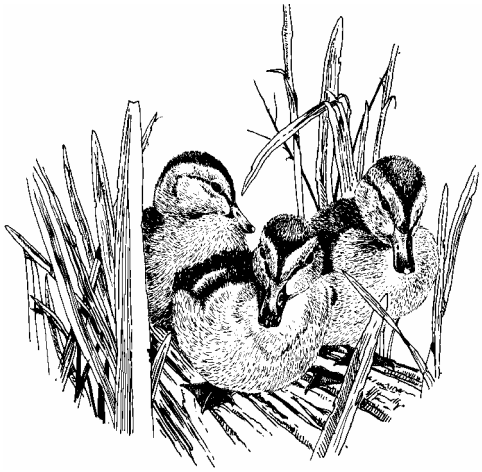
This will be determined by the managers at both refuges. These releases may be needed to reflood part of Mud Lake after a drawdown or to address a botulism problem in Mud or Sand lakes.

— Control cattail.

If the wetland experiences only shallow flooding, emergent vegetation may eventually expand through vegetative propagation to dominate the entire wetland. The resultant buildup of litter and organic material from emergent species can reduce water depth or eliminate shallow water areas (Hammond 1961; Ward 1942, 1968). Decreased waterfowl use is commonly associated with the decreased habitat variation in stands of tall, emergent hydrophytes, which typically form monotypes in the absence of disturbance.

General references (Kozlowski and Ahlgren 1974, Wright and Bailey 1982) indicate that burning of marsh vegetation releases nutrients and opens the canopy and detrital layer. Reduction in the height and density of tall, emergent hydrophytes by fire generally benefits breeding waterfowl. Such benefits are an increase in pair density probably related to increased interspersion of cover and open water, which decreases visibility among conspecific pairs (Kantrud 1986). Grazing by cattle also may remove much organic matter and create open water areas where submersed plants flourish (Schultz 1987).

Prolonged deepwater flooding reduces emergent macrophytes due to extended inundation and the expansion of muskrats and their consumption of macrophytes (Euliss et al. 1999). Drawing the wetlands down early in the summer when mud temperatures are too cool to allow cattail germination helps discourage cattail invasions. Alternately, allowing the subimpoundments to drain naturally will expose the mud flats in midsummer and likely encourage cattail proliferation.



— Control sedimentation within the upper James River basin.

The James River is embedded within an agricultural landscape where cultivation of wetland catchment areas has likely increased the intensity of runoff events and decreased the time available for infiltration.

Although all major dams constructed on rivers have a finite life span due to natural sedimentation processes, human-caused influences on sedimentation rates have great potential to fill prematurely Mud and Sand lakes, degrading their wetland functions.

Increased sediment in water generally reduces the depth of the photic zone, reducing the light available for primary production by aquatic macrophytes and algae (Ellis 1936, Robel 1961). Sediment depths of 0.1 inch can significantly reduce species richness, emergence, and germination of wetland macrophytes (Jurik et al. 1994, Wang et al. 1994).

Because of the negative impacts on aquatic vegetation from sediments, water quality functions may be altered (Gleason and Euliss 1998). Such loss of standing vegetation structure and algal biomass generally makes wetlands less productive for invertebrates (Euliss and Grodhaus 1987, Krecker 1939, Krull 1970, Neill and Cornwell 1992). Aside from their obvious role in the feeding ecology of waterfowl and other birds, invertebrates provide critical food chain support for a wide variety of other organisms and play significant roles in nutrient cycling and overall wetland productivity (Murkin and Batt 1987).

In 2000, the USGS estimated the vertical accretion rate of sediment near the Mud Lake dike to be 0.5 inch per year, with sedimentation rates greater than 0.8 inch per year during the 1990s when river flows were especially high (Gleason et al. 2003).

At the current rate of sedimentation, the projected loss of water depth over the next 20 years would prohibit manipulation of water levels in Mud Lake. Lacking the ability to cycle vegetation and create an interspersion of cover and water, current wildlife objectives would not be met. Once Mud Lake fills with sediment, sedimentation rates are expected to escalate in Sand Lake as well.

If Mud Lake basin continues to fill with silt at its current rate, it could lose most of its original wetland volume. Methods to restore the basin will need to be evaluated within the context of economics and the postrestoration potential to provide targeted functions. Future work should assess current sedimentation rates in Sand Lake to project the life span of this impoundment.

Maintenance of the topographic relief of the basins of Mud and Sand lakes is essential to maintaining the functions and biological diversity of the wetlands. Management of the upper basin may be the most practical alternative to reducing sediment in these lakes.

Conservation practices that target sustained agricultural production and long-term wetland management can be quite effective in slowing overland input into the James River, as follows:

- fencing out riparian zones
- creating greenways
- establishing grassed waterways and vegetative buffer strips
- implementing the NRCS's best management practices

The NRCS has already implemented the wetland reserve and conservation reserve programs on scattered lands along the James River. However, based on lack of significant enrollment in these programs, a new approach may be necessary to achieve coordinated effort among landowners to address effectively runoff issues along the James River.

One approach may include an entirely new program designed specifically for protection of the James River basin. Economic incentives could be used to facilitate landowner implementation of the program. Partners will be needed to develop such a large-scale program and could include the James River Watershed District, soil conservation districts, state and federal agencies, and other conservation organizations.

This approach could also involve a presentation of existing programs with a coordinated effort among multiple state and federal agencies. This outreach effort could be directed toward property owners on the James River floodplain to ensure that they are made aware of their options. Region 6's Partners for Fish and Wildlife Program will be one avenue for promoting new and existing programs to private landowners.

The USDA has the CREP, which has great potential although it has not yet been implemented in South Dakota. Based on observations in other states, the CREP program may prove to be a valuable tool to achieve the desired James River environmental goals.

In addition, the possibility of land easements or purchases could be made available. Perpetual protection of the floodplain would be preferable to a temporary solution. However, consideration should be given to the fact that perpetuity clauses may inhibit landowner participation.

Subimpoundment Objective: Manage the subimpoundments as dynamic wetland systems that cycle between drawdown and flood events, within 5 years of CCP approval, to provide quality habitat for waterfowl, shorebirds, and wading birds. During periods between drawdowns, manage the subimpoundments to provide 10–75 percent emergent vegetation and annuals, a mean water-column invertebrate biomass of 0.007 ounce per activity trap per 24-hour set during the June sampling period, and water depths of 0.4–9.8 inches over 50 percent of the flooded area for a portion of the time between April 1 and October 15.

USFWS

American Avocets

Rationale

The subimpoundment objective purposely includes broad ranges, as water levels are intended to vary like natural wetlands. The success and timing of such management actions are subject to dynamic weather patterns.

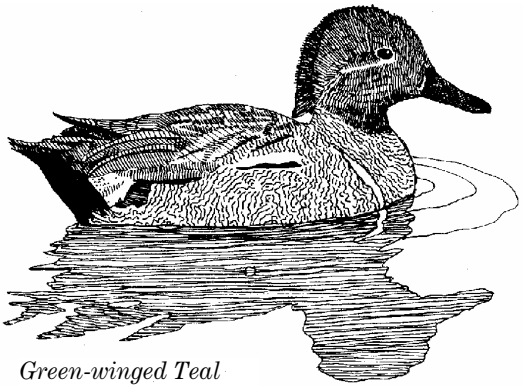
Plant communities in prairie wetlands are continually changing because of short- and long-term fluctuations in water levels and salinity. Prairie wetlands have evolved under these fluctuating conditions. The process of cycling with wet and dry periods makes prairie wetlands productive. For instance, exposure of mud flats during drought periods is necessary for the germination of many emergent macrophytes and facilitates the oxidation of organic sediments and nutrient releases that maintains high productivity.

Within the framework of a dynamic wetland system, management of the subimpoundments is directed toward waterfowl (foraging, breeding pairs, and broods), shorebirds, and wading birds. This objective sets an upper and lower threshold of emergent vegetation, because an interspersion of emergent vegetation and wetland openings is preferred by both dabbling and diving ducks and their broods (Kantrud 1986).

Interspersed emergent vegetation also benefits other marsh-dwelling birds and mammals (Seabloom 1958, Vogl 1973, Weller and Spatcher 1965). Such conditions may also result in avian communities of greater species diversity or richness (Weller 1978, Weller and Spatcher 1965). In addition, Voigts (1976) found maximum invertebrate abundance occurring where beds of submerged vegetation were interspersed with stands of emergent vegetation.

A lower invertebrate biomass threshold is part of the subimpoundment objective. Invertebrate abundance is quantified relative to biomass in June, because that is when invertebrate biomass is known to peak in most wetlands (Euliss and Mushet 2003). Abundance of aquatic macroinvertebrates is positively related to waterfowl use (Kaminski and Prince 1981, Schroeder 1973, Swanson and Meyer 1973) and early growth of ducklings (Chura 1961, Perret 1962, Sugden 1973). Aquatic invertebrates also are important food resources for shorebirds (Eldridge 1987), amphibians (Clark 1978, Deutschman 1984), and other marsh birds (Weller 1981).

Shallow water conditions during some portion of the year are also favorable. Deep water may reduce the availability of invertebrates to feeding waterfowl (Laperle 1974, Murkin and Kadlec 1986) and shorebirds. Optimum foraging depths for dabbling ducks, shorebirds, and wading birds are 2–9.8 inches, 0–9.8 inches, and 3–23.6 inches, respectively (Jasmer 2000). Diving ducks can also exploit food resources in shallow water (Fredrickson and Reid 1988).



Green-winged Teal
© Cindie Brunner

Strategies

— Conduct drawdowns and subsequent reflooding events.

Water could be moved in and out of the five subimpoundments opportunistically, as flows in the James River and water levels in Mud and Sand lakes allow.

When management action is necessary and water elevations in the main pools are not conducive to take advantage of gravity flow, a 16-inch Crisafulli pump could be used to move water into or out of these subimpoundments. This will add significantly to the cost, will be time consuming, and must not violate restrictions placed on the refuge's water rights. However, it could create the desired habitat conditions when other management alternatives are not available.

Most of the subimpoundments are smaller areas separated from the main pools by an embankment. Water could be diverted into or out of the subimpoundments by gravity flow. Because of their smaller size and isolation from the main pools, it will be possible to provide some water level control, thereby influencing the plant and invertebrate communities, as well as the productivity of the subimpoundments.

Plant and invertebrate production could be maximized through carefully planned drawdowns and subsequent reflooding events. Drawdowns of the subimpoundments will be accomplished in different years to provide a diversity of habitat conditions during any given year. The need for rejuvenation of plant and invertebrate communities within each unit and the ability to move water out of the unit will largely determine when drawdowns could be conducted.

— Control cattail.

If the wetland experiences only shallow flooding, emergent vegetation may eventually expand through vegetative propagation to dominate the entire wetland. The resultant buildup of litter and organic material from emergent species can reduce water depth or eliminate shallow water areas (Hammond 1961; Ward 1942, 1968). Decreased waterfowl use is commonly associated with the decreased habitat variation in stands of tall, emergent hydrophytes, which typically form monotypes in the absence of disturbance.

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Public Use Goals

The six wildlife-dependent priority public uses specified in the National Wildlife Refuge System Improvement Act are hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation.

All six activities are allowed and provided for at Sand Lake National Wildlife Refuge within the bounds of refuge mandates and purposes.

The public use goals will be met through the following objectives and strategies.

Wildlife-dependent Recreational Use Goal

Provide opportunities for quality, wildlife-dependent recreation for visitors to Sand Lake National Wildlife Refuge.

Consumptive Use Subgoal: Provide wildlife-dependent, consumptive, recreational opportunities that are compatible with refuge purposes and contribute to a quality outdoor hunting or fishing experience.

Hunting Objective: Allow annual, compatible, fall-hunting opportunities for deer, upland game birds, and waterfowl, consistent with applicable state regulations and principles of sound game management.

Strategies

— Provide hunting opportunities for deer, upland game birds, and waterfowl.

Areas will be designated for deer, upland game birds, and perimeter-boundary waterfowl hunting. An additional universally accessible hunting blind and parking area will be developed to increase opportunities for physically challenged hunters.

The refuge will open to upland bird hunting after the close of refuge rifle deer seasons according to state regulations and permit archery and firearm deer seasons based on consultation with the state, local landowners, and hunters.

— Create an updated hunting brochure and map for distribution at various locations around the refuge to provide hunters with up-to-date hunting rules and regulations.

— Develop a proactive law enforcement program including the establishment of a permanent, full-time law enforcement position to regulate hunting activities on the refuge and enforce wildlife laws.

Fishing Objective: When available and accessible, allow open water and ice fishing yearly from the five designated fishing areas only. Prohibit motorized and nonmotorized boating.

Paul Kerris/USFWS

Strategies

— Allow fishing at five designated locations.

The public will be made aware of the fishing program through notification of rules, updated brochures, and information in the state fishing handbook.

— Develop a proactive law enforcement program including the establishment of a permanent full-time law enforcement position to monitor and regulate fishing activities and enforce wildlife laws.

Nonconsumptive Recreation Subgoal: Provide wildlife-dependent, compatible, nonconsumptive, recreational activities on the refuge that increase public understanding and appreciation of wildlife and its conservation.

On-site Visitors Objective: Educate an additional 5,000 on-site refuge visitors about local and regional conservation issues, the National Wildlife Refuge System, and Sand Lake National Wildlife Refuge within 5 years of CCP approval.

Bob Savannah/USFWS

Strategy

— Develop, update, and maintain visitor services.

An on-site education center will be constructed to provide space and materials to inform students, educators, and the visiting public about the refuge, wildlife conservation, and the National Wildlife Refuge System.

Updated kiosk panels will reflect modern wildlife management practices and conservation issues, and provide general refuge information.

All brochures will be updated, using the Service's graphic standards format, to provide visitors with current information and refuge policies.

Nonconsumptive Recreation Objective: Provide opportunities for wildlife observation, wildlife photography, and interpretation annually, from April 1 to October 15, sunrise to sunset daily.

Strategy

— Develop, update, and maintain on-site nonconsumptive recreational facilities.

The 15-mile auto tour route ("wildlife drive") will be maintained and improved to provide visitors with a quality experience for viewing wildlife. This will include updating the route's self-guided brochure, updating and improving signs on the route, and maintaining pull-off sites.

The observation tower and viewing platform will continue to be maintained for public use. The currently accessible Columbia Day Use Area will be improved to provide better wildlife-viewing opportunities through hiking trails, kiosk information, and wildlife blinds.

At least one permanent photography blind will be constructed to allow photographers better access to wildlife species.

Information kiosks will be enhanced to provide visitors with up-to-date refuge information at the refuge headquarters, the Columbia Day Use Area, and on Highway 10.

An education center will be constructed to provide the visiting public with space and materials for educating about the refuge, wildlife conservation, and the Refuge System.

Public Education and Outreach Goal

Provide wildlife- and wildland-viewing opportunities for the public to enjoy and, through education and outreach, encourage them to gain a greater understanding and appreciation of national wildlife refuges and wildlife resources in general.

Public Education and Outreach Objectives:

- Annually host an average of two to three on-site special events designed to educate the public about wildlife resources and the National Wildlife Refuge System.
- Continue the off-site program and continue working with the radio, television, and print media. Provide an annual average of 24 radio and 8 television interviews, and annually provide information for newspaper articles at least 30 times.
- Construct an education center.

USFWS

Students learn hands-on about waterfowl during a field trip to the refuge.

Local School Districts Objective: Increase and maintain awareness within all local school districts of the education resources and opportunities available at the refuge, through additional on- and off-site programs and workshops within 5 years of CCP approval.

Strategy

— Increase education and outreach opportunities.

A survey to determine the level of awareness of the refuge's education programs will be conducted within all local school districts.

An education outreach plan will be developed and an education brochure will be created to promote on- and off-site field trip opportunities and to inform educators of the availability of learning trunks, the education trail, and teacher guides.

Up to 25 additional educational opportunities will be created including teacher workshops, in-classroom programs, promotion of conservation learning trunks, and teacher resource kits.

An on-site education center will be built and will offer space for programs and other materials needed for students and teachers who use the refuge for outdoor classroom activities.

Communities Objective: Promote awareness of, and generate support for, Sand Lake National Wildlife Refuge and the National Wildlife Refuge System within local and regional communities through participation in a minimum of 3 additional off-site special events within 5 years of funding.

Strategies

— Increase outreach activities and education activities.

Opportunities will be sought to promote the refuge and wildlife conservation to the public. Off-site opportunities include: (1) providing speakers for community and civic groups; (2) frequently updating local congressional offices and key staff on emerging or potentially controversial issues; (3) participating in local fairs, outdoor shows, and other public events; and (4) continued participation in the Water Festival.

— The refuge's website will be maintained and improved to provide up-to-date information to the public on refuge policies, regulations, and wildlife.

— New educational and interpretive kiosks promoting the refuge and wildlife conservation issues will be developed at the Aberdeen Regional Airport, Wylie Park, Northern State University, and other strategic locations within the community.

— Five new partnerships with local and or regional interest groups will be sought and fostered to build support for the refuge and general conservation issues.

— A "friends group" will be established to provide the public with an opportunity to support the refuge.

— Weekly media contacts will continue with the "Refuge Corner Update," and news releases and articles will be made available to local media outlets including television, radio, and newsprint.

Monitoring and Evaluation

Habitat management on refuges is an ongoing process and the Service recommends that planning be conducted within the context of adaptive resource management (USFWS 1995b, 1996a).

Vegetative structure, as indicated by VORs, will be the primary method for monitoring vegetation. The dominant and subdominant species of vegetation also will be recorded annually. At present, more detailed species' descriptions are not necessary for the floristically simple habitat blocks.

Vegetative species composition will be evaluated relative to the percentage of forbs present and the percentage of Canada thistle present. More in-depth evaluations of vegetative species may be necessary once seeded natives become a more prominent component of the overall upland habitat.

Time permitting, wildlife response to habitat treatments should also be evaluated. However, monitoring wildlife response must be conducted in concurrence with habitat monitoring, as it is difficult and unreliable to evaluate the merits of various treatments when relying on wildlife response alone.

A more specific protocol for the habitat-monitoring plan will be outlined within a section of the step-down plan for habitat management.

Plan Monitoring and Evaluation

Implementation of this CCP will be monitored throughout its effective period, 2005–19.

Accomplishment of objectives listed in this CCP will be monitored annually by the supervisor of the project leader for the refuge. Monitoring of accomplishments is critical to the implementation of this CCP.

It is reasonable to believe that substantial changes could occur within the Service during the next 15 years. The objectives of this CCP will be examined at least every 5 years to determine if revisions are necessary and to allow the addition or deletion of objectives.

Personnel and Funding

The personnel and funding needed to carry out this CCP are described below.

Personnel

Currently, the refuge complex has a staff of 13 full-time employees to manage the refuge and the Sand Lake WMD. Table 5 (next page) lists these positions, along with seven new positions that are needed for full implementation of this CCP (those positions

needed only for the refuge). The proposed positions are also included in the database for refuge operations needs (appendix L).

Bill Schultze/USFWS

The staff carpenter builds a footbridge on the new education trail.

FUNDING

Funding to implement this CCP is derived from three sources:

- The refuge operations needs system (RONS) includes requests made to the Congress for funding and staffing above the existing base budget needed to administer programs and carry out projects.
  - — Five of the seven new refuge positions are associated with RONS projects and will have a first-year cost of $589,500 with an annual cost of $296,000 (this does not include proposed visitor use or fire positions).
- The maintenance management system (MMS) is a database that documents the maintenance and replacement needs for existing equipment, buildings, roads, fences, and other property (appendix M).
- Cost estimates are developed for projects needed to implement this CCP, which are not yet reflected in the RONS or MMS.

Table 5. Current and proposed staff, Sand Lake National Wildlife Refuge, South Dakota

	Current Positions	*Additional Proposed Positions (Unfunded)*
Management Staff	Refuge complex project leader, GS[1]-14 Deputy project leader, GS-13 Supervisory refuge operations specialist[2], GS-12 Refuge operations specialist[2], GS-9 Refuge operations specialist[2], GS-9	Supervisory refuge operations specialist, GS-11
Biological Staff	Refuge complex biologist, GS-12 Biologist trainee, GS-9 Private lands biologist[2], GS-11	Resource specialist, GS-11
Public Use Staff	Outdoor recreation planner, GS-11	Law enforcement officer, GS-9 Law enforcement officer, GS-9 (0.5 FTE[3]) Visitor use assistant, GS-5
Administrative Staff	Administrative officer, GS-9	Clerk, GS-5
Maintenance Staff	Engineering equipment operator, WG[1]-10 Carpenter, WG-9 Biological science technician, GS-6	None
Fire Management Staff	Range technician, GS-6	Fire management officer, GS-9

[1]*GS=general schedule employee; WG=wage grade employee.*
[2]*This position supports both the refuge and the wetland management district (WMD).*
[3]*FTE=full-time equivalent.*