CHAPTER 7–Analysis of Management Alternatives for the Benton Lake National Wildlife Refuge

Neal Mischler

Pronghorn on the grasslands of the refuge complex.

During the planning process, it became evident that the issues surrounding the management of the Benton Lake Refuge, and the wetland basin in particular, were of serious concern within the refuge complex. The Service and the public have identified declining wetland health and selenium contamination, and its effect on wildlife and management on the refuge, as the most critical issues needing to be addressed in this CCP.

Because of the complexity of the analysis for Benton Lake Refuge, all aspects of NEPA evaluation unique to the refuge are presented together in this chapter and described in detail. When completed, the management direction for the refuge complex, described in chapters 1–6, and the management direction for the Benton Lake Refuge, described in this chapter, will be used in conjunction to serve as a working guide for management programs and activities throughout the refuge complex over the next 15 years.

7.1 The Planning Process

One of the most important issues identified for the refuge complex during the planning process, by both the public and the planning team, was the declining condition of the Benton Lake Refuge wetlands. Refuge staff had concerns that long-term selenium contamination problems in the wetland were increasing and potentially becoming critical. In addition, staff had observed expansions of nonnative wetland vegetation and declining open water habitat important to waterfowl. Overall use by wetland dependent birds had also appeared to have declined from historic numbers. The public, particularly migratory gamebird hunters, also commented on the lack of open water and difficulty accessing wetlands with deep layers of sedimentation.

To better understand what was causing this declining condition, the Service met with consultants from Greenbrier Wetland Service on April 28 and July 29, 2009, to develop a hydro-geomorphic assessment of Benton Lake. The scientists from Greenbrier Wetland Services are recognized experts in the field of wetland ecology. They worked with Service staff to understand what changes had occurred in the Benton Lake wetlands over time and how this might relate to the observed declines in bird use, increases in invasive species and increasing selenium contamination (Heitmeyer et al. 2009). In addition, USGS developed a water budget model based on more than 30 years of data (Nimick et al. 2011) and a selenium model based on research conducted by USGS and the University of Montana (Knapton et al. 1988, Nimick et al. 1996, Zhang and Moore 1997) on the refuge. These models, coupled with the wetland assessment, were used to develop and analyze the management alternatives and to select one as the proposed action for the refuge.

After initially identifying the proposed action at a planning meeting in February 2010, refuge staff began another scoping effort to share the results with the public. Refuge staff focused on groups and individuals who had expressed interest or concern about Benton Lake during the first scoping effort. Refuge staff organized and led presentations to local interest groups (Russell County Sportsmen's Association, Upper Missouri Breaks Audubon, Sun River Watershed Group), MFWP, congressional representatives and the public. Many people attended the meetings and provided comments that the Service recorded.

At the request of local stakeholders including Ducks Unlimited, National Wildlife Federation, Russell County Sportsmen's Association, local and State Audubon organizations, and MFWP, a workshop was held in Great Falls, Montana, June 9, 2011, to explore options related to water management, selenium contamination, and public use at the refuge. Many good ideas were generated at the workshop including recognition that achieving refuge objectives for selenium and wetland habitat would require dealing with inputs from the highly altered Lake Creek watershed, as well as refuge water management.

As a result of these scoping efforts, the planning team decided that more alternatives were needed for Benton Lake than the three that had been developed earlier for the complex-wide planning effort.

7.2 Establishment, Acquisition, and Management History

The refuge (figure 15) was established by Executive order of President Herbert Hoover in 1929. It is located on the northern Great Plains, 50 miles east of the Rocky Mountains and 12 miles north of Great Falls, Montana. The original area of the refuge was 12,235 acres, of which about 3,000 was flooded wetland in 1928 (Great Falls Tribune 1929a). Originally owned and managed by the Bureau of Reclamation as part of the Sun River Reclamation Project, Benton Lake subsequently became part of the National Wildlife Refuge System. Impetus for establishing the refuge came mostly from local sportsmen and women, especially waterfowl hunters, in the mid-1920s when about 8,000 acres of U.S. Government-controlled land near Benton Lake was proposed to be opened for settlement. Sportsmen and women supported the establishment of the refuge even though this designation "will mark the end of hunting on the lake, which for years has been the favorite duck shooting grounds of Great Falls sportsmen" (Great Falls Tribune 1929a).Figure 15. Map of the pump station, easement, and travel route of water from Muddy Creek to the Benton Lake National Wildlife Refuge, Montana.

The refuge was unstaffed, with infrequent visits from refuge managers stationed at the National Bison Range until 1961, when local support from the Cascade County Wildlife Association prompted a major effort to increase the water supply and management capabilities of the refuge. A pump station, pipeline, and water control structures were constructed from 1958–1962 to bring irrigation return water from Muddy Creek, about 15 miles to the west, to the refuge. The acquisition of the pumping station near Power, Montana, brought the refuge to its current 12,459.88 acres (12,383 fee-title acres and 76.88 acres of right-of-way easement). A complete acquisition history can be found in table 2 (see chapter 2, section 2.1).

In 1962, the first water was pumped from Muddy Creek and managed by the new, permanent staff on the refuge. The historic Benton Lake bed was divided into six wetland management units (Unit 4 was later subdivided into three subunits) by dikes, ditches and water control structures to facilitate management of water.

In addition to construction of dikes, ditches, water control structures and pumps, many other topographic alterations have occurred on the Benton Lake Refuge since the early 1960s. These alterations include roads, parking lots and building complexes, excavations and mounds within wetland units for nesting islands, sedimentation and filling of some wetland depressions, construction of drainage ditches within units and deposition of hard material (for example, riprap, rock, concrete, and gravel) into wetlands (USFWS 1961–99). Most of the nesting islands were built in the 1980s; however, the islands in Unit 4b were later removed when they attracted large gull colonies that preyed on waterfowl nests.

Water management at the refuge, since the Muddy Creek pumping system was developed, has typically sought to consistently flood some wetland units each year to provide breeding and migration habitat for waterfowl. Since 1962, water typically has been pumped from late August through October to provide water for fall migrating waterfowl and to store water in units for the next spring. In many years, water is also pumped from mid-April to mid-June to raise water levels for waterfowl reproduction. From 1962 through the late 1980s, some water was also pumped during the summer to support water levels; however, in the last 20-plus years the pumps generally have not been used during summer and Units 3–6 are mostly dry from mid-July until pumping resumes in August. This gradual change in water management was the result of discovering that deep season-long flooding did not stimulate desirable wetland vegetation and was often associated with botulism in Units 3–6. Largely because botulism has never been a significant problem in Units 1 and 2, these units have traditionally been managed for more permanent water. Water is held in these units throughout the summer to provide brood rearing habitat for waterfowl (USFWS 1961–99).

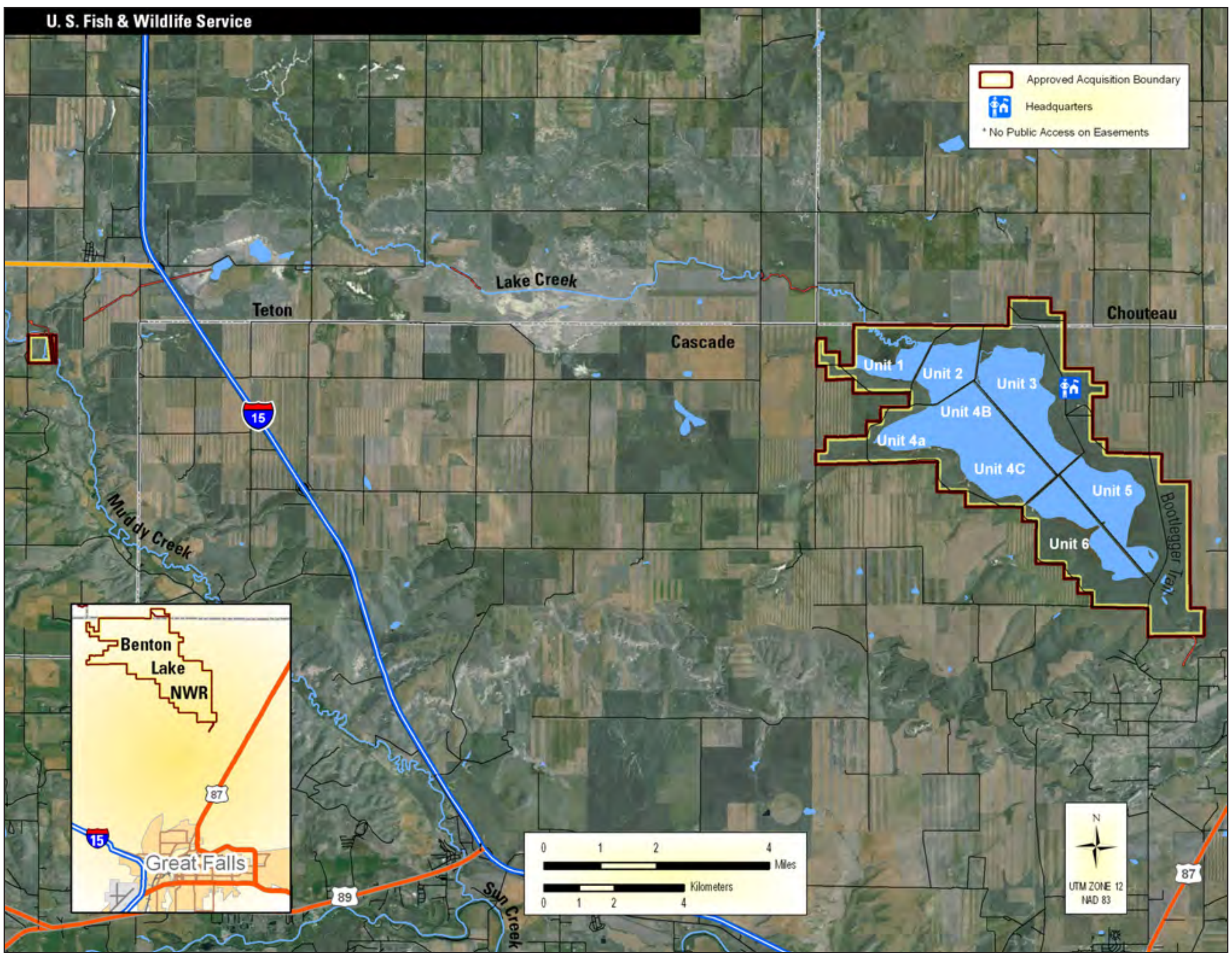

Figure 15. Map of the pump station, easement, and travel route of water from Muddy Creek to the Benton Lake National Wildlife Refuge, Montana.

In the uplands, management of the early 1960s included breaking more than 600 acres of native prairie for agricultural production, planting many shelterbelts, and a reduction in haying and grazing activities that had dominated the refuge's first 30 years. During the 1970s, the agricultural lands were gradually converted to DNC, grazing was ended, and waterfowl production was the primary emphasis of the refuge.

7.3 Purpose, Goals and Planning Issues

Chapter 2, section 2.2 details the purpose for which Benton Lake Refuge was established.

The Service developed a set of goals for the refuge complex, which can be found in chapter 2, section 2.4. All of these apply to the Benton Lake Refuge.

Comments collected from scoping meetings and correspondence were used in the development of a final list of issues for the refuge. The following issues are unique to the refuge and are the reason this chapter was developed.

Adjacent Landowners and Land Uses

When private landowners keep their fields in grass through the CRP, this helps prevent the accumulation of salinity and selenium in seepage areas. This help may be lost if large areas currently in the (CRP) are converted to crops. It has been suggested by Refuge staff, members of the public, and interest groups that staff should consider working more with private landowners, particularly surrounding the refuge, to build partnerships that improve water quality and reduce saline seeps.

This planning issue involves several planning elements and carries through all alternatives in chapter 7 under the preserving intact landscapes and grasslands planning element heading.

Loss of Ecological Processes

Natural fluctuations in water levels (seasonal flooding and drying)—integral to a healthy functioning and self-sustaining wetland system—have been lost at the refuge. The most striking manifestations of the loss of fluctuating water levels and flooding intervals include: the domination of nonnative species such as Garrison creeping foxtail, the spread of monotypic stands of native and nonnative species that depend on stable water conditions (for example, cattail, alkali bulrush), lack of sediment solidification, increasing loss of open-water habitat, and the diversity of plant and wildlife species that result from dynamic water levels. However, there is uncertainty around whether or not dry periods need to be as long as occurred naturally or historically to restore and support wetland ecological health.

The functionality and productivity of wetlands are also related to the way water moves across the wetland and floods the basin. This water movement has been severely disrupted at the refuge. Instead of shallow 'sheet flow' from Lake Creek across the wetland basin, the water is diverted into a distribution canal and flows first into deep ditches along the dikes, rather than spreading quickly across the basin, resulting in negative effects on sedimentation, selenium distribution, microtopography, vegetation, and invertebrate and seed availability for wildlife.

This planning issue involves several planning elements and carries through all alternatives in chapter 7 under the grasslands and wetlands and riparian areas planning element headings.

Declining Wetland Ecological Health

An absence of historical dry periods at the refuge that sustain wetland health is a concern. The altered source, depth, timing and duration of flooding affects contaminant and sediment loading and distribution, as well as nutrient cycling. It appears that these changes are likely altering the type, distribution and biomass production of vegetation and invertebrates, which provide resources (for example, food, breeding habitat) required for wildlife to meet their life cycle needs.

In the years following the initial pump house construction and subsequent flooding of Benton Lake, the wetland basin was very productive with tens of thousands of waterfowl, shorebirds and other waterbirds using the refuge. In recent years, refuge staff and the public have noticed significant declines in the number of waterbirds. Current estimates of waterfowl during migration peak at 10,000–30,000 birds, as compared to 50,000–100,000 noted in the early years of refuge water management. Despite designation as a Western Hemisphere Shorebird Reserve Network Site, refuge staff rarely see peak numbers of more than 500 shorebirds using the refuge.

This planning issue involves several planning elements and carries through all alternatives in chapter

7 under the water resources and wetlands and riparian areas planning element headings.

Water Quantity, Delivery, and Cost

Water management, at the Benton Lake Refuge is a key issue for the refuge complex. The refuge's impoundments are intensively managed with supplemental water transported across substantial distances at great financial cost. In recent years, the delivery and management of this water has cost as much as $135,000 annually. As costs for electricity continue to rise, pumping costs have risen as well. This has required the reallocation of money that could be used for land management to accommodate the increasing pumping costs.

How best to use the water budget to maximize wetland health and migratory bird productivity needs to be addressed. How the refuge's water rights in Muddy Creek may be affected by changes in water management also needs to be defined.

This planning issue involves several planning elements and carries through all alternatives in chapter 7 under the wetlands and riparian areas and water resources planning element headings.

Water Quality and Selenium Contamination

Major issues that have affected the management of the refuge in the last 20 years include increasing accumulation of contaminants (selenium) in the wetland, dense stands of monotypic vegetation that have increasingly become dominated by nonnative species, pumping costs for electricity and declining bird use. Refuge records suggest that the large numbers of migrating and breeding waterfowl that used the refuge in the 1970s and 1980s have declined over the last 20 years. Current estimates of waterfowl during migration peak at 10,000–30,000 birds, as

USFWS

Seep at Benton Lake National Wildlife Refuge.

compared to 50,000–100,000 noted in the early years of refuge water management.

Selenium concentrations in the water, sediment and biota of portions of the Benton Lake Refuge are currently at levels that can affect reproduction of species that are particularly sensitive to selenium, such as waterfowl species. These levels have been increasing over the last 50 years and if they continue to increase, selenium could reach levels that cause reproductive failure in waterfowl and other waterbirds in in some parts of the refuge in as little as 10 years.

The Sun River Watershed Group has been working to improve water quality in Muddy Creek, in particular reducing sediment loading into the Sun River. This group would like the refuge to continue withdrawing water, either through the pump house or a siphon (if built), to help reduce flows in Muddy Creek.

Some interest groups identified the need for the refuge to continue to pump or siphon water from Greenfields Irrigation District to dilute concentrations of contaminants (salinity and selenium) entering the refuge. The Service received several comments suggesting that the refuge needs to address selenium inputs from the Lake Creek watershed by working with landowners and other partner organizations and consider establishing a conservation easement program that includes the refuge, Muddy Creek, and Lake Creek watersheds. It was also suggested that working in the watershed should be a higher priority, and would be more effective, for improving water quality on the refuge than changes to management.

There may be more impairments to water quality from sediments, pesticides, and nutrient loading on the refuge that have not been studied.

This planning issue involves several planning elements and carries through all alternatives in chapter 7 under the preserving intact landscapes and water resources planning element headings.

Invasive Plants, Nonnative Plants, and Noxious Weeds

Nonnative grasses, forbs, and woody species are of concern because they diminish the quality and suitability of habitat and reduce its potential to support many native wildlife species. If nonnative species are particularly invasive they can spread easily, replace native habitat, reduce diversity, and cause great expenditure of financial and human resources. Nonnative grasses such as crested wheatgrass, Garrison creeping foxtail, Kentucky bluegrass, Japanese brome and cheatgrass are concerns on refuge lands. Several fields on the refuge are planted with nonnative grasses, which should be evaluated for replanting to native species to provide optimal habitat conditions for wildlife.

Shelterbelts of planted, nonnative trees and shrubs occur on the refuge where woody vegetation did not naturally occur. Shelterbelts were originally planted to increase wildlife diversity, but current research suggests that they increase predation and negatively affect imperiled grassland birds. Whether or not these shelterbelts should be removed or supported needs to be evaluated.

This planning issue involves several planning elements and carries through all alternatives in chapter 7 under the grasslands and wetland and riparian areas planning element headings.

Wildlife Management

Protecting habitat and managing for a wide variety of migratory birds is a priority for the refuge complex. Waterfowl and other waterbirds, grassland songbirds, and riparian area-dependent birds are some of the highest priority groups. Grassland birds, in particular, have experienced the most severe declines of any group of birds across the U.S. Managing the refuge to help these species is a concern.

The public is also concerned about waterbirds such as white-faced ibis, black-crowned night-herons, and Franklin's gulls that use the refuge and depend on relatively deep, permanent water.

There is concern that the refuge wetlands should be flooded every year to provide wetland habitat for wildlife that compensates for other wetland habitat that has been drained or altered in Montana.

Botulism has been a problem in some of the refuge units in the past. Flooding Units 3–6 during late summer in hot, dry years has historically led to botulism outbreaks killing thousands of birds. Botulism needs to be considered in future management scenarios.

This planning issue involves several planning elements and carries through all alternatives in chapter 7 under the preserving intact landscapes and visitor services planning element headings.

Hunting

Hunters have expressed concern that the quality of waterfowl hunting at the refuge has declined significantly over the last several years. Excessive vegetation, limited open water, and low-water levels were mentioned specifically. Several comments suggested that significant management actions would be needed to improve conditions. Opening other parts of the refuge normally closed to hunting, while management actions were implemented on the current hunt units, was also suggested.

Comments were also received that the access for hunters with disabilities needs to be improved.

This planning issue involves several planning elements and carries through all alternatives in chapter 7 under the visitor services and visitor and employee safety planning element headings.

Wildlife Observation

The public enjoys viewing wildlife on the refuges and waterfowl production areas within the refuge complex. The Benton Lake Refuge in particular, because of its close location to the city of Great Falls, is especially valued by birdwatchers. The public has requested the expansion of opportunity to observe sharp-tailed grouse on their dancing leks, a very popular activity. Expanding birdwatching opportunities for a wide diversity of birds should be evaluated.

This planning issue involves several planning elements and carries through all alternatives in chapter 7 under the visitor services and visitor and employee safety planning element headings.

Comments Received from the Public and Found to be Outside the Scope of the Plan

Many issues were identified through scoping, including public meetings, letters, emails, and other written correspondence from the public. The following comments from the public, however, were reviewed by the Service and found to be outside of the scope of the plan because they conflict with existing policy; the Service's, or the Refuge System's, mission and purpose; the best available science; or with other information:

- The focus of the refuge should be for ducks, not other species. The highest and best use should dictate management and give residents access for several hunting and recreational pursuits.

This comment suggests refuge management actions that are not congruent with the purpose of the refuge. The refuge was established as "a refuge and breeding ground for birds" (Executive Order No. 5228, November 21, 1929). One species group is not considered more important than another. The Improvement Act requires that "each refuge shall be managed to fulfill the mission of the Refuge System, as well as the specific purpose for which that refuge was established" (section 4 (a)(1)(3)(A)). There is a strong and singular wildlife conservation mission for the Refuge System and, when found to be compatible, wildlife-dependent recreational uses are legitimate and proper uses but secondary to the primary purpose for which the refuge was established.

- Federal Duck Stamps purchased the refuge so it has to be managed for ducks and migratory bird funds and Pittman–Robertson Funds spent on the refuge clearly show a long-term dedication on the part of the public to sound wetland management to help waterfowl and other wetland species.

This comment suggests that the refuge was bought by Federal Duck Stamp revenue, but it was not. The refuge lands were reserved during homesteading. The lands were subsequently transferred from the Bureau of Reclamation to the Service as a refuge and breeding ground for birds by Executive order. There was no hunting allowed of any species at that time. No Federal Duck Stamp or Pittman–Robertson monies were used to construct the levees and water control structures. All alternatives presented in the document reflect sound wetland management to help waterfowl and other wetland species.

- If a long dry period is implemented, when the basin is wet again, the birds will not be able to find the refuge because management has broken the birds' tradition.

This comment suggests that water-dependent birds have not adapted to long-term flooding and drying cycles. Although some species of waterfowl tend to return to the same breeding area used the year before (such as homing), most species of waterfowl exhibit some degree of flexibility in settling patterns in response to local wetland conditions (Johnson and Grier 1988). Examples of this occur regularly on the waterfowl production areas within the wetland management district where basins under natural hydrological regimes are flooded following a relatively long dry cycle with significant associated bird use.

- There are no visible deformities yet, so why is the Service proposing such radical solutions now?

This comment suggests that the Service knowingly not address accumulating selenium, which would be in direct opposition of the Improvement Act, the mission of the Refuge System, and the purpose of the refuge. When selenium contamination reaches levels where visible deformities can readily be observed, the refuge is likely to be so highly contaminated that extreme measures such as capping portions of the refuge, as occurred at the Kesterson NWR in California in the 1980s, will be necessary. At lower levels, selenium causes impairments that prevent eggs from hatching, which is not easily observed without careful monitoring. However, at these levels there are more options available to managers to reduce selenium levels. The Improvement Act directs that “the Secretary shall ensure that the biological integrity, diversity, and environmental health of the Refuge System are supported for the benefit of present and future generations of Americans” (section 4 (4) (B)).

- The refuge should just treat the selenium problem, for example by scraping out or removing the contaminated sediment, to solve the wetland health issues.

This comment suggests that the Service take an approach in addressing wetland health issues that treats a symptom (selenium) of the problem, not the problem, itself. Chapter 7 analyzes management alternatives and impacts that focus on the underlying changes to wetland ecological processes, such as alterations to the flooding and drying cycle, that result in symptoms such as selenium contamination. By taking this approach, the Service expects that selenium contamination will be reduced, and overall wetland health will be improved, so that the refuge can be managed in a way that provides long-term solutions that help migratory birds and other wildlife.

- It has been suggested that botulism should not be given strong consideration in developing a management scheme.

This comment suggests that the Service purposefully carry out management strategies that have proven in the past to cause significant wildlife mortalities. Several units on the refuge have a history of botulism outbreaks and botulism is known for recurring outbreaks in earlier disease locations. Refuge staff recognize that wildlife mortalities, from a variety of causes, are natural and to be expected. However, the purpose of the refuge as a breeding ground for birds indicates that the Service should strive to manage so that the refuge is not a population sink.

- If the refuge does not pump water it will result in the abandonment of the refuge and management.

This comment suggests that management actions such as prescribed fire, grazing, treating invasives, ARM, and providing for public uses would not continue to occur. However, such management actions are currently considered under all alternatives.

- Members of the public suggested that under certain alternatives the participation of the Great Falls Public School Third Graders at the refuge would be discontinued.

All alternatives under consideration would continue to provide opportunities for the third graders who visit the refuge. Discussions with school staff identified no concerns. The teachers stated that they would adjust their curriculum to the future conditions of the refuge.

- Over the last three decades conservation partners have invested close to $750,000 in water management infrastructure that affects 655 acres on the refuge. Removal or modification of this infrastructure would mean a loss of this investment.

The Service recognizes and appreciates the past efforts of the refuge’s partners in supporting the development of infrastructure on the refuge. These efforts were based on the best available wildlife management expertise and science at the time. Just as this infrastructure was built with the intention of helping wildlife, it may be that removing some or all of it is now of greater help to wildlife. The Service is committed to an ARM approach, and when new information becomes available, the Service must stay flexible to adjust management accordingly.

- The Service received a comment that removal of the basin infrastructure is a “criminal act.”

This comment suggests that there is legal standing for this position, but that is not the case. The refuge operated without any infrastructure from its establishment in 1929 to 1960 and was considered to be fulfilling the purpose for which it was established. Modification to infrastructure is analyzed under a variety of the alternatives presented in the document.

- The refuge should be turned over to the State so that hunting would have higher priority in management.

This comment suggests a change of management, but the Service does not consider divestiture unless a unit no longer meets the purposes for which it was established. The refuge provides significant natural resource benefit and continues to meet the purpose as a refuge and breeding ground for birds. Furthermore, reserving and protecting wetland health is a concern regardless of ownership.

- Some hunters asked the Service to consider purchasing public access rights from landowners of conservation easements or purchase fee title instead, so that the public may have the opportunity to access more lands for hunting.

This comment suggests fee title acquisition, but this does not meet the Service's regional priorities (which is easement acquisition); and it is not as cost effective for protecting landscape level habitats that protect a broad array of trust species. Landowners interested in entering into perpetual conservation easement contracts have a suite of Federal, State and nongovernmental organization contracts to choose from. The easement contracts differ in which individual property rights are encumbered depending on the specific agencies' mission. Landowners who are interested in easement programs that will provide public access to their land are referred to the State. Purchasing this right is more closely aligned with MTFWP's mission and money. In addition, the State offers public access incentive programs (Block Management Program) available to private landowners regardless of whether or not their properties are encumbered by Service easements. These are short-term (1- 3 year) agreements that landowners may consider for financial or ethical reasons.

Prioritizing the easement program on protection of wildlife habitat enables the Service to protect more acres and deliver conservation on a landscape scale. One of the main reasons why most landowners are attracted to the Service's conservation easement program is that the Service allows the landowner to support control over public access. Changing this policy would likely reduce landowner interest. In addition, purchasing public access rights is estimated to add 25 to 30 percent to the cost of the easement which would mean fewer acres could be protected with annual money allocations. Lastly, the increased challenges of administering the provisions of public access on easements would likely detract from the ability of staff to protect more habitat acres.

Fee title acquisition, such as new waterfowl production areas, has considerable limitations. These lands would first have to qualify under the purchasing constraints of the Migratory Bird Program by supporting enough wetlands on a tract of land to sustain a minimum of 25 pairs of breeding ducks per square mile. There has to be an adequate amount of Migratory Bird Funds available in Montana for acquisition (current money levels would only secure approximately 600 acres per year). Private landowners would have to be willing to sell these specific tracts of land. Fee title acquisitions would cost at least 70 percent more per acre than conservation easements, because the purchase price would be full appraised market value. In addition, the Service would incur all operation and maintenance costs for these new fee title tracts. Fee title acquisition decreases the county tax base and is generally unpopular within local communities.

- A conservation area (like those on the Rocky Mountain Front, Blackfoot Valley and Swan Valley) should be established for the area surrounding Benton Lake Refuge (for example, Lake Creek watershed).

This comment suggests establishing a conservation area, but the Service currently has tools that can be used by refuge staff to protect land and work with private landowners in the area around Benton Lake without needing to establishing a conservation area. The refuge complex staff have analyzed the issue of working with partners to improve water quality in the area surrounding the refuge. The Service's successful model for conservation easements is to partner with landowners to support their current land management (typically ranching) to create a win-win for landowners and wildlife. Conservation easements in the Lake Creek watershed would require landowners to change their current land management which would likely reduce the success of this approach. Also, the significantly modified landscape does not rank as highly for benefits to trust resources as more intact landscapes within the State.

7.4 Development of Alternatives

The Service assessed the planning issues identified in section 7.2, the existing biological conditions described in section 7.10, and external relationships affecting the refuge complex. This information contributed to the development of alternatives; as a result, each alternative presents different approaches for meeting long-term goals. Each alternative was also evaluated according to how well it would advance the vision and goals of the refuge complex and the mission of the Refuge System, along with how well it would address the planning issues.

The following alternatives are specific to Benton Lake Refuge and do not apply to the rest of the refuge complex.

- alternative A1–no action

- alternative B1
- alternative B2
- alternative C1–proposed action
- alternative C2

However, alternatives A1 through C2 are extensions of alternatives A, B, and C that would apply to the entire refuge complex, as shown in table 30:

Table 30. Each Benton Lake National Wildlife Refuge Complex-level alternative is linked to one or more alternatives for Benton Lake National Wildlife Refuge, Montana.

Refuge Complex Alternative	A	B	C
Benton Lake Refuge Alternative	A1	B1, B2	C1, C2

Planning elements and their accompanying planning issues from section 7.2 are as follows:

- Grasslands: Loss of Ecological Processes, Invasive Plants, Nonnative Plants and Noxious Weeds
- Wetlands and Riparian Areas: Loss of Ecological Processes, Declining Wetland Ecological Health, Water Quantity, Delivery and Cost; Invasive Plants, Nonnative Plants and Noxious Weeds; Loss of Ecological Processes
- Water Resources: Declining Wetland Ecological Health; Water Quantity, Delivery and Cost
- Visitor Services: Wildlife Management, Hunting, Wildlife Observation
- Staff and Funding
- Resource Protection

The planning team decided that further examination of the forests and woodlands planning element in chapters 3 and 5 was not needed for Benton Lake Refuge.

Elements Common to All Alternatives

Regardless of the alternative selected, refuge management will strive to achieve key objectives that show wetland health and sustainability are improving wildlife. For elements common to all alternatives, see section 3.2. Those elements that are common only to alternatives A1 through C2 include:

- reducing selenium contamination to levels where it does not impact reproduction in wildlife, particularly waterbirds. This is evaluated by measuring selenium at multiple trophic levels (for example, water, sediment, invertebrates and eggs).
- supporting wetland vegetation to consist of at least 80 percent native species.
- avoiding the creation of a sink for wildlife populations. This objective applies especially to alternatives B1 and B2 where the possibility of artificially flooding the lower units during summer could lead to increased botulism mortality over natural conditions.

Actions Same as the Refuge Complex

Management actions and environmental consequences for the climate change, preserving intact landscapes, species of concern, migratory birds and visitor and employee safety planning elements in chapters 3 and 5 apply equally to alternatives A1 through C2 in chapter 7 as they do to alternatives A through C.

7.5 Alternative A1 (Current Management–No Action)

Alternative A1 is the no-action alternative, which represents the current management of the refuge. This alternative might not meet all the CCP goals. It is provided as a basis for comparison with the other alternatives. It also fulfills the requirement in

Two key objectives for wetland health for all alternatives:

- Reduce selenium so it does not impair reproduction in wildlife (for example,<2ug/g in sediment)
- Wetland vegetation should be at least 80% native species

NEPA that a no-action alternative be addressed in the analysis process.

Management activity being conducted by the Service would remain the same. The Service would not develop any new management, restoration, or education programs at the refuge complex. Budget and staff levels would remain the same with little change in overall trends. Programs would follow the same direction, emphasis and intensity as they do at present.

Current management on the refuge would continue and would focus, primarily, on the individual wetland units. Most staff time and efforts would be directed toward providing migration and breeding habitat every year for wetland-dependent wildlife, primarily waterfowl. Annual flooding would be supported by pumping water from Muddy Creek to supplement natural run-off. Water management within the 8 wetland units on the refuge would be similar each year so that units are flooded at approximately the same time and depths consistently. This alternative would provide an opportunity for waterfowl hunting every fall. Managing grasslands and other wildlife-dependent public uses (wildlife observation and photography, environmental education and interpretation, and upland game-bird hunting) on the refuge are a secondary focus.

Grasslands

Protection of native grasslands through easement programs would continue to be a high priority throughout the refuge complex. Within authorized conservation areas, easements would be regularly used to protect native grasslands. Easements would be aggressively monitored and proactively enforced.

Native grasslands would be managed to sustain grassland health, composition and native plant diversity. This would be done by emulating historical disturbance regimes such as fire, treatment of invasive species using IPM and EDRR, and proper periods of rest. Grazing would not be used as a tool to manage grasslands on the refuge.

Management of tame grass on the refuge would strive to support health and longevity of stands with periodic disturbance with fire or haying.

Nonnative tree plantings in grasslands (shelterbelts) are present, but would not be actively managed. Most of the nonnative tree plantings on the refuge complex occur on the Benton Lake Refuge.

Wetlands and Riparian Areas

Pumping is used to supplement the refuge's natural runoff and artificially flood wetland habitat. The refuge would continue to pump an average of 4,000 acre-feet per year, although this may decline over time if electricity costs increase. The water would be pumped from Muddy Creek primarily in the fall and occasionally in early summer. Most wetland units would be flooded to some extent every year. The distribution, depth and timing of flooding would be similar each year. The lower units (Units 3–6) would be managed to dry out during July and August to reduce the likelihood of botulism and waterfowl mortality. Units 1 and 2 would be flooded year-round to provide brood habitat. (A detailed description of current water management can be found in section 7.10).

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Waterfowl workshops for youth are held at Benton Lake National Wildlife Refuge.

Water Resources

Annually about 4,000 acre-feet of water (of a 14,600-acre-foot water right) would continue to be pumped from Muddy Creek and runoff from the Lake Creek drainage is captured within the wetland basin.

Visitor Services

The overarching goal of the public use program would continue to be to enhance wildlife-dependent recreation opportunities and access to quality visitor experiences while managing units to conserve fish, wildlife, plants, and their habitats. Recreational uses should continue to help visitors focus on wildlife and other natural resources, and provide an opportunity to make visitors aware of resource issues, management plans, and how the unit contributes to the Refuge System and Service mission. National wildlife refuges are encouraged to provide wildlife-dependent recreation where feasible and compatible with the purpose of the refuge.

Hunting

Hunting of waterfowl (duck, goose, swan (by permit only), and coot) and upland gamebirds (pheasant, sharp-tailed grouse, and gray partridge) would continue in designated areas of the refuge on approximately 4,600 acres of upland and wetland habitat. Big game hunting would continue to be prohibited. Hunting rabbits or any other wildlife species, including furbearers would continue to be prohibited.

Hunting on the refuge begins with the opening of the State waterfowl season and runs through November 30. Benton Lake Refuge is open for the youth waterfowl season, which typically occurs the weekend before the opening of the general waterfowl season. Hunting is on a first-come, first served basis. One disabled accessible hunting blind is available in Unit 5 through special use permit.

Wildlife Observation and Photography

The Prairie Marsh Wildlife Drive would provide year-round wildlife-viewing and photography opportunities via auto, bicycle, equestrian, or foot-traffic, including hiking, snowshoeing, or cross-country skiing.

Lower Marsh Road would continue to be available to vehicles, foot-traffic, bicycling, and equestrian use for wildlife-viewing and photography opportunities from July 15 until the opening day of waterfowl hunting season. Rough road conditions prevent the use of RVs, vehicles towing trailers, and large vehicles.

Facilities providing more opportunities for wildlife observation and photography include the Unit 1 photographic blind and the Prairie Marsh Boardwalk with spotting scope and interpretive panels. More year-round opportunities for wildlife observation and photography by means of temporary blinds on Prairie Marsh Wildlife Drive would continue to be available. Blinds in other selected areas may be authorized as well through special use permit.

Cross-country skiing and snowshoeing for wildlife-viewing and photography would continue to be permitted refuge-wide from December 15 until the end of February. Equestrian and bicycle use would be limited to roads open to motorized vehicles.

The Sharp-Tailed Grouse Blind would continue to be available to refuge visitors by reservation on weekends during April and May. The grouse blind provides a highly sought-after opportunity to observe and photograph the courting rituals of sharp-tailed grouse.

Environmental Education and Interpretation

The refuge would continue to offer joint-sponsored outdoor education courses with the MFWP, including Youth Waterfowl Safety Clinic and the Becoming an Outdoor Woman series. Partnership with the Great Falls Public School would continue to provide the opportunity for all third graders in the Great Falls Public School system to come to the refuge and learn about natural resources. This highly popular activity includes more than 850 students annually. Refuge staff would provide information about the refuge and education specialists from the GFPS perform onsite activities and learning modules. Geocaching would continue to be prohibited; however virtual geocaching would be authorized if requested.

Refuge staff would continue to take part in the annual Montana Envirothon in Lewistown, Montana. The event attracts student teams from all across Montana while they compete for the opportunity to represent Montana and compete at the National Envirothon Competition. Refuge staff help students learn about fish and wildlife resources and their associated habitat. More than 200 students and teachers take part in the annual event. As time allows, the refuge would also continue to collaborate with other school groups to provide tours, teach science, and work together on monitoring projects.

Refuge staff would continue to take part in the STEM Expo hosted in Great Falls, Montana. This exposition hopes to develop into an annual event promoting math and science within the community. The event would offer staff the opportunity to reach more than 550 children, teachers, and parents. Benton Lake Refuge participation in the future was identified as a beneficial educational outreach activity.

Staff and Funding

The refuge complex headquarters is located on the Benton Lake Refuge. Service operations would continue to consist of the staff, facilities, equipment, and supplies needed to administer resource management and public use programs throughout the refuge complex, which is located across a 12-county area covering more than 2,700 square miles. Within this area, the Service would be responsible for the protection of 163,304 acres of lands and waters.

Staff

The refuge has seen a reduction in staff since 2000. Currently, the refuge complex staff is comprised of 9.5 permanent full-time employees (table 12 in chapter 4, section 4.7). Staff assigned to the Benton Lake Refuge would continue to include: a part of the wildlife refuge manager, the deputy wildlife refuge manager, an administrative officer, and a wildlife refuge biologist, maintenance worker, term-seasonal biological technician, and part-time generalist. The wetland district manager would continue to often help with refuge support.

Since 1998, the refuge complex has lost three positions—one full-time law enforcement position, one permanent biological science technician and a permanent maintenance worker. The complex has gained a wildlife refuge specialist assigned to the Rocky Mountain Front CA and Assistant Fire Management Officer assigned to the complex. The current staff level remains well below the minimum prescribed in the "June 2008 Final Report—Staffing Model for Field Stations" (USFWS 2008e), which recommended ¬8 more staff including a GS–13 refuge manager, GS–12 wildlife refuge specialist, GS–9 park ranger (visitor services specialist), GS–9 park ranger (law enforcement), GS–12 wildlife biologist, WG–8 maintenance worker, and GS–6 biological science technician (0.5 full-time equivalent employee).

Resource Protection

Same as refuge complex alternative A.

7.6 Alternative B1

Benton Lake Refuge wetland impoundments would be intensely managed to improve health over current conditions, yet provide for wetland-dependent wildlife habitat and recreation (waterfowl hunting) every year at consistent levels. Efforts would be made to improve wetland health and sustainability for individual wetland units through short-term drying rotations, prescriptive management treatments and working in the Lake Creek and Muddy Creek watersheds. Drying rotations may be extended if necessary to achieve wetland health objectives. Managing grasslands and other wildlife-dependent public uses (wildlife observation and photography, environmental education and interpretation, and upland game-bird hunting) would be a secondary focus.

Grasslands

Protection of native grasslands through easement programs would continue to be a high priority throughout the refuge complex. Within authorized conservation areas, easements would be regularly used to protect native grasslands. Easements would be aggressively monitored and proactively enforced.

Native grasslands would be managed to sustain grassland health, composition and native plant diversity. This would be done by emulating historical disturbance regimes such as fire, treatment of invasive species using IPM and EDRR, and proper periods of rest. Grazing would not be used as a tool to manage grasslands on the refuge.

Management of tame grass on the refuge would strive to support health and longevity of stands with periodic disturbance with fire or haying.

Nonnative tree plantings in grasslands (shelterbelts) are present, but would not be actively managed. Most of the nonnative tree plantings on the refuge complex occur on the Benton Lake Refuge.

Wetlands and Riparian Areas

Initially, similar amounts of water would be pumped from Muddy Creek as in alternative A1 (4,000 acre-feet per year) to extend the natural flooding cycle in the spring, summer, and fall, and to provide consistent wetland habitat every year on the refuge. However, short-term dry periods (7+ years in Units 1 and 2 and 3-5+ years in Units 3-6) would be rotated among units to volatilize selenium to change it into a vapor that would reduce its level in the wetland reduce invasive vegetation and improve wetland health. If necessary, more dry time may be implemented in individual units until wetland objectives are met. Added treatments of increased prescribed fire, discing vegetation, spraying invasive plants and reseeding would be used if needed. Flooding the lower units during summer will continue to be avoided to prevent botulism outbreaks unless it becomes necessary to dry Units 1 and 2 simultaneously for selenium control. In this case, one of the lower units may be flooded through summer to provide brood habitat. The flooding and drying rotation, water control structures and other management tools would continually be assessed and modified through an adaptive management process. This could include building more infrastructure such as a diversion channel around Units 1 and 2, expanding dry cycles, and adding management treatments.

Water Resources

Same as alternative A1, except the total acre-feet pumped would depend on progress toward wetland objectives.

Visitor Services

Hunting

Same as alternative A1, except the area open for waterfowl hunting could change from year to year based on the flooding and drying rotation of the units. More upland gamebird habitat might be available if particular units within the hunt area are in their drying cycle.

Wildlife Observation and Photography

Same as alternative A1, except there may be modifications to the opening and availability of Lower Marsh Road depending on the sequence of implementing the dry cycle in various units, which could affect access by bicycle or foot. These modifications would be implemented if unacceptable disturbance is occurring that needs to be reduced or if management actions need adjusting.

Foot-traffic, including hiking, snowshoeing, and cross-country skiing, would be permitted only on designated trails; roads open to motorized vehicles; and in the refuge hunt area during the refuge hunting season.

The auto tour route may be adjusted to accommodate adjustments to water management units and changes in hunt area and water availability.

May establish mobile photo blinds through special use permit.

Environmental Education and Interpretation

Management actions would be the same as alternative A1, plus greater emphasis would occur with interpretive panels and maps to explain (1) the purpose and importance of emulating natural processes for the health and vitality of ecological system and (2) changes to public use regulations and access areas to accommodate rotating closed area due to changes in wetland and water management.

Staff and Funding

Significant increase in staff and money for the intense management actions and monitoring would be necessary. Increases in permanent staff to accomplish this alternative include: a 1.0 FTE supervisory biologist, a term 0.8 FTE biological technician, and 1.0 FTE maintenance worker. The supervisory biologist will be assigned to work throughout the complex and on Benton Lake Refuge to direct restoration and monitoring efforts and supervise the permanent wildlife biologist and term and temporary biological technicians. A large proportion (80 percent) of their work load is expected to be focused on the refuge. To accomplish monitoring responsibilities and to make sure that objectives are be-

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A spotting scope is on hand for educational use and for wildlife observation at the visitor center at Benton Lake National Wildlife Refuge.

ing met is expected to also require two seasonal 0.8 FTE biological technicians. In addition, a full time law enforcement officer, assigned to the complex, is expected to spend a part (25 percent) of his/her time patrolling and protecting natural resources and helping visitors on the refuge.

Water level management (operations and maintenance) efforts are expected to be same as alternative A1. Pumping (electricity) expenses are expected to be similar to alternative A1.

Monitoring efforts would be implemented to assess results to make sure that the objectives for selenium, vegetation, and wetland health are being met. This is especially important to establish baseline information and to decide if more drying is needed. A significant increase in expense is expected over alternative A1.

Prescriptive habitat treatment (discing, mowing, herbicide treatment, etc.) would be implemented in individual units. Significant increase in expense to accomplish this will occur above alternative A1.

This alternative includes the possible construction of a diversion channel that could divert water to and from Units 1 and 2, which would increase water management flexibility.

Resource Protection

Same as refuge complex alternative B, plus more law enforcement and administrative help needed to make sure that boundaries are properly signed and literature is available to support possible shifts in hunting areas. Efforts would focus on preventative law enforcement.

7.7 Alternative B2

Benton Lake Refuge wetland units would be intensely managed to improve health over current conditions, yet provide for wetland-dependent wildlife habitat and recreation more often than would occur naturally. Efforts would be made to improve wetland health and sustainability through an initial, basin-wide dry period to "reset" the system, prescriptive management treatments and work in the Lake Creek and Muddy Creek watersheds. When wetland health has improved sufficiently, pumping may be incrementally reintroduced and reevaluated annually. Managing grasslands and other wildlife-dependent public uses (wildlife observation and photography, environmental education and interpretation, and upland game-bird hunting) on the refuge would occur as resources allow, primarily during the initial, basin-wide dry period.

Grasslands

Same as refuge complex alternative B. In addition, up to 3.5 miles of nonnative tree plantings in grasslands (shelterbelts) would be removed. Shelterbelts that have the greatest negative effect on grasslands would be the highest priority for removal. Degraded tame grass stands (up to 207 acres) would be planted back to native grass species where proper and feasible.

Formal monitoring of grasslands would be focused on native prairie with an emphasis on linking management actions to grassland condition (adaptive management). Restoration of habitats (native grass planting and tree removal) would be formally monitored to evaluate success. Monitoring of tame grasslands would be minimal and informal.

Wetlands and Riparian Areas

The refuge would be managed to improve wetland health and sustainability through an initial, basin-wide drying period (8 plus years) to "reset" the system. During the initial dry period, pumping will cease and all units will only receive natural run-off. When conditions allow, more intensive management (prescribed fire, discing, and herbicide application) will occur. All wetland infrastructure (dikes, ditches, water control structures), the pumphouse, equipment, and conduit between the pump station and the refuge would remain in place.

When wetland health has improved sufficiently and objectives have been achieved, pumping may be incrementally reintroduced. The objectives for wetland management are the same as those described under alternative B1. If pumping is reintroduced, short-term dry cycles on a unit-by-unit basis and more management techniques, similar to those described in alternative B1, will continue to be part of the long-term management of the wetland. The decision to flood or dry each unit would be an annual decision based on an adaptive resource management approach. Wetland cycles, health, and wildlife response would be tracked with intensive monitoring to provide feedback on management success.

Water Resources

Pumping water would not occur during the initial dry period. Once wetland objectives are achieved, pumping could resume. Natural runoff would still be captured from the Lake Creek watershed every year.

Visitor Services

Hunting

During the initial dry period, management actions would be similar to alternative C1. During these years, there would be no waterfowl hunting opportunities on Benton Lake since there would be no, or very limited, water in the fall.

During years with adequate water (runoff or pumped), the area open for waterfowl hunting could change from year to year based on the flooding and drying rotation of the units.

The upland gamebird season would be expanded to the end of the State season.

Wildlife Observation and Photography

During the initial drying period, same as alternative A1, except foot-traffic, including hiking, snowshoeing, and cross-country skiing, would be permitted only on designated trails; roads open to motorized vehicles; and in the refuge hunt area during the refuge hunting season. Same as alternative B1 during any pumping or high run-off years.

Environmental Education and Interpretation

Management actions would be the same as alternative B1, plus interpretive panels and maps would also explain the need to reset the natural processes in the wetlands with an initial dry period.

Staff and Funding

Staff needed to carry out this alternative same as alternative B1, except a slight reduction (10 percent) in the part of time the supervisory biologist would spend dedicated to the refuge is expected to occur.

Water level management (operations and maintenance) efforts are expected to be significantly reduced from alternatives A1 and B1. A significant cost saving during the extended drying period would be the reduction in pumping (electricity) and water management (operations and maintenance) expenses.

If pumping resumes, infrastructure and facilities to support water management of the refuge would need annual maintenance similar to the alternatives A1 and B1. Monitoring efforts are expected to be similar to alternative B1. Monitoring efforts would include assessing results to make sure that the objectives for selenium, vegetation, and wetland health are being met. This is especially important if pumping is resumed. Efforts to establish baseline information and monitoring changes from the extended dry period are expected to be enhanced over alternatives A1 and B1.

During the dry phase, active prescriptive habitat treatment (discing, mowing, herbicide treatment, etc.) is expected to be intense and similar to alternative B1, but instead of being applied to a single unit at a time, the treatments could be applied basin-wide.

The diversion channel is not expected to be needed.

Resource Protection

Same as refuge complex alternative B, plus more law enforcement and administrative help needed to make sure that boundaries are properly signed and literature is available to support possible shifts in hunting areas. Efforts would focus on preventative law enforcement.

7.8 Alternative C1 (Proposed Action)

Benton Lake Refuge management would focus on the refuge as a whole, with emphasis on restoring the health and long-term sustainability of the wetland basin, to support a wide diversity of migratory birds and a variety of wildlife-dependent recreation. This would be accomplished by reintroducing the full extent and variability of the natural wet-dry cycles, prescriptive management treatments and working in the Lake Creek watershed. The wetland basin would receive only natural run-off and wetland basin infrastructure (for example, ditches, dikes, and water control structures) could be modified or removed only if necessary to achieve wetland health objectives. The pumphouse and all water rights would be supported. As the wetland basin is restored and becomes self-sustaining, more resources would be directed toward managing and restoring upland grasslands, providing other wildlife-dependent public uses (wildlife observation and photography, environmental education and interpretation, and upland game-bird hunting), and providing support for conservation easement acquisition in the complex.

Grasslands

Same as refuge complex alternative C, plus up to 19 miles of nonnative tree plantings in grasslands (shelterbelts) would be removed. Shelterbelts that have the greatest negative effect on grasslands would be the highest priority for removal. Up to 728 acres of tame grass stands would be planted back to native grass species.

Formal monitoring of grasslands would be focused on native prairie with an emphasis on adaptive management. Restoration of habitats (native grass planting and tree removal) would be formally monitored to evaluate success. Monitoring of tame grasslands would be minimal and informal.

Wetlands and Riparian Areas

Same as A1, except all units on the refuge would be subject to natural hydrologic regimes. Limited pumping may occur (estimated once every 8 years) to support water rights to Muddy Creek or for specific restoration purposes only (for example, flooding out nonnative vegetation). To facilitate this, the pump house, underground pipeline (4 miles), and several structures on Lake Creek will be supported. Units 1 and 2 would be restored to wet meadow wetlands, with water entering the refuge through the old Lake Creek channel and natural diffuse runoff. Infrastructure on the refuge could be modified or removed incrementally if monitoring results show that is necessary to achieve refuge objectives. Staff will work with our partners in the Lake Creek watershed to carry out conservation actions that improve water quality and wetland health on the refuge.

Formal monitoring of wetlands would focus on wetland health and sustainability through adaptive management. Monitoring would track long-term trends in wetland cycles, health and wildlife use. For restoration efforts, monitoring would be especially important to decide if systems are recovering.

Water Resources

Only natural runoff would be captured on a regular basis protecting Lake Creek water rights. To preserve the Muddy Creek water rights, occasional pumping may occur (estimated once every 8 years).

Visitor Services

Hunting

During years with limited precipitation and runoff, there would be no waterfowl hunting opportunities on the refuge since there would be no, or very limited, water in the fall. These dry years would provide increased upland gamebird habitat for hunting. The upland gamebird hunting season would be extended to the end of the State season (same as alternative B2).

During years with adequate water, a decision would be made on an annual basis about the location of open and closed areas. These designated areas may be rotated depending on water and vegetative conditions.

Wildlife Observation and Photography

Same as alternative A1, except foot-traffic, including hiking, snowshoeing, and cross-country skiing, would be permitted only on designated trails; roads open to motorized vehicles; and in the refuge hunt area during the refuge hunting season. If modification or removal of water management infrastructure occurs, parts of the existing auto tour route could be changed. Efforts would be made to reestablish the auto tour route in another location. If interior roads are removed for habitat management purposes, more hiking trails that access the interior of the refuge may be established to facilitate wildlife

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The Canada goose is a frequent visitor to Benton Lake National Wildlife Refuge.

observation and photography. Any new opportunities would be implemented in a way that reduces disturbance to wildlife.

Environmental Education and Interpretation

Same as refuge complex alternative C regarding implementation of expanded environmental education and interpretation program. In addition, at the Benton Lake Refuge, greater emphasis would occur with environmental education, outreach, interpretive panels and maps to explain (1) the purpose and importance of conserving, managing, and restoring healthy functioning ecosystems, (2) the importance of natural hydroperiods in wetlands, and (3) changes to public use regulations and access areas to accommodate changes in wetland and water management. Environmental education curriculum may be adapted to reflect changes in habitat from restoration efforts.

Staff and Funding

Staff

Staff increases expected to be needed to carry out this alternative include: a part (50 percent) of the 1.0 FTE park ranger assigned to the complex, a part (25 percent) of the 1.0 FTE law enforcement officer assigned to the complex, a part (70 percent) of the 1.0 FTE supervisory biologist assigned to the complex, and 0.8 FTE biological technician. From alternative B2, this is a reduction of two, 0.8 FTE biological technicians, and 1.0 maintenance worker and an increase of a part (50 percent) of the 1.0 FTE park ranger assigned to the complex.

Money and resources are expected to be reallocated throughout the refuge complex to deal directly with constraints to manage for self-sustaining systems. Areas requiring extra effort will have resources reallocated toward restoring ecological processes and removing constraints. Water level management (operations and maintenance) efforts are expected to be significantly reduced from alternatives A1, B1, and B2. A significant cost saving would be the reduction in pumping (electricity) and the associated water management (operations and maintenance) expenses. Limited pumping is expected to only be used to support the refuge's water rights or as a prescriptive habitat management effort.

Monitoring efforts are expected to be slightly reduced from alternatives B1 and B2. Monitoring efforts would include assessing results to make sure that the objectives for selenium, vegetation, and wetland health are being met while applying an adaptive resource approach to infrastructure modification or removal. Infrastructure will be incrementally assessed and only removed to achieve wetland objectives.

Prescriptive habitat treatment (discing, mowing, herbicide treatment, etc.) is expected to be less intensive than alternatives B1 and B2, and applied basin-wide relatively simultaneously.

Restoration and rehabilitation of altered habitats and ecosystems are expected to require more staff, equipment, and money. Activities expected include wetland basin restoration, shelterbelt restoration, and tame grass conversion.

Resource Protection

Same as refuge complex alternative C.

7.9 Alternative C2

Benton Lake Refuge management would focus on the refuge as a whole, with particular emphasis on restoring the long-term sustainability of the wetland basin, to support a wide diversity of migratory birds and wildlife-dependent recreation. This would be accomplished by reintroducing the full extent and variability of the natural wet-dry cycle, removal of the water management infrastructure (for example, ditches, dikes, and water control structures), prescriptive management treatments, working in the Lake Creek watershed and decommissioning of the pump house. As the wetland basin is restored and becomes self-sustaining, more resources would be directed toward managing and restoring upland grasslands, providing other wildlife-dependent public uses (wildlife observation and photography, environmental education and interpretation, and upland game-bird hunting), and providing support for conservation easement acquisition in the complex.

Grasslands

Same as refuge complex alternative C, plus up to 19 miles of nonnative tree plantings in grasslands (shelterbelts) would be removed. Shelterbelts that have the greatest negative effect on grasslands would be the highest priority for removal. Up to 728 acres of tame grass stands would be planted back to native grass species.

Formal monitoring of grasslands would be focused on native prairie with an emphasis on adaptive management. Restoration of habitats (native grass planting and tree removal) would be formally monitored to evaluate success. Monitoring of tame grasslands would be minimal and informal.

Wetlands and Riparian Areas

Full restoration of the Benton Lake basin would begin immediately, although the process would likely take several years to complete. All units on the refuge would be subject to natural hydrologic regimes. Pumping would cease and the pumphouse, equipment, and conduit between the pump station and the refuge would be removed or reclaimed. Infrastructure within the wetland basin (ditches, dikes, water control structures) would be modified or removed. Units 1 and 2 would be restored to wet meadow wetlands, with water entering the refuge through the old Lake Creek channel and natural diffuse runoff.

Formal monitoring of wetlands would focus on wetland health and sustainability through adaptive management. Monitoring would track long-term trends in wetland cycles, health and wildlife use. For restoration efforts, monitoring would be especially important to decide if systems are recovering.

Visitor Services

Hunting

During years with limited precipitation and runoff, there would be no waterfowl hunting opportunities on the refuge since there would be no, or very limited, water in the fall. These dry years would provide increased upland gamebird habitat for hunting. The upland gamebird hunting season would be extended to the end of the State season (same as alternative B2).

During years with adequate water, a decision would be made on an annual basis about the location of open and closed areas. These designated areas may be rotated depending on water and vegetative conditions.

Wildlife Observation and Photography

Same as C1 plus, more wildlife observation and photography opportunities would be established.

Environmental Education and Interpretation

Same as refuge complex alternative C regarding implementation of expanded environmental education and interpretation program. In addition, at the Benton Lake Refuge, greater emphasis would occur with environmental education, outreach, interpretive panels and maps to explain (1) the purpose and importance of conserving, managing, and restoring healthy functioning ecosystems, (2) the importance of natural hydroperiods in wetlands, and (3) changes to public use regulations and access areas to accommodate changes in wetland and water management. Environmental education curriculum may be adapted to reflect changes in habitat from restoration efforts.

Staff and Funding

Staff

Same as alternative C1, except one less 0.8 biological technician would be required, and the timeline for restoration is quickened and higher costs are expected to occur immediately. Full restoration is associated with this alternative and includes the highest restoration costs.

Resource Protection

Same as refuge complex alternative C.

7.10 Alternatives Considered but Eliminated

The following options were eliminated from further analysis as described below.

Siphon

The possibility of augmenting the current pumphouse with a siphon has been discussed and evaluated by refuge staff and partners since 1992. The purpose of the siphon was to alleviate the high electricity costs associated with pumping water with the current pumphouse and facilities on the refuge. Other benefits that were originally identified included the ability to supply water during the winter and spring, the potential for the refuge to fully exercise its 14,600-acre-foot water right for Muddy Creek, and conservation of electricity. Given the recent concerns about selenium accumulation, the siphon was also proposed as a way to bring higher quality water to the refuge. However, given the high cost of building a siphon ($5 million), insufficient flows to replace pumping needs, and uncertain improvements in water quality, pursuing this alternative is not beneficial to the refuge at this time.

In 1992, the refuge requested that the Bureau of Reclamation complete an appraisal to use a siphon system to supply water from the Sun River Irrigation Project. The final report, "Appraisal Design Report for Water Supply Study, Benton Lake National Wildlife Refuge," dated October 3,1992, outlined plans for completion of the project and estimated associated costs under a range of options. The Bureau of Reclamation report found the siphon system to be technically feasible using an existing irrigation return water canal (Muddy Creek Tributary #3) near the existing pump station. No design obstacles were noted. Easements would need to be acquired from four landowners to complete the project.

In 2006, the Bureau of Reclamation completed a 30-percent Conceptual Design of the siphon project. The siphon would tie into the existing pipeline just downstream of the pump station. The siphon would consist of two reinforced concrete structures, approximately 2 miles of 36-inch diameter pipe, a 12-foot-long steel flume over Muddy Creek, and a 36-inch in-line valve and a valve house. A small intermittent tributary of Muddy Creek would also have to be relocated for approximately 300 feet. The siphon would deliver water to the refuge using gravity flow and the capacity of the system is 20 cfs based on the pipe diameter. The most current estimate (2006) by the Bureau of Reclamation for the cost of the siphon project is $5 million dollars .

In 2007 and 2008, waterflows in the Upper Muddy Creek Tributary #3, where the siphon intake would be located, were measured by Montana State University. Water flowed in this tributary from May through October and flows during the irrigation season varied from 0 to 23 cfs. The estimate for the total volume of water flowing through the tributary was 2,186 acre-feet in 2007 and 2,759 acre-feet in 2008 (personal communication, Alan Rollo).

Currently, the refuge pumps approximately 4,000 acre-feet per year in dry years. At the time the siphon was originally proposed, the refuge was pumping 6,000–8,000 acre-feet per year. The 2007–8 flow data show that the amount of water from the siphon would not be enough to entirely replace current pumping. Furthermore, to capture the full 2,186–2,759 acre-feet, water would need to be siphoned during the entire irrigation season. Siphoning during summer months would be challenging because there would be high losses to evaporation, increased risk of wildlife mortalities from botulism, and further alteration to the natural hydrologic cycle that is likely to have a negative effect on nutrient cycling, vegetation, invertebrates, and wetland health. The quality of the water, specifically the selenium levels, at the proposed siphon inlet are not well understood. The siphon would take water from the Greenfields Bench. As of 2010, Montana Department of Agriculture water monitoring reported 202 detections of 30 different pesticide compounds from 22 samples across the Greenfields Bench. For the most part, concentrations were low and none of the detections exceeded or approached human health or aquatic life benchmarks. Nitrate concentrations were elevated, but below the drinking water standard. In addition, the siphoned water still has to flow through Lake Creek where it would pick up more selenium before reaching the refuge.

Only Pumping in Spring

Based on the results of the hydro-geomorphic assessment of the refuge (Heitmeyer et al. 2009), pumping in the spring, instead of the fall, would more closely emulate the annual historical flooding cycles. Refuge staff modeled a rotational system drying out one unit at a time for 3 years with a spring pumping scenario (500 acre-feet in May and 1,500 acre-feet in June). These months and water volumes were chosen based on availability of water from Greenfields Irrigation District, evaporation rates, and costs. The scenario was run through a water model developed by USGS for the refuge (Nimick et al. 2011). This early modeling exercise showed a couple of key results. In a dry cycle, only pumping in May–June meant that the wetland water was (1) too late to attract as many spring migrants as fall flooding, (2) capable of flooding nests of early nesting bird species, (3) providing water on the refuge during July–August, which increased botulism risk and (4) comprised of surface water that usually evaporated before fall negating any opportunity for annual waterfowl hunting. Pumping earlier in the year may be possible, but without return flows in Muddy Creek from irrigation, only one pump can be used to pump a small amount of water. In dry years, this small volume is likely to be lost to ground saturation and evaporation, making this choice less effective and more costly (per acre-foot) than late spring or fall pumping. Based on this analysis, an alternative with only spring pumping was eliminated from further consideration.

Restore Units 1 and 2 and Pump Water to Lower Units

Early during the planning process, staff considered a rotational management scenario for drying out the lower units for 3 years as well as restoring the original Lake Creek channel and Units 1 and 2 to wet meadows based on the HGM assessment. This report found that Units 1 and 2 historically were an alluvial fan meant to be the highest and driest part of the wetland basin, and instead have been converted to the deepest, wettest part of the wetland basin. These are also the units with the highest selenium levels and restoring this part of the basin to temporarily flooded wetlands, rather than semipermanent wetlands, would reduce selenium levels.

The Service modeled a rotational system drying one of the lower units at a time for 3 years with Units 1 and 2 restored to temporarily flooded wetlands. In this scenario, the only brood habitat on the refuge would be whichever lower units were in their wet cycle. If the lower units have standing water in July and August, they have an increased risk for botulism based on past history, particularly in hot summers. If the lower units were flooded less deeply so that they dry out in July–August (as is current practice to prevent botulism), there would be no brood habitat. This means that refuge would be attracting birds to the refuge by fall pumping, which creates attractive water in the spring for migrants, and knowingly managing the refuge so it dries out before the birds could successfully raise a brood. Although it is possible that wetland birds could be attracted to spring water at Benton Lake that dries out during the summer under natural conditions, this would not happen every year as proposed under this alternative. Therefore, supporting Units 1 and 2 as potential brood habitat was considered preferable for any scenario with pumped water (see alternatives B1 and B2) and this alternative was eliminated from further consideration.

Minimal Pumping in the Fall Primarily for Recreation

A small amount of water could be pumped in the fall for hunting. The amount of water would be managed so that it evaporates by freeze-up or early the next spring. One benefit of this scenario is that there would be fall hunting and fall migration habitat every year on the refuge, although it would be less than currently is available. There would be less water pumped onto the refuge, so the negative effects from pumping would be reduced. However, this alternative would focus on recreation without addressing issues of wetland health. In addition, this scenario would not be very cost effective, because of the electricity demand charge for pumping lower volumes of water results in significantly higher costs per acre.

7.11 Affected Environment

The summary of the affected environment in chapter 4 includes Benton Lake Refuge. However, aspects that specifically affect the management alternatives at the refuge are discussed in detail in this section. In addition, the hydrogeomorphic assessment for the refuge (Heitmeyer et al. 2009) can be provided on request.

Climate

The climate of the Benton Lake Refuge is semiarid continental, which is characterized by cold, dry winters and warm, dry summers. Subzero weather normally occurs several times during a winter, but the duration of cold spells typically lasts only several days to a week after which it can be abruptly terminated by strong southwesterly Chinook winds. The dynamic Chinook winds often prohibit large accumulations of snow over winter and reduce large spring runoffs because snow melts in smaller increments throughout winter and is mostly absorbed into the ground.

During the period of record at Great Falls, the average annual precipitation is 14.98 inches. Yearly precipitation extremes have ranged from 25.24 inches in 1975 to 6.68 inches in 1904.

Long-term temperature and precipitation data show dynamic patterns of recurring peaks and lows on a 10- to 20-year cycle (NOAA 2009), depicted in figure 16. Regional precipitation decreased and temperatures rose from the late 1910s to the late 1930s. A steady rise in precipitation and declining temperatures occurred from the early 1940s to the mid-1950s followed by another decline in precipitation and local runoff in the 1960s. Precipitation rose again during the late 1970s and early 1990s, and remained about average during the 1980s and late 1990s to early 2000s. Currently, the region appears to be heading back into a wet cycle, with 2010 being the wettest year since 1993 (NOAA 2011a).

Climate Change

Although temperature increases over the next several decades appear inevitable, the resulting effect on precipitation, moisture and wetland hydroperiods is highly uncertain. Some modeling has suggested that there could be shifts of highly favorable water and cover conditions for waterfowl breeding if precipitation does not increase along with temperatures (Johnson et al. 2005, Johnson et al. 2010). However, other researchers have found that precipitation

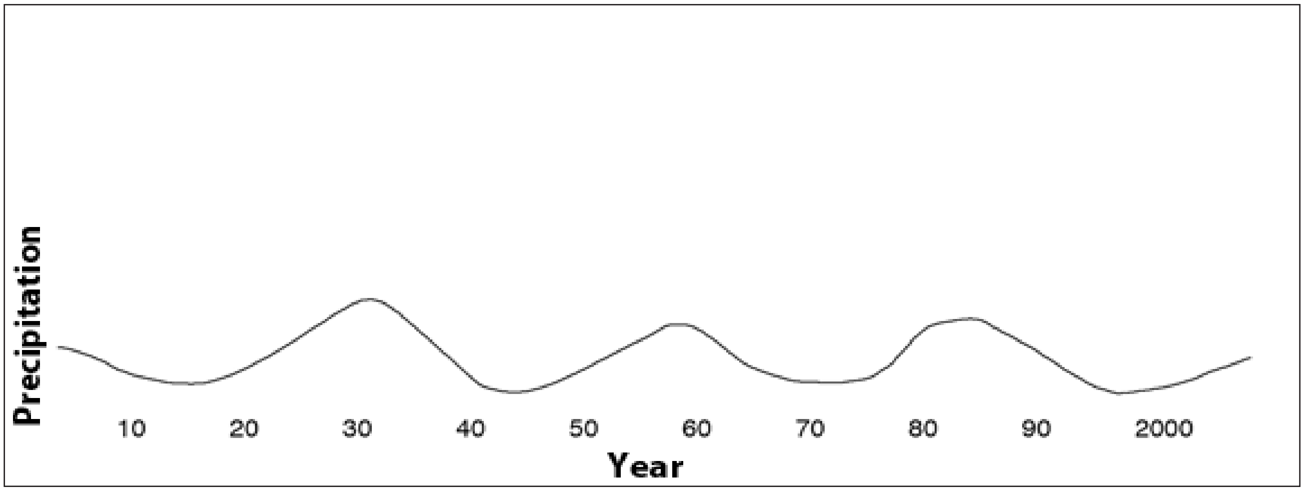

Figure 16. Model of long-term dynamics of water levels in Benton Lake, Montana. Source: USFWS and NOAA 2008.

and temperature alone were insufficient to explain annual wetland water conditions in the PPPLCC's Prairie Pothole Region when compared to a dataset of 40,000 basins spanning 1998–2007 and expressed concern about using climate change models that were calibrated with just a few wetlands (Niemuth et al. 2010). In addition, the natural variation in wet–dry cycles in the PPPLCC's Prairie Pothole Region may eclipse any smaller, climate-change driven shifts that occur in the near term (Niemuth et al. 2010).

Geology

Detailed geologic mapping has been completed for the Benton Lake area (Maughan 1961, Lemke 1977, Maughan and Lemke 1991). The Benton Lake basin is characterized by gently dipping sedimentary bedrock formed during the Cretaceous period (145–65 million years ago) overlain in many places by deposits from glaciers and streams from the last ice ages (Maughan 1961). The ancient sedimentary bedrock that lies beneath the Benton Lake basin is important because of the effect it has on water quality today as a source of selenium. Bedrock in most of the Benton Lake basin is seleniferous marine shale of the Cretaceous Colorado Group, often referred to as Colorado Shale (Maughan 1961).

During the last Pleistocene ice sheet, Glacial Lake Great Falls covered low-lying parts of the Benton Lake region. Glacial lake deposits near Benton Lake are primarily clay and silty clay and are up to 100 feet thick (Lemke 1977). Glacial drift associated with the last ice sheet was deposited northeast of Benton Lake and east of Priest Butte Lakes and formed the closed Benton Lake basin.

Most geomorphic surfaces on the current Benton Lake bed are deposits from Glacial Lake Great Falls. A second surface of local stream and sheetwash deposits cover a small area along the Lake Creek drainage on the north, and a small tributary drain on the southwestern side of Benton Lake. These deposits were formed by overbank deposition and scouring of sediments along the drainages that entered Benton Lake and resemble small natural levees and alluvial and colluvial fans that are 2–8 feet higher in elevation than the adjacent Benton Lake bed. These elevated geomorphic surfaces have been converted from the highest and driest part of the basin to the deepest and wettest units on the refuge (Units 1 and 2).

Within Benton Lake proper, elevation gradients are relatively subtle ranging from about 3,614 feet amsl in the lowest depressions in the middle of the historical lakebed to about 3,622 feet amsl on the edge of the lake that defines its full-pool water level (figure 17). A detailed elevation map of the south part of Benton Lake prepared in the early 2000s indicates several deeper depressions historically were present in the lakebed, and likely reflected glacial scouring when the basin was created. Uplands terraces on the refuge range from about 3,622–3,850 feet amsl.

Soils

Surface soils at the refuge are predominantly clays and silty clays (Vertisols) deposited in the lake-system environments of glacial Lake Great Falls and Benton Lake. The Benton Lake bed and surrounding lower elevation areas are mostly plastic clays and exceed 100 feet deep under parts of Benton Lake. These are Pendroy, Thebo Vanda and Marvan clays (NRCS 2011c). In the area where Lake Creek enters Benton Lake, soils are mostly silt and sand with minor clay and gravel present in soil stratigraphy.

Thickness of these soils range from 10 to 40 feet where they become intermixed with underlying lake-system-type deposits. Higher elevation terrace-type soils along the western and southern edges of Benton Lake are mostly 10–30 feet thick silty clay loam types overlying reddish-brown, poorly sorted sand and gravel dominantly of subangular to slabby sandstone and subrounded quartzite, shale, granite, and argillite (Maughan and Lemke 1991). Some of these surfaces have interesting, stratified soils indicating various depositions from historical marine environments, Glacial Lake Great Falls, and underlying Colorado Shale (Condon 2000).

Water Resources

Benton Lake lies within a closed basin (figure 18). For the first 30 years of the refuge history, the refuge was not staffed and the hydrological regime in Benton Lake mirrored seasonal and long-term regional precipitation patterns (Nimick 1997, Heitemeyer et al. 2009). During this time, Lake Creek provided much of the water input to Benton Lake while runoff from local drainages surrounding the lake and onsite precipitation provide the remainder. Since 1961, the refuge also receives water inputs via water pumped from Muddy Creek in the adjacent watershed.

Lake Creek is an intermittent, ephemeral, stream with greatest flows during spring and early summer following snowmelt and increased spring rains (Nimick 1997). Water is assumed lost from the wetlands solely by evaporation, which averages about 40–41 inches per year Soil Conservation Service 1970). Nimick and others (1996) concluded that little water is lost from Benton Lake to ground

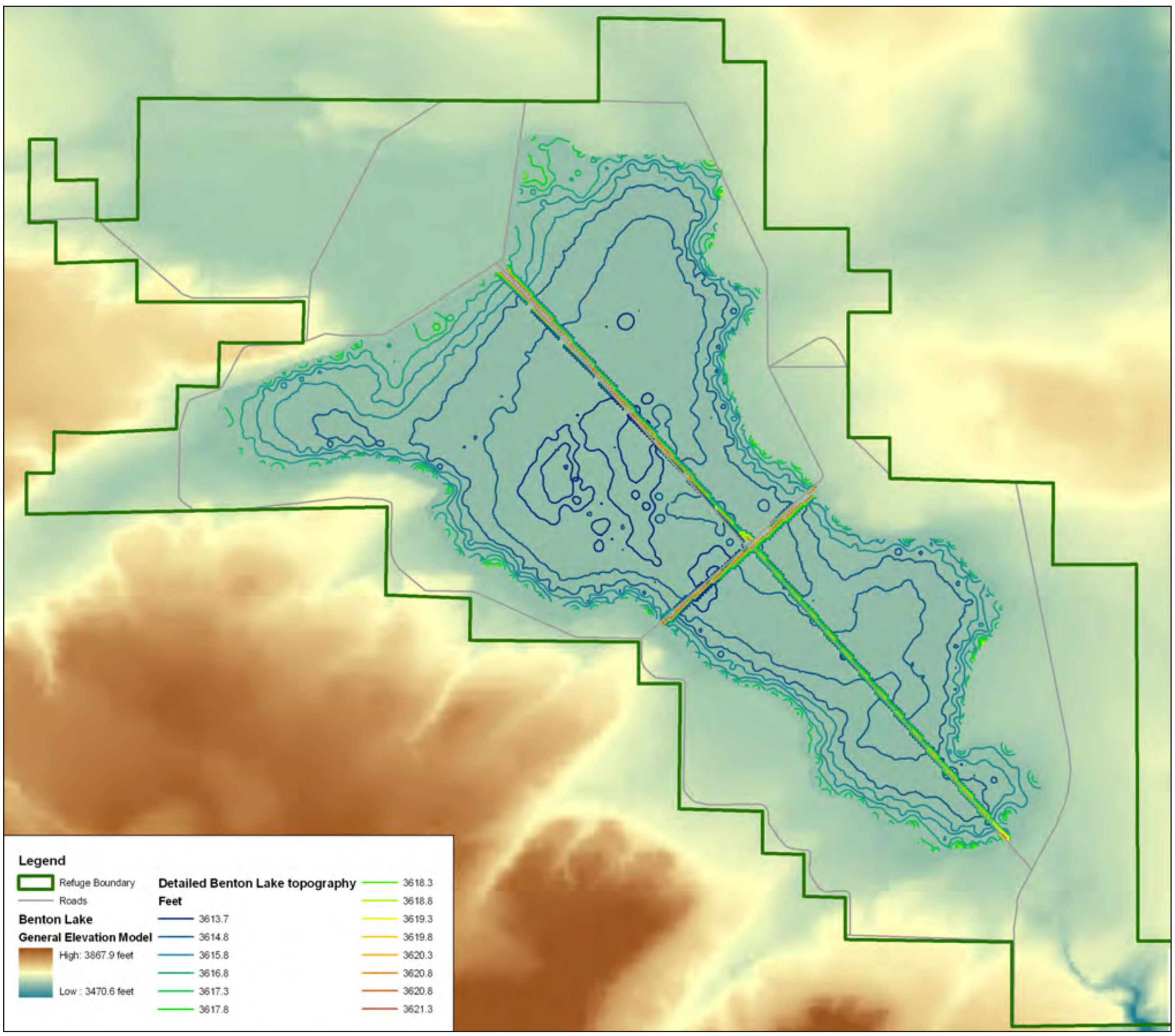

Figure 17. Map of the topography of the Benton Lake National Wildlife Refuge, Montana.

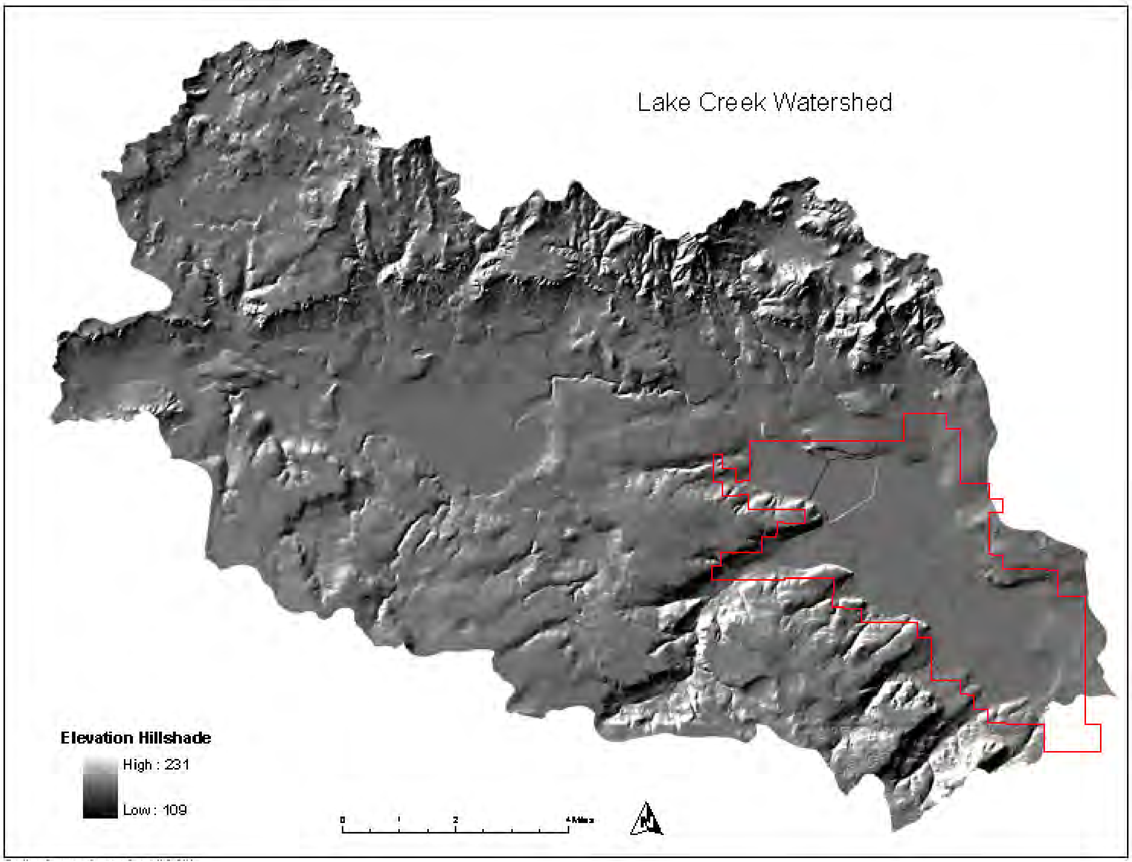

Figure 18. Map of the Lake Creek watershed, Montana.

water because of the relatively impermeable glacial-lake sediment that underlies the wetlands.

Inputs from natural runoff and precipitation are highly dynamic and have a strong seasonal pattern. These inputs are highest in spring and early summer, followed by gradual declines during summer and fall. The wetland units typically are completely ice covered from mid-to-late November through mid-to-late March. Major spring snowmelt events during March and April are infrequent, but can create several thousand acre-feet of runoff when the weather first warms. The highest rainfall months are May and June, which produce smaller runoff events, typically a few hundred acre-feet. Total annual natural runoff has varied from 0–19,200 acre-feet since 1970 (table 31).

Table 31. Annual amounts of pumped water, natural runoff, and selenium entering Benton Lake, 1970–2010.

Year	*Pumped water (acre-feet)*	*Runoff (acre-feet)*	*Estimated pumped selenium (pounds)*	*Estimated natural selenium (pounds)*	*Total estimated selenium (pounds)*
1970	3,670	3,000	50	122	172
1971	6,371	0	87	0	87
1972	9,079	990	123	40	164
1973	6,643	0	90	0	90
1974	5,897	334	80	14	94
1975	0	13,933	0	568	568
1976	2,978	400	40	16	57
1977	4,167	0	57	0	57
1978	0	19,200	0	783	783
1979	68	12,100	1	493	494
1980	2,000	1,100	27	45	72

Table 31. Annual amounts of pumped water, natural runoff, and selenium entering Benton Lake, 1970–2010.

Year	*Pumped water (acre-feet)*	*Runoff (acre-feet)*	*Estimated pumped selenium (pounds)*	*Estimated natural selenium (pounds)*	*Total estimated selenium (pounds)*
1981	3,650	500	50	20	70
1982	3,037	4,132	41	168	210
1983	2,822	1,763	38	72	110
1984	4,790	1,947	65	79	144
1985	6,380	1,157	87	47	134
1986	3,376	4,759	46	194	240
1987	7,987	350	109	14	123
1988	7,517	208	102	8	111
1989	212	9,710	3	396	399
1990	4,797	1,056	65	43	108
1991	8,028	943	109	38	148
1992	7,276	21	99	1	100
1993	1,932	3,049	26	124	151
1994	5,800	227	79	9	88
1995	5,555	344	76	14	90
1996	3,969	846	54	34	88
1997	4,430	2,245	60	92	152
1998	5,693	622	77	25	103
1999	5,033	122	68	5	73
2000	5,385	54	73	2	75
2001	5,082	51	69	2	71
2002	3,975	610	54	25	79
2003	3,868	4	53	0	53
2004	3,985	73	54	3	57
2005	2,730	422	37	17	54
2006	3,951	827	54	34	87
2007	3,542	486	48	20	68
2008	4,204	673	57	27	85
2009	4,866	1,730	66	71	137
2010	3,069	3,433	42	140	182
Mean	4,337	2,264	59	92	151
Median	4,167	673	57	27	94
Total	177,814	92,833	2,417	3,785	6,202

Source: unpublished records on file at Benton Lake Refuge; Nimick et al. 1996.

In 1957, money was secured to construct pumping and water delivery structures from Muddy Creek to the refuge with support from members of the Cascade County Wildlife Association. A pump station (figure 15) and pipeline were constructed from 1958–62 to bring irrigation return flows in Muddy Creek from the central and northeast parts of the Greenfields Bench to the refuge. The first water pumped to Benton Lake from Muddy Creek occurred in 1962. Water from the Muddy Creek pump station is moved about 5 miles through an underground pipeline over a low-drainage divide and then is discharged into the natural Lake Creek channel where it flows for about 12 miles to its mouth in Benton Lake. Pumping from Muddy Creek has corresponded to times of irrigation return flow in the Greenfields Irrigation system and is generally from May until mid-October. The Benton Lake Refuge has rights for up to 14,600 acre-feet of water from Muddy Creek each year depending on adequate flows in the creek (Palawski and Martin 1991). Water from Muddy Creek is free, but the refuge must pay electrical costs for the three pumps (two 350-horsepower and one 250-horsepower).

Natural runoff in the intermittent Lake Creek typically occurs from March through June and averages about 0.1 cfs except during periods of snowmelt and heavy precipitation. During July and August, Lake Creek normally is dry except when summer thunderstorms cause brief periods of flow. Without pumped water, Lake Creek would also be dry in September and October most years. In contrast to natural runoff and instream flows in Lake Creek, streamflow during periods of pumping generally ranges from 30–42 cfs when the three Muddy Creek pumps are run simultaneously. The full capacity of the three pumps is used only when streamflow in Muddy Creek is augmented sufficiently by irrigation drainage within the Greenfields Irrigation Division.

Water Management

Managing water at the refuge is complex because of the unpredictability of the timing and volume of inflows from natural runoff and the inability to drain most units. In addition, the flooding and drying must be managed individually for each unit to achieve refuge objectives. The amount of water pumped is decided annually and is governed, in part, by natural runoff received that year, the timing and amount of flows in Muddy Creek due to management by Greenfields Irrigation District and availability of money in the refuge budget for electricity to run the pumps. The greatest theoretical pump capacity is 41.5 cubic feet per second, or 82.3 acre-feet per day. Typically, sufficient water is available in Muddy Creek for pumping between May 1 and October 31. Pumping may be possible earlier in the season after ice has melted; however, lower flows significantly increase the cost per acre-foot and consequently may reduce the total volume of water that can be pumped with a given year's pumping budget.

Historically, the volume of water pumped to Benton Lake was calculated from the hours of pump operation, the rated capacities of the three pumps, and monthly changes in unit water levels. Since 1991, the volume of pumped water also has been measured at the Lake Creek gauging station and reported in annual water-use reports. Added diffuse runoff flowing from ungauged parts of the Benton Lake basin continued to be estimated from changes in unit water levels.

The amount of natural runoff into Benton Lake and water pumped from Muddy Creek has varied substantially since the pump station was developed. For example, natural runoff has varied from 0 (1971, 1973, 1977) to 19,200 (1978) acre-feet and pumped water has ranged from 0 acre-feet during the very wet years of 1975 and 1978 to 8,028 acre-feet in 1991. Because of this wide range of variability, simple long-term averages can be misleading. For example, during a relatively wet period, mean annual natural runoff into Benton Lake was 3,361 acre-feet during 1970–93, while pumped water averaged 4,278 acre-feet. During a dry period from 1994 to 2007, an average of only 495 acre-feet of natural runoff entered Benton Lake from the Lake Creek watershed, while an average of 4,500 acre-feet of water was pumped from Muddy Creek.

Water management is constrained by the current infrastructure capabilities. Smaller amounts of natural runoff flow from the surrounding drainages into Units 3, 4a and 6, but most natural runoff, and all pumped water, enters the refuge via Lake Creek into Unit 1 (figure 15). From there, water flows into Unit 2. From Unit 2, water can be directed to Units 4a, 4b, and the interunit canal. Water that is directed to the interunit canal flows via gravity to the south end where it can be directed into Units 3, 4c, 5, and 6. A water control structure allows water to flow from Unit 4c to Unit 4b. Currently, there is not functional infrastructure to dry out the lower units (Units 3–6) by any means other than evaporation. An interunit pump has been used in the past on the refuge, but equipment failures, unexpected precipitation, and the topography of the wetland units prevented full dewatering.

Water management has typically sought to flood some wetland units predictably, and consistently, each year to provide breeding and migration habitat for waterbirds (Annual Narratives, 1961–99) (figure 19). This water management has varied among years and has significantly altered natural hydrological regimes, both seasonally and long term, in Benton Lake proper. Except in years of exceptional natural runoff, water has been pumped into Benton Lake in late-August through October since 1962 to provide water for fall migrant waterfowl and to store water in units for the next spring. If necessary, water from Muddy Creek is also pumped into Benton Lake from mid-April to mid-June to raise water levels in the units for waterbird reproduction (Nimick 1997, USFWS 1961–99). From 1962 through the late 1980s, some water was pumped to the refuge during the summer in most years to support water levels in the management units; however, in the last 20-plus years, the pumps generally have not been run during summer, and water levels in units have receded from evapotranspiration.

Units 1 and 2 traditionally have been managed for more permanent water regimes and water storage. Water levels in the deepest parts of these units are more than 3 feet deep in some areas. Water from Lake Creek enters these units first and, with current water control infrastructure, year-round storage of water is considered most efficient in these units. In addition, these units have not experienced large botulism die-offs during the summer, and therefore can provide brood-rearing habitat for waterbirds (see wildlife disease section).

Depending on annual water availability and management objectives, some or all of Units 3–6 have been flooded seasonally or for longer periods. From 1962 to the mid-1980s, water was typically moved into these units in spring and held at higher, more completely flooded, levels through the summer to provide nesting and brood rearing habitat for waterfowl and other waterbirds. For example, Unit 3 was managed for year-round inundation from 1964 to 1975 (USFWS 1961–99). In the last 20-plus years, water moved into these units in spring has not been supplemented with summer pumping and water levels have gradually receded until fall pumping begins. This gradual change in water management represented an evolution in learning that deep, season-long flooding was not meeting refuge objectives, especially in the lower units (Units 3–6) and that shallower, seasonal flooding encouraged more desirable emergent wetland vegetation and helped reduce the incidence and severity of botulism outbreaks (USFWS 1961–99) (see wildlife disease section).

Selenium and Water Quality

In 1983, incidents of mortality, physical abnormalities, and reproductive failures in waterfowl were discovered by the Service at the Kesterson National Wildlife Refuge in the western San Joaquin Valley, California, where irrigation return flows had been impounded to form wetlands. Selenium was detected in high concentrations in the irrigation water used to flood impoundments. Subsequently, the severity

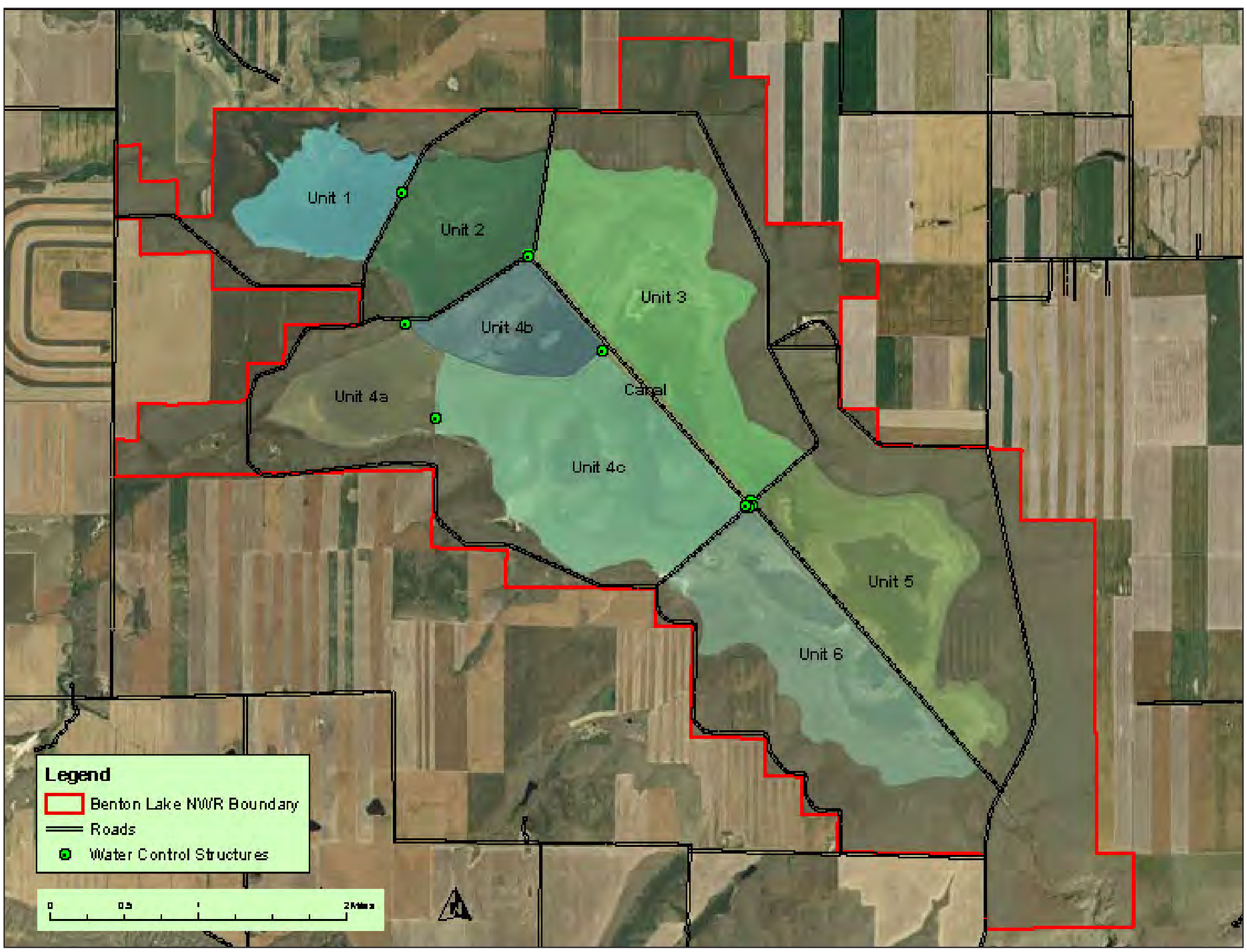

Figure 19. Water management pools on the Benton Lake National Wildlife Refuge, Montana.

of the situation required the Kesterson Refuge to "cap" (fill in) the wetland.

During this period, potentially toxic trace elements and pesticide residues were detected in other areas in Western States that receive irrigation return flows (Nimick et al. 1996). Because of similar geologic and hydrologic characteristics in many irrigated areas of the Western United States, there was concern that potentially toxic conditions related to selenium or other contaminants in return flows might not be limited to the Kesterson area. To address this concern, the DOI began the National Irrigation Water Quality Program in 1985 to evaluate whether irrigation-related problems existed at other irrigation projects the Department constructs or manages including national wildlife refuges or other wetland areas.

The Sun River area of west-central Montana was selected in 1986 for a DOI reconnaissance study. The study found that most sampling sites within the Greenfields and Fort Shaw Divisions of the Sun River Irrigation Project had constituent concentrations that were below established criteria for the protection of humans, fish and wildlife (Knapton et al. 1988). However, several sites within Freezeout Lake Wildlife Management Area and the Benton Lake Refuge had selenium concentrations in water, bottom sediment, and biota that were associated with biological risk and moderately to considerably higher than regional background values or reference concentrations.

Selenium (Se) is a semimetallic trace element that is an essential nutrient for animals. However, there is a very narrow margin between nutritionally optimal and potentially toxic dietary exposure for vertebrates. Based on the known margins of safety between normal and toxic dietary exposures, selenium is more poisonous than either arsenic or mercury (DOI 1998). Relatively small increases in the dietary exposure of animals is potentially harmful. A general rule of thumb for selenium is that thresholds for adverse effects in vertebrate animals begin at concentrations less than ten times above normal, although immunotoxic effects have been documented at concentrations less than 5 times above normal levels. Reproduction in vertebrates is particularly sensitive to selenium toxicity, especially in egg-laying vertebrates such as birds (DOI 1998). Birds are also vulnerable because selenium bioaccumulates through the food chain (Lemly 1995, 2002).

The underlying geology, land use changes in the landscape surrounding the refuge, and alterations to natural hydrology (water source, timing, and duration of flooding) have all contributed to the increased selenium levels on the refuge (Lemly and Smith 1987, Lambing et al. 1994, Nimick et al. 1996). Bedrock in most of the Benton Lake basin is seleniferous marine shale of the Cretaceous Colorado Group, often referred to as Colorado Shale (Maughan 1961). Selenium in these formations is highly mobile and biologically available in arid regions with alkaline soils, as is the case in much of north-central Montana.

The crop–fallow method of wheat farming that surrounds the refuge is the primary contributor to saline seep development in the watershed. Seeps are formed during fallow periods when precipitation exceeds the storage capacity of the soil. The excess water percolates through salt-laden soil layers dissolving salts and eventually forming a saline water table above a deeper, impermeable layer, such as shale. The saline water then moves horizontally downslope until it discharges at the surface, where it evaporates and concentrates salts, including selenite (Se4+) and selenate (Se+6), in the immediate area (Brown et al. 1982). Runoff that flows through these areas in the Lake Creek watershed washes selenium and other concentrated salts into Benton Lake at the bottom of the watershed, where it accumulates (figure 20).

Construction of the multiple units and introduction of Muddy Creek water via pumping has also increased total selenium accumulation on the refuge (Zhang and Moore 1997, Heitmeyer et al. 2009). Before 1961, Benton Lake was one large wetland and no water was pumped into the basin. In most years, pooled water from spring runoff was lost to evaporation during the following summer. Selenium concentration pre-1961 sediment collected in cores from the Unit 3 inlet area was approximately 0.2–0.3 micrograms per gram (µg/g). This low concentration of selenium in older sediment suggests that equilibrium concentrations were very low before construction of the unit system.

After the unit system was constructed in 1961, and Muddy Creek water was pumped into the refuge, inputs of selenium increased and outputs decreased. The total pounds of selenium that enter the refuge annually in pumped water and natural runoff is highly variable among years (table 31). From 1970–2010, the total selenium load from natural run-off was approximately 3,785 lbs. Pumping from Muddy Creek imported an added 2,417 lbs. to the refuge.

Although selenium is transported to the refuge in the surface and ground water that flows to the refuge, almost all of the selenium that enters the refuge accumulates in wetland sediment. Selenium is not evenly distributed among or within the units, but rather accumulates more rapidly near the locations of primary selenium inputs and more permanently flooded units (Zhang and Moore 1997). In general, selenium concentrations in sediments are highest where Lake Creek enters Unit 1 and 2 and in Unit 4c near a large seep. The remaining units in the refuge receive less selenium inputs, because they are further from the mouth of Lake Creek (Knapton et al. 1988, Nimick et al. 1996, Zhang and Moore 1997).

The natural dry cycle, which is important for removing selenium from the system, also has been significantly reduced since pumping began. Selenium is removed from the refuge primarily by transferring directly to the air from water or sediment (volatilization). The rate of selenium volatilization depends on the form of selenium, microbial activity, and various environmental conditions, but is much higher from exposed sediment than open water (Zhang and Moore 1997). Selenium now enters the refuge in Unit 1, which is rarely dried, and consequently average selenium concentrations in sediment are 2.7 µg/g, with some values above the toxic threshold of 4 µg/g.

Selenium Toxicity at Benton Lake

The toxic threat to wildlife from selenium is based on the degree of contamination present and the extent of exposure. The method used in this CCP to assess selenium contamination and the toxic threat to aquatic systems is a simple, scientifically credible process developed by A. Dennis Lemly (1995,2002). The Lemly protocol incorporates key parameters such as concentration, exposure and abiotic and biotic cycling. By using this protocol, refuge staff can develop an overall hazard value that can be compared across sites and over time. This hazard assessment focuses on bioaccumulation and its ultimate impact on reproductive impairment in aquatic birds.

The protocol defines five hazard levels:

- High: a toxic threat sufficient to cause complete or nearly complete reproductive failure in sensitive species of aquatic birds (for example, ducks and stilts).
- Moderate: a toxic threat of sufficient magnitude to substantially impair, but not remove reproductive success; some species will be severely affected while others will be relatively unaffected.
- Low: a toxic threat that could marginally affect the reproductive success of some sensitive species, but leave most species unaffected.

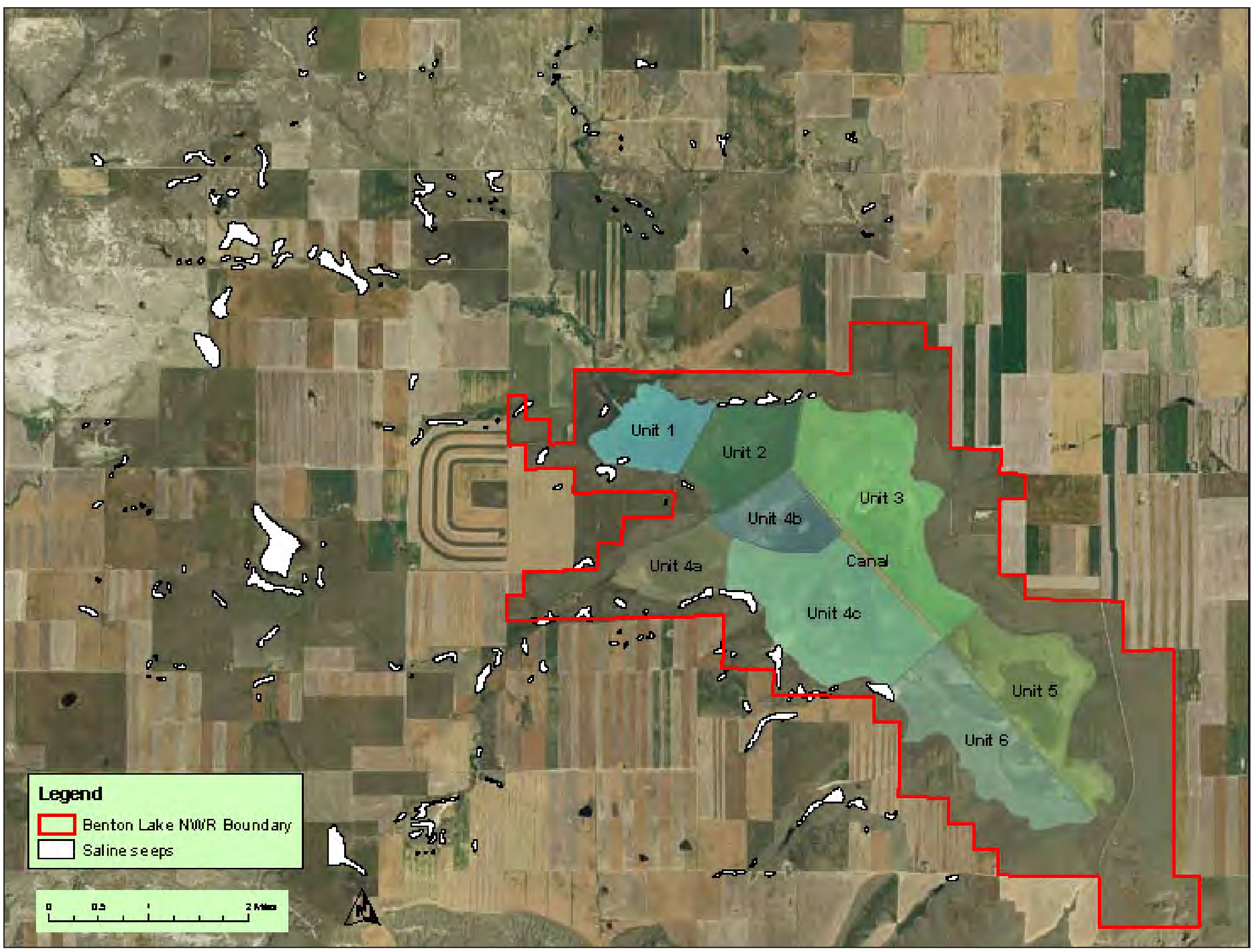

Figure 20. Map of saline seeps in the Benton Lake region, Montana.

- Minimal: no imminent toxic threat is identified, but concentrations of selenium are slightly elevated in one or more ecosystem components (water, sediment, benthic invertebrates, birds).
- None: no toxic threat is identified and selenium concentration are not elevated in any ecosystem component.

To conduct a hazard assessment, samples must be collected from multiple ecosystem components. This includes water, sediment, invertebrates and aquatic bird eggs. Selenium hazard has been defined independently for each component. These values are based on extensive studies, in a wide range of habitats and environmental conditions (table 32).

Table 32. Lemly Hazard Assessment score by component.

Hazard	*Score*	*Water (ug/l)*	*Sediments (ug/g)*	*Macroinvertebrates (ug/g)*	*Aquatic bird eggs (ug/g)*
None	1	<1	<1	<2	<3
Minimal	2	1-2	1-2	2-3	3-5
Low	3	2-3	2-3	3-4	5-12
Moderate	4	3-5	3-4	4-5	12-20
High	5	>5	>4	>5	>20

The "scores" for the sample with the highest selenium concentration in each component is then combined to get an overall hazard rating:

- No hazard = 4
- Minimal hazard = 5-7
- Low Hazard = 8-10
- Moderate Hazard = 11-14
- High hazard = 15-20

The method is not simply additive, but considers multiple routes of exposure and synergistic effects. Across all of the alternatives for Benton Lake Refuge, the service has designated "minimal" hazard as the objective for future management.

The highest concentrations of selenium that can occur in various ecosystem components for which no toxic threat is associated has been described by Lemly (1995, 2002). For water this is less than 2 µg/l, sediment less than 2 µg/g, macroinvertebrates less than 3 µg/g, and aquatic bird eggs less than 5 µg/g. Many samples from several years have found selenium concentrations higher than these thresholds for each of these ecosystem components at the refuge (Nimick et al. 1996, 2006–8, Henny et al. 2000) (figure 21). These values can be combined to create an overall hazard assessment for a given area, such as individual units on the refuge (Lemly 1995, 2002).

In 2006, water, sediment, invertebrates, and wetland-dependent bird eggs were sampled from Unit 1, 3, 5 and the seep in Unit 4c to get an updated hazard assessment for the refuge (table 33). These units were chosen to capture the high and low ends of selenium contamination in the wetland. Samples were taken within units at a subset of the same sampling sites used in earlier studies (Zhang and Moore 1997). In cases where multiple samples were taken in a unit, such as sediment and eggs, the highest selenium value was used to be the most conservative (not likely to underestimate) in assessing the threat. In Unit 1, where natural runoff and pumped water enter the refuge via Lake Creek, there was a high hazard level. Selenium concentrations were low in the water and eared grebe egg, but high in the sediment and invertebrate samples. The results of the Lemly assessment at the seep next to Unit 4c showed that this area also has a high overall hazard. Selenium concentrations were high in water and sediments, but the gadwall egg sampled from this area had a very low selenium level. The other two units, 3 and 5, had low overall hazard levels, respectively, reflecting the distance of these units from the selenium inputs and the benefit of seasonal drying (Zhang and Moore 1997).

The highly hazardous conditions found at the seep next to Unit 4c were not surprising given that seeps are primary sources of selenium contamination in the Lake Creek watershed and on the refuge (Nimick et al. 1996, Nimick 1997). A hazard rating of high means an "imminent, persistent toxic threat sufficient to cause complete reproductive failure in most species of fish and aquatic birds" (Lemly 1995, 2002). The selenium concentration in the water in 2006 (33.8 µg/g) was within the wide range of concentrations (10–500 µg/L) found during earlier studies (Knapton et al. 1988, Nimick 1997). Selenium concentrations in the sediment and invertebrates were similar to earlier samples (Knapton et al. 1988, Lambing et al. 1994, Zhang and Moore 1997). Interestingly, the gadwall egg sampled from this area had such low selenium concentration that Lemly considers it no threat. This suggests that even though

Table 33. Lemly Hazard Assessment Results for four sites at the Benton Lake National Wildlife Refuge. Contamination hazard levels are assigned to each of four trophic levels sampled at each site between May 15 and July 15, 2006. The overall hazard level is figured out by combining the individual hazard assessments according to Lemly (1995,2002).

Trophic level	*Unit 1*	*Unit 4c seep**	*Unit 3*	*Unit 5*
Water (micrograms/liter (µg/L))	2.2	33.8	0.56	2.2
Hazard	Low	High	None	Low
Sediment (micrograms/grams dry weight (µg/gDW))	4	20.3	0.32	1.09
Hazard	High	High	None	Minimal
Invertebrates (µg/gDW)	7.65	4.01	2.14	1.75
Hazard	High	Moderate	Minimal	None
Bird species, egg (µg/gDW)	Eared grebe 8.71	Gadwall 1.86	Teal 3.19	American Avocet 5.32
Hazard	Low	None	Minimal	Low
Overall hazard	High	High	Minimal	Low

*sampled at seep only

there are acutely hazardous conditions in the immediate area of the seep, birds probably spend a very small percentage of their time in the seep area and the hazards are mitigated by their feeding primarily in other units, such as in Units 3 and 5, which are nearby and have lower levels of selenium. In 2006, most of Unit 4c that is next to the seep had been dry for several years, which would limit mixing between the seep and the wetland unit and reduce the influence of the seep on avian reproduction.

The high hazard level in Unit 1 is of greater concern. Unit 1 is a large wetland that can exceed 750

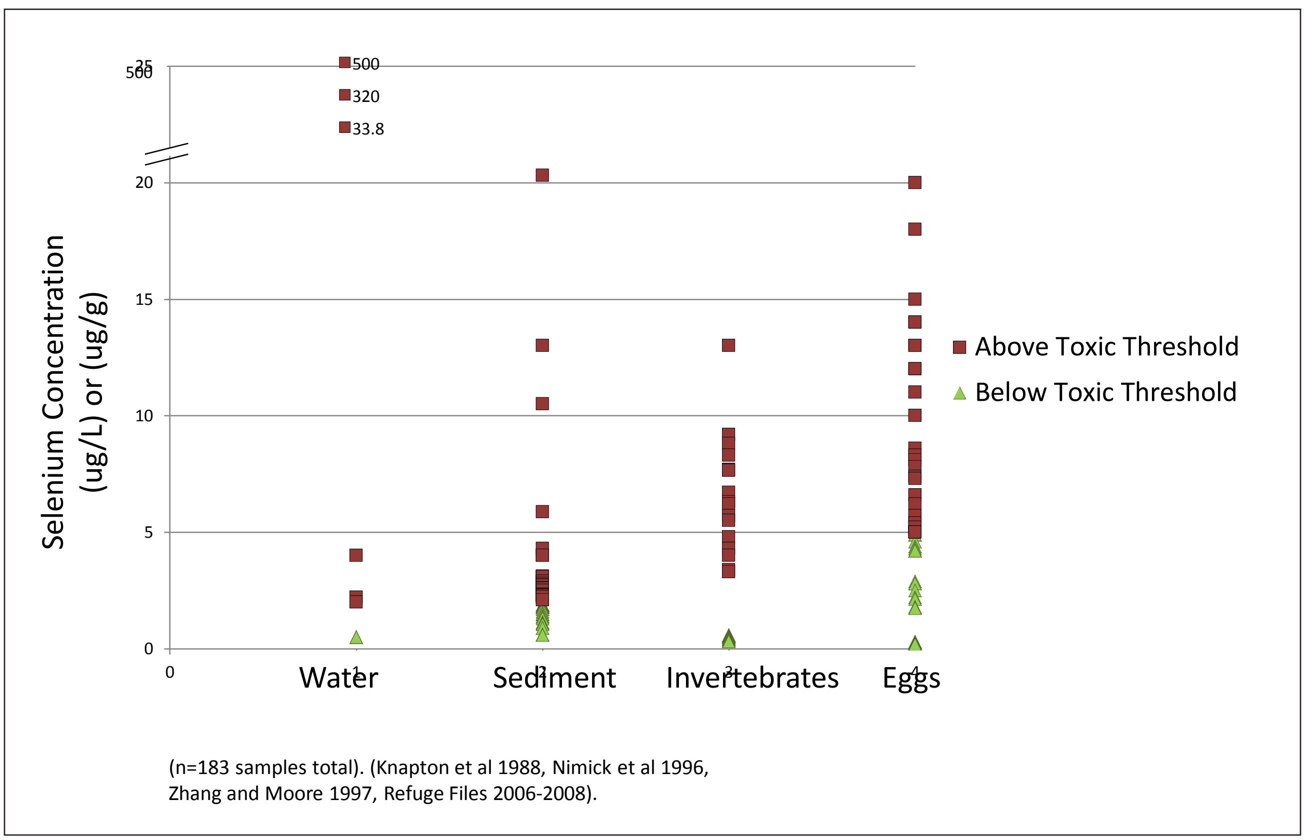

Figure 21. Graph showing the range of selenium concentrations from water, sediment, invertebrates, and egg samples across Benton Lake National Wildlife Refuge, 1986–2008.

acres at full-pool levels. The high threat level was primarily due to selenium concentrations in the sediment and invertebrates, while all other trophic levels had low concentrations. In particular, selenium concentrations in eared grebe eggs were low, which is the trophic level of greatest concern for managers. Because of this, it is tempting to downplay the overall high hazard level except that the Lemly protocol is based on the understanding that the toxic effects of selenium are interactive and best characterized by considering all of the trophic levels simultaneously.

Selenium Modeling

A model of selenium cycling (Zhang and Moore 1997) was developed for the refuge to understand the dynamics of selenium accumulation on the refuge and predict outcomes for various management scenarios. The main selenium reservoirs on the refuge are the sediment and water. Sediment is considered highly hazardous when average concentrations for a unit exceed 4 µg/g (Skorupa and Ohlendorf 1991, Lemly 1995, 2002). With the assumption that the input and output of selenium to the refuge was similar to the long-term average, and starting with selenium levels measured in 1994, the original model runs predicted that Units 1 and 2 would exceed this hazard threshold in 9 years (2004) and 17 years (2012), respectively. Due to the annual drying of the lower units, Units 3, 5 and 6 would never cross the toxic threshold. Unit 4, because of adjacent saline seeps, was predicted to cross the threshold in 67 years despite annual drying.

In 2006, mean selenium levels measured in sediment samples from Unit 1 (2.3±0.3 µg/g) had not yet reached the toxic threshold of 4 µg/g. To be sure this discrepancy was not due to sampling error, in 2008 the sediment in Unit 1 was resampled to target the upper 0.8 inch, which is the most sensitive to selenium accumulation, increase the 2006 sample size, and to capture all of the same locations sampled in 1994. The actual 2008 mean value was 2.7±0.2 µg/g, which was still below the 5.4µg/g predicted for 2008 in the original model.

The model was reevaluated to find the cause of the discrepancy. The original model runs assumed selenium inputs in the future would be similar to the long-term average up to that point (1970-1993); however, 1994–2007 was a dry period and natural runoff was only 14 percent of this long-term average (495 acre-feet versus 3,615 acre-feet). When the model was run again with all of the same starting data from 1994, but with only 14 percent of the selenium inputs, the predicted values for 2008 were closer to those actually measured in the field (model =3.5 µg/g, 2008 field samples = 2.7 ± 0.2 µg/g).

These results suggest that the model is strongly influenced by inputs but somewhat overestimates the rate of accumulation of selenium. When natural runoff and selenium inputs increase during the next wet cycle, which appears to have begun in 2009, selenium accumulation is expected to increase again. Units 1 and 2 may have a few more years than the 9 and 17 years originally predicted by the model before they become highly toxic. However, it may actually be fewer years, because the mean selenium concentration in the upper 0.8 inch of sediment of Unit 1 was 60-percent higher in 2008 than the original model values in 1994 (Zhang and Moore 1997). Regardless, if there is no change in management, the toxic threshold is still likely to be crossed in these units soon enough to be of serious concern.

Selenium Remediation Efforts

An action plan, “Calming Troubled Waters,” was written in 1991 by refuge staff to address the selenium issue at the refuge. The goal of the plan was to “maintain or reduce levels of trace elements such as selenium at levels which pose no threat to species using Benton Lake” (USFWS 1991). This plan focused primarily on the watershed and the negative effect on water quality caused by the agricultural practices in the surrounding landscape. The primary strategy at that time was to clean up the refuge by cleaning up the watershed. The plan was estimated to take 5–10 years and cost $4.5 million dollars ($7.1 million in today’s dollars). The Service was successful in using a CRP incentive program to enlist five landowners in CRP contracts. In addition, the refuge collaborated with the Lake Creek Improvement Association and the Lake Creek Partnership to obtain Federal grants to improve water quality in the watershed. Seeps and recharge areas were mapped in the watershed and 27 producers signed 5-year contracts to try alternative cropping practices. The report shows that production from these crops went “as well as to be expected.” The refuge also worked with one neighbor to keep a field in a key seep recharge area in alfalfa for 5 years. Monitoring indicated that this continuous cover was effective in reducing ground water levels, which helps to dry up seeps. While these efforts resulted in short-term successes, the program ended when money for a full-time contaminants specialist and annual payments to landowners to keep their fields in cover crops was no longer available. Supporting continuous cover in the watershed in key areas, to reclaim seeps and improve water quality, requires sufficient incentives for landowners to choose this practice over current crop–fallow systems for small grains. “Calming Troubled Waters” did not consider any reduction in pumping water as a way to manage selenium levels on the refuge.

Other selenium removal approaches have been considered elsewhere. The three types of remediation commonly pursued are containment, removal, and treatment (Higashi et al. 2005). Containment has been difficult to achieve in many cases and where open-water systems are used, they are still a source of contamination to waterbirds drawn to the containment areas. Removal of selenium has been difficult, because of typically low starting concentrations and chemical similarity to sulfur, which can be present in as much as million-fold higher concentrations. One treatment choice, algal-bacterial reduction of selenate was developed to the point of large-scale trials. It removed approximately 80 percent of the selenium in water, but was found to increase concentrations of selenium in invertebrates 2–4 times. Biovolatilization is another remediation approach that takes advantage of natural biogeochemical processes, but is problematic because it draws selenium into the biota and consequently up the food chain. For example, vascular plants volatilize a relatively small amount of selenium while sequestering selenium in bio-available food web materials such as the shoots and roots. Although the shoot could be harvested and disposed of, the selenium is mostly contained in the belowground parts of the plants, which are not practical for harvesting or likely to be consumed in a prescribed fire (Higashi et al. 2005). Removal of selenium using organic materials such as rice straw has been successful in laboratory trials (Zhang and Frankenberger 2003). However, this technique has not been tested in the field to decide if it is a practical solution.

Key selenium concepts:

The underlying geology, land use changes in the surrounding watershed, increased selenium inputs from pumped water and decreased wetland drying have contributed to selenium accumulation on the refuge.

Selenium accumulates in the food chain and concentrations in the water, sediment, invertebrates and wildlife must all be considered when assessing the threat to reproduction

Selenium is not evenly distributed across the refuge. It is highest near input locations (currently Unit 1) where it accumulates in sediment. Selenium levels in Unit1 are currently high enough to impair reproduction in sensitive species.

The primary ways to reduce selenium accumulation are by exposing wetland sediment to air (such as drying) and reducing inputs by improving water quality or reductions in pumping.

Refuge specific models of selenium cycling show that highly hazardous levels of selenium could be reached in Units 1 and 2 in the next two decades.

Other Water Quality Concerns

While monitoring selenium accumulation levels has been a priority at the refuge, other water chemistry variables also have been studied (Knapton et al. 1988, Nimick 1997). A USGS study analyzed the water chemistry at the refuge, with an emphasis on dissolved solids (Nimick 1997). From 1974–95, specific-conductance values for the refuge varied substantially from year to year and over multiyear periods. However, no significant trend of increasing specific conductance was clear in the long-term record. The study concluded that accumulation of dissolved solids in the refuge appeared to be negligible. Benton Lake Refuge management that dried Units 3–6 at least 1 month per year appeared to be effective in managing salts (Nimick 1997).

Initial water quality testing during the DOI Reconnaissance Study did not find elevated levels of nutrients such as nitrogen and phosphorous (Knapton et al. 1988). However, due to the intense agriculture in both the Muddy Creek and Lake Creek watersheds, levels of these nutrients, as well as sedimentation, may be problems that have been overlooked in recent years. More studies, including an updated baseline, would be needed to assess these issues.

Water Rights

Benton Lake Refuge has two primary water rights. One is for 14,600 acre-feet of surface water from Muddy Creek (41K 188174 00) with a priority date of April 28, 1958. The other is for the natural flow in the Lake Creek drainage, including the unnamed tributaries to Benton Lake, where the drainage enters the refuge in the amount of natural flow remaining after the satisfaction of the following rights:

- all rights recognized under State law with a priority date before the effective date of the Compact

- any rights for stock watering ponds with a priority date after the effective date of the Compact and a maximum capacity of the impoundment or pit of less than 15 acre-feet and an appropriation of less than 30 acre-feet per year from a source other than a perennial flowing stream

- any right to appropriate ground water with a priority date after the effective date of the Compact by means of a well or developed spring with a maximum appropriation of 35 gallons per minute (gpm) or less that does not exceed a total appropriation of 10 acre-feet per year.

The refuge also has a ground water right to 2 acre-feet per year diverted at a maximum rate of 45 gpm from ground water beneath the Benton Lake Refuge.

The "Montana House bill 717–Bill to Ratify Water Rights Compact" (compact) is a water rights compact between the State of Montana and the Service signed July 17, 1997. The parties to this agreement recognize that the water rights described in the compact are junior to any tribal water rights with a priority date before the effective date of the compact, including aboriginal rights, if any, in the basins affected.

Biological Resources

The following narrative describes habitats and wildlife on the Benton Lake Refuge.

Grasslands

Benton Lake Refuge has approximately 5,724 acres of native and planted tame grasslands (figure 22). The native mixed-grass prairie is characterized by predominantly cool-season species on Benton Lake's clay soils. This ecological site developed under the northern Great Plains climatic conditions, geological parent materials, fire, biotic factors, and under the natural influence of herbivory. The cool-season species evolved to take advantage of the precipitation regime that peaks in late spring–early summer. Research consistently shows that precipitation is the principle factor altering productivity on ecological sites in the northern Great Plains (Heitschmidt et al. 2005).

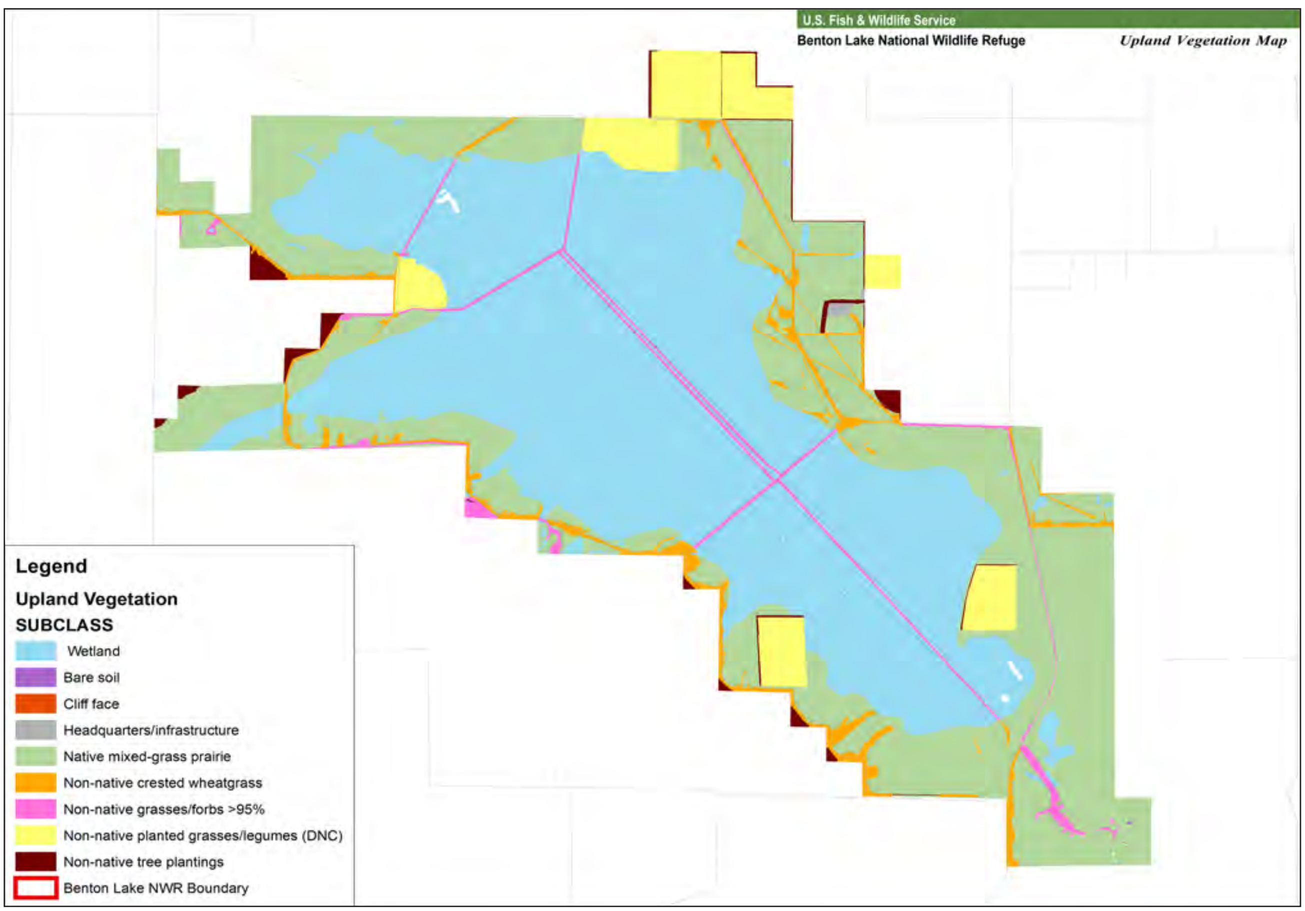

Figure 22. Map of upland vegetation at the Benton Lake National Wildlife Refuge, Montana.

The dominant plant community is represented by green needlegrass, western wheatgrass, thick-spike wheatgrass and bluebunch wheatgrass. Prairie Junegrass is the most common shortgrass. Other shortgrasses and sedges include plains reedgrass, threadleaf sedge, and needleleaf sedge. Bluebunch wheat grass is a dominant species on the clayey 10–14 inch precipitation zone site in the northern Glaciated Plains. Blue grama is the only common warm-season grass. Grasses represent about 80 percent of the total annual production in this community (NRCS 2005).

Dotted gayfeather, American vetch, white prairie clover, and purple prairie clover are forbs that commonly occur on the clayey sites. American vetch and the prairie clover are nitrogen-fixing species and valuable forage producing plants. Groundplum milkvetch, scurfpea, and prairie thermopsis are lower successional forbs that have the ability to fix nitrogen. White milkwort, biscuitroot, wild onion, and western yarrow may be present as minor components of the plant community. Forbs represent about 15 percent of the total annual production (NRCS 2005). Silver sagebrush, Nuttall's saltbush, fringed sagewort, broom snakeweed, and prickly pear cactus also may represent minor shrub components. Overall, shrubs account for about 5 percent of the annual plant production (NRCS 2005).

There are approximately 728 acres of tame grasslands on the refuge. Some of the tame grasslands were inherited as former farm ground when the refuge was established; however, there were some areas of native prairie on the refuge that were broken and seeded to tame grass in the 1960s and early 1970s. The predominant herbaceous cool-season species used were varying combinations of intermediate wheatgrass, tall wheatgrass, slender wheatgrass, pubescent wheatgrass, western wheatgrass, and crested wheatgrass; the legumes were alfalfa and sweetclover. The basic seeding rates were comprised of 75-percent wheatgrass and 25-percent legumes. These species, commonly referred to as DNC, were chosen based on research that showed that they are highly attractive and beneficial to waterfowl (Duebbert 1969). DNC fields on the refuge range from excellent to poor conditions. Most stands are in some type of rotational management scheme to rejuvenate and extend the longevity of the planting.

In the recent past, planting shelterbelts was advocated in the Great Plains as a method of increasing species diversity (Schroeder 1986 and others), particularly bird diversity. A total of 19 miles of shelterbelts have been planted on the Benton Lake Refuge. Many of the shelterbelt trees and shrubs have died, which may be the result of recent drought conditions. A few shelterbelts are in moderate condition and most shelterbelts are in poor condition relative to their potential to increase bird diversity on the refuge. The most common tree and shrub species remaining in the shelterbelts are Russian olive and caragana. Attempts have not been made to irrigate or replant the shelterbelts.

Upland Invasive Species

The refuge is generally free from highly invasive, noxious weeds. Through EDRR, early colonizing plants of spotted knapweed and leafy spurge, in particular, have been eradicated every year and prevented from spreading. Canada thistle has been present for many years on the refuge. Thistle patches are found near many roads, dikes, wetland edges, and other disturbed areas. Some dense stands have been treated with success, but most areas go untreated.

In addition to the nonnative species described in the wetland section, several nonnative species are of concern for their impact in changing the native grassland habitat, even if they are not on the State's noxious weed list.

Crested Wheatgrass

Crested wheatgrass has been the most commonly planted exotic grass in western North America since the early 1900s. Invasion of this species into native rangeland can have a negative effect on plant and wildlife diversity (Reynolds and Trost 1981, Christian and Wilson 1999, Davis and Duncan 1999). Crested wheatgrass was used to landscape areas around the refuge headquarters area in the 1960s and to revegetate roadsides and other areas of disturbance. Since then, it has spread throughout the refuge to varying degrees and covers approximately 400 acres. The refuge has begun a pilot program to evaluate the most effective methods for controlling crested wheatgrass and restoring the native vegetation.

Russian Olive

This species is adaptable in semiarid and saline environments and has been promoted as a source of food and cover for some wildlife species (NRCS 2002), particularly ring-necked pheasant. With this in mind, refuge staff planted Russian olive trees on the refuge until the 1970s. Since that time, research has shown that Russian olive and other nonnative trees fragment native prairie by causing avoidance of these areas by some nesting grassland birds and increased predation of nests, adults, and juvenile grassland-dependent birds (Delisle and Savidge 1996, Gazda et al. 2002, Helzer 1996, Johnson and Temple 1990). Fortunately, at the refuge, Russian olive trees have not spread and are generally confined to shelterbelts where they were planted or single individuals scattered on the refuge.

Japanese Brome

This grass has been present in the refuge for many years with almost no attention given to treatment. Currently efforts are underway to map and estimate the extent and density of the infestation on the refuge. The degree to which this species affects wildlife use of native prairie is unknown.

Kentucky Bluegrass

This grass has been present in the refuge for many years with almost no attention given to treatment. Currently, efforts are underway to map and estimate the extent and density of the infestation. Recent efforts in the Dakotas has shown that many areas of native sod on fee title lands in the northern Great Plains have become heavily invaded with Kentucky bluegrass, which is associated with loss of floristic and avian diversity as well as negatively affected nutrient pools, energy flows, soil invertebrate and mycorrhizal relationships, and water cycles (Murphy and Grant 2005, Grant et al. 2009).

Cheatgrass

This grass has been present on the refuge for many years with almost no attention given to treating it. It is mostly restricted to the southeast part of the refuge east of the Bootlegger Trail. It is of concern because of its interaction with fire. Prescribed fire is the primary management tool at the refuge; however, cheatgrass can readily spread after burning (Zouhar 2003). Efforts to map the infestations and to develop a preburn treatment plan are in progress.

Other nonnative species that occur in low numbers or limited extent but could become an invasive problem include smooth brome, reed canarygrass, salsify, alfalfa, and yellow sweetclover.

Wetlands and Riparian Areas

This section describes the historical conditions of the refuge's wetland vegetation and current vegetation including invasive plants.

Historical Wetland Vegetation

The historical gradation of vegetation zones within the refuge from robust emergent in deeper depressions to grasslands on uplands has been altered over time. Most historical vegetation communities are still present on the refuge, but their distribution and extent have changed. Developments for water management and subsequent altered hydrology and water chemistry in units are responsible for most vegetative changes. Generally, communities have shifted to more extensive distribution of wetter and more alkaline-tolerant species. Increasing amounts of exotic and invasive species also now occur on the refuge (Heitmeyer et al. 2009).

Historical vegetation communities on the Benton Lake Refuge ranged from dense emergent wetland vegetation in the lowest elevation depressions to upland grassland on higher elevation terraces and benches next to the lakebed. This gradation of plant communities is typical of wetland basins in the northern Great Plains of Montana (Hansen et al. 1995). Plant species distribution reflected tolerance to timing, depth, and duration of annual flooding, salinity, and underlying soils and geomorphic surfaces. (table 34). The precise distribution of historical wet

Table 34. Hydrogeomorphic matrix* of historical distribution of habitat types on Benton Lake National Wildlife Refuge, Montana.

Habitat type	*Geomorphic surface* [a]	*Soil type*	*Flood frequency* [b]	*Elevation* [c]	*Estimated acres*
Robust emergent	Ql	clay	A–PM	<3614.5	73
Sedge–rush	Ql	clay	A–SP	3614.6–3615.7	1,728
Sedge–rush alkaline	Qac	clay	A–SP	3614.6–3615.7	53
Seasonal herbaceous	Ql	silt-clays	A–SE	3615.8–3616.3	1,040
Cordgrass–saltgrass	Qac	silt-clays	A–SE	3615.8–3616.3	143
Wet grassland	Ql	silty clay	1–SE	3616.4–3622	3,167
Wet grassland alkaline	Qac	silty clay	1–SE	3616.4–3622	1,216
Upland grassland	Qt and Kbb	silty clay	R	3622	4,802

**Relationships were figured out from land cover maps prepared by the General Land Office (1920),geomorphology maps (Maughan 1961), soils maps prepared by NRCS, hydrological data (unpublished NOAA and Benton Lake Refuge records on file at Benton Lake Refuge), various accounts by naturalists and settlers, and publications from the late 1800s and early 1900s.*

[a] *Ql =Quaternary lake, Qac =Quaternary alluvium and colluviums, Qt =Quaternary terrace, Kbb = Cretaceous Bootlegger.*

[b] *A–PM =annually flooded permanent, A–SP= annually flooded semipermanent, A–SE =annually flooded seasonal, 1–SE = irregularly flooded among years seasonal, R = rarely if ever flooded.*

[c] *Feet above mean sea level.*

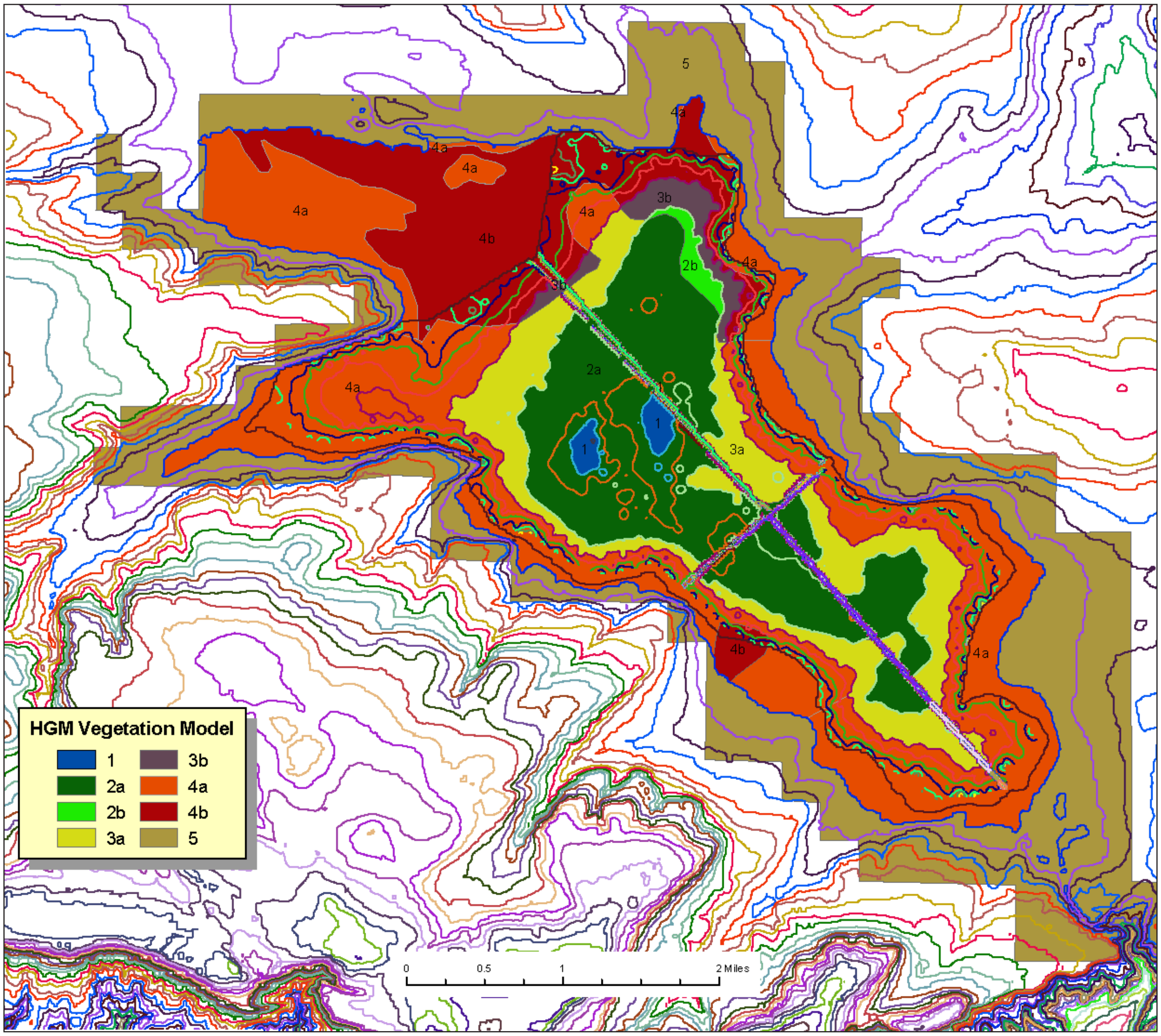

Figure 23. Map of potential historical vegetation communities on the Benton Lake National Wildlife Refuge, Montana. Vegetation community: 1=robust emergent, 2a=sedge–rush, 2b=alkaline sedge–rush, 3a=seasonal herbaceous, 3b=prairie cordgrass–saltgrass, 4a=wet grassland, 4b=alkaline wet grassland, 5=upland grassland.

land vegetation species groups in the refuge proper undoubtedly varied over time as surface water coverage and depth changed in the long-term wet to dry cycles (for example, van der Valk and Davis 1978, van der Valk 1989). The relative juxtaposition of historical plant communities occurred along a wetness continuum where specific groups expanded or contracted and moved either up or down elevation gradients as water levels rose and fell in Benton Lake basin over time. Furthermore, some communities with specific distribution associations, such as saltgrass that was associated with higher alkaline or saline conditions, also probably changed locations somewhat over time depending on the intensity and location of saline seeps as saline conditions in the lake became more or less concentrated or diluted during more extreme flooding versus drawdown phases of the long-term hydrologic cycle.

Recognizing the annual variation in flooding regimes and latent chronological and distribution response dynamics of wetland plant species to changing moisture conditions, an HGM matrix of potential vegetation communities related to geomorphologic, soil, elevation, and hydrology conditions historically present at Benton Lake was developed. The distribution of these HGM-predicted vegetation communities assumes average long-term flooding and drying periods of 10–20 years with peak highs and lows lasting about 5–6 years. This duration of peaks and lows is based primarily on historical aerial photographs of the refuge, especially the sequential basin photographs from 1950, 1951, 1954, 1956, and

1957. This HGM matrix was extrapolated to historical (such as before construction of levees and water control structures) basin conditions using the geographical information data sets on geomorphology, soils, and elevation (figure 23).

Using this HGM matrix (table 34) and potential historical vegetation map (figure 23), about 73 acres of the lowest elevations in the Benton Lake basin (less than 3,614.5 feet amsl) contained some surface water throughout most years and supported open-water aquatic plant communities surrounded by concentric bands of robust emergent vegetation including cattail and hardstem bulrush. Soils in these depressions were heavy clays and within the geomorphic surface formed by historical lake-system environments. Water in these depressions was fresh, with little salt concentration. Historical aerial photographs, surveys, and naturalist accounts from the Benton Lake region show that dense emergent vegetation was present in the deeper depressions at Benton Lake, at least during wet years of the long-term flooding cycle, but it is unclear which emergent species were present. It is likely that most emergent vegetation was hardstem bulrush, but some cattail probably was present also, based on similar wetland conditions in western Montana (Hansen et al. 1995) and the extensive presence of cattail within Benton Lake at present. The width of this emergent vegetation band varied depending on extent and duration of flooding and chronological position of the long-term hydrological cycle. Submergent aquatic plants such as pondweeds, naiads, coontail, widgeongrass, and milfoil were present in the deepest open areas and rich algal blooms occurred in these areas.

Semipermanently flooded sites that were slightly higher elevation (3,614.6–3,615.7 feet amsl) next to cattail and bulrush zones contained slightly less permanent water regimes and supported diverse sedge and rush species (figure 24). These sedge–rush communities covered about 1,728 acres and supported diverse herbaceous wetland plants including alkali bulrush, three-square rush, Nuttall's alkaligrass, beaked sedge, Nebraska sedge, and water smartweed. The sedge–rush community apparently

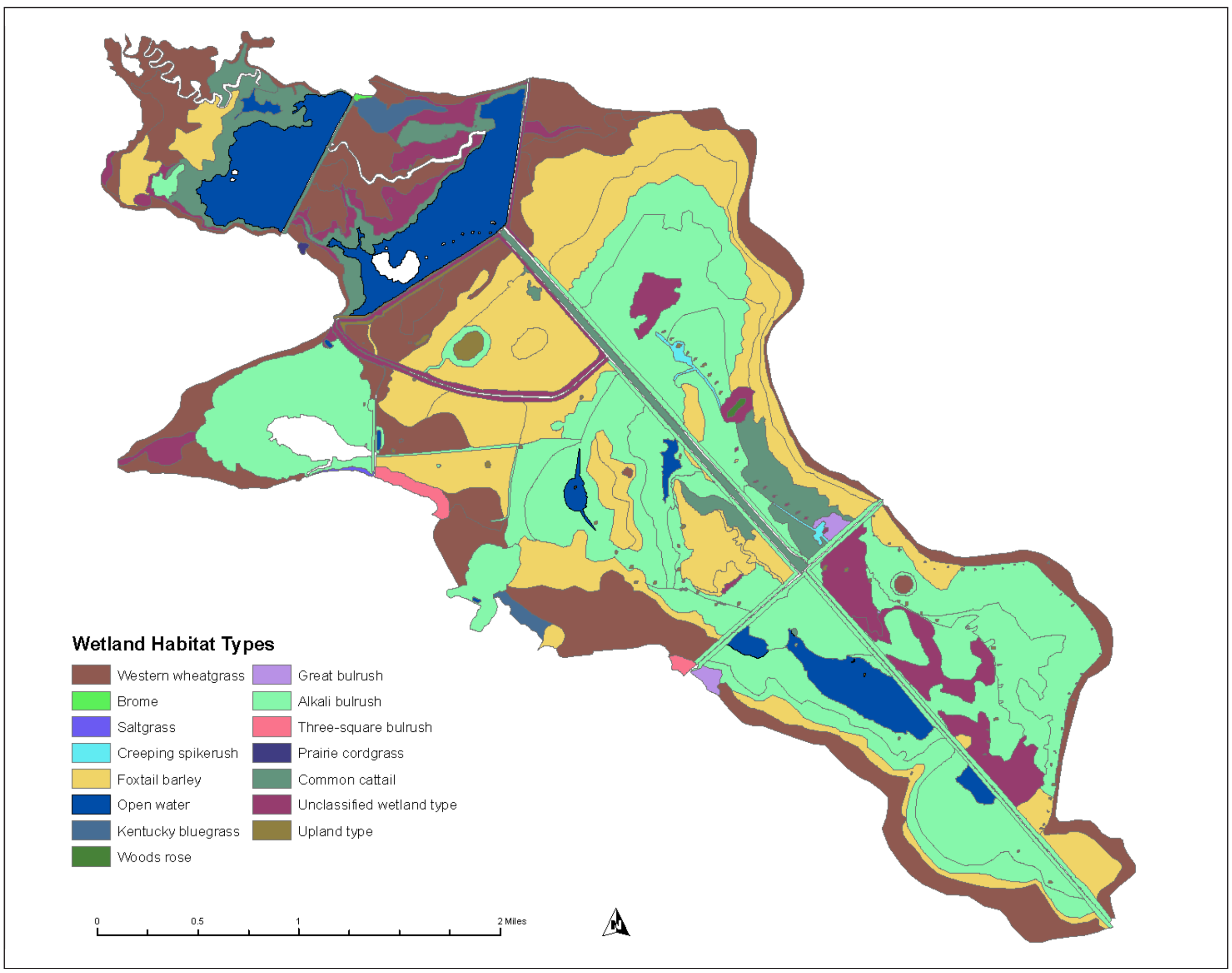

Figure 24. Vegetation communities on Benton Lake National Wildlife Refuge, Montana.

covered more area within the Benton Lake bed than other communities and historical accounts of the lake (for example, the General Land Office, 1920) comment on the wide bands and extensive coverage of sedges and rushes. This sedge–rush community may have expanded during wet periods to even higher elevation edges of Benton Lake and then contracted to lower elevations during extended dry periods. The periodic flooding and drying of these vegetation zones likely caused moderate alkaline soil conditions.

Seasonally flooded areas next to sedge–rush communities (3,615.8–3,616.3 feet amsl) contained diverse annual and perennial herbaceous plants and wet-prairie meadow grasses such as spikerush, lambsquarter, annual smartweeds, prairie cordgrass, and saltgrass. Prairie cordgrass apparently occurred in temporary and overflow areas along streams and the edges of marsh sites that had silty clay soils, less alkaline conditions, and where seasonal (usually spring) sheetflow of surface water occurred. Spikerush usually was in relatively narrow bands along yearly flooded stream and tributary sites and the margins of lake communities. In contrast, saltgrass was most common in more saline or alkali sites including areas where seeps flowed into Benton Lake and in some overflow areas next to Lake Creek.

The highest elevation edges of Benton Lake (3,616.4–3,622 feet amsl) typically had short duration seasonal flooding regimes and represented the transition zone from wetland to upland grassland plant communities (figure 24). Foxtail barley was present on the higher annually drawn down margins of the lake basin and in some ephemeral depressions. Foxtail barley gradually graded to western wheatgrass on terraces next to the lake. Eventually, these wetland-edge grass communities graded into upland grassland (elevations more than 3,622 feet amsl).

Current Wetland Vegetation and Invasive Plants

A survey of vegetation in Benton Lake Refuge units was conducted in 2001 and documented composition and distribution of plant communities (Thompson and Hansen 2002). At that time 91 plant species were documented in wetland units and the dominant vegetation communities (habitat types) were alkali bulrush (31.2 percent of total area within wetland units), western wheatgrass (18.1 percent), foxtail barley (17.4 percent), open water (9.6 percent), varied moist-soil annuals (8.8 percent), and cattail–hardstem bulrush (6.6 percent) (figure 24). The invasive creeping foxtail covered only 2.8 percent of the units in 2001. Creeping foxtail is an introduced rhizomatous perennial species. Its distribution has expanded through Benton Lake basin in recent years and generally occurs in bands or zones lying immediately above the zone occupied by cattail. The precise taxonomy of this creeping foxtail is unknown but may be the “Garrison” cultivar named and released by the NRCS Plant Materials Center in Bismarck, North Dakota in 1963 (NRCS 2007). The original collection of the Garrison cultivar was made in 1950 where plants were growing on the margins of prairie pothole wetland basins; it is especially adapted to cold-temperature regions next to wet areas such as the Benton Lake bed. Native species comprised 50, 100, 54, 58, and 58 percent, respectively, of tree, shrub, grass, forb, and total plants in wetland units in 2001.

Units 1 and 2, which have been managed for more permanent water regimes, contain large amounts of open water with extensive stands of cattail next to deeper open-water areas. Open-water areas contain abundant aquatic submergent vegetation, especially milfoil and pondweed. Creeping foxtail has spread into areas formerly dominated by foxtail barley at higher elevation edges of Units 1 and 2. Foxtail barley now occupies a relatively small amount of area of each unit. Western wheatgrass still occupies large areas on the highest upland edge of Units 1 and 2 but invasive Kentucky bluegrass, crested wheatgrass, and smooth brome are expanding in area. Some reed canarygrass also now is present in both units.

Unit 3 contains extensive, but declining areas of alkali bulrush in lower elevations and foxtail barley in higher sites. Creeping foxtail is gradually expanding coverage in the unit. In contrast, Canada thistle and field milk-thistle now occupy large areas of higher, drier edges of the unit. Former island areas also have small coverage by Woods’ rose. Unit 3 now is managed for short duration seasonal flooding, but for more than 15 years (1964–78) it was managed for yearlong inundation (USFWS 1961–99).

Vegetation in Unit 4 varies among the three subunits and reflects permanency of water regimes and past excavations and construction of levees, nesting islands, and internal drainage ditches. Unit 4a has more natural vegetation communities than other subunits and is dominated by alkali bulrush. Subunit 4a has been allowed to flood and dry on more natural cycles, with deeper interior areas holding water for longer periods and supporting more alkali bulrush communities, compared to Units 4b and 4c. Foxtail barley and western wheatgrass remain dominant species on the edges of Unit 4a, but creeping foxtail has taken over most of the eastern part of the unit between the water control structure and the deeper interior.

Vegetation in Unit 4b is highly altered from historical condition. The historical geomorphology of the Unit 4b area was a higher alluvial depositional surface that historically flooded only for short periods during high-flow events of Lake Creek, mainly in spring, and it appears to have been dominated by prairie cordgrass, foxtail barley, wheatgrass, and possibly some saltgrass. Construction of the internal levee to subdivide Unit 4, construction of nesting islands, and excavations shifted this site to wetter regimes in the 1960s to 1980s. In more recent years Unit 4b has been managed for shorter duration flooding. Common species in Unit 4b are foxtail barley, common orache, lambsquarter, prickly lettuce, western wheatgrass, and the invasive crested wheatgrass. Little creeping foxtail is present in the subunit, which may be a result of the limited flooding this unit has received in the last 10–15 years.

Unit 4c is the largest subunit of Unit 4 and is becoming highly invaded by creeping foxtail. In 2001, the subunit kept a large amount of native foxtail barley, western wheatgrass, and alkali bulrush (Thompson and Hansen 2002), but each of these species is declining at present. Expansion of creeping foxtail may be increasing, because the site appears to have prolonged soil saturation, but not extensive surface flooding. Soil saturation may be discouraging less water tolerant native grasses and moist-soil-type species. It is uncertain if this saturation is being caused by leakage from the main water distribution canal or seasonal diversion of surface water into the unit.

Units 5 and 6 historically had several deeper depressions and these deeper sites remain dominated by alkali bulrush with some scattered cattail present. Similar to Unit 4c, creeping foxtail has spread across the areas with prolonged soil saturation in these units. Photos taken between 1996 and 2010 in Unit 6 show almost total replacement of alkali bulrush with creeping foxtail in transition zone between the inlet of the water control structures and the deeper depressions. The outer edges of these units that are flooded less frequently are now covered mainly by foxtail barley, lambsquarter, strawberry blight, rillscale, and western wheatgrass.

Wildlife

A rich diversity of wildlife species use the Benton Lake basin (appendix D). Aquatic invertebrates include a variety of Crustacea (such as *Daphnia* sp., *Gammarus* sp., and *Hyalella azteca*) and insects such as Corixid beetles, damselflies and dragonflies, Notonectid backswimmers, and Chironomids (Heitmeyer et al. 2009).

Several amphibian and reptile species also used Benton Lake including tiger salamanders, boreal chorus frogs, painted turtles, and common, western and plains garter snakes. There is one historical record of northern leopard frog on the refuge, but no recent occurrences. Uplands are used by western rattlesnakes and racers.

Fathead minnows are the only fish species occasionally present on the main refuge unit.

Mammal species diversity and abundance in the Benton Lake wetland basin is relatively low, except for many small rodents such as mice and voles. Several species of bats likely use wetlands as foraging areas, but no formal surveys have been conducted. Muskrat often create openings in wetland vegetation with den building, but shallow water that freezes completely every year may be limiting numbers. Additionally, many mammal species that mostly use the uplands, such as coyote, white-tailed deer, mule deer, and pronghorn, may also use dry parts of the wetlands to forage and breed. Very rare sightings of other mammals on the refuge include black bear, elk and moose.

The refuge provides migration and breeding habitat for a variety of birds. The Benton Lake Refuge has been designated as a Western Hemisphere Shorebird Reserve Network site and an Audubon Important Bird Area (IBA) (National Audubon Society 2012).

Grassland bird species are a priority for the refuge due to the conversion of native prairie in the surrounding areas and the overall trend of grassland bird species decline. During the past quarter-century, grassland birds have experienced steeper, more consistent, and more widespread population declines than any other avian guild in North America (Vickory et al. 2000). On Benton Lake Refuge priority grassland bird species include the ESA candidate species Sprague's pipit as well as ferruginous hawk, upland sandpiper, long-billed curlew, marbled godwit, burrowing owl, short-eared owl, grasshopper sparrow, and chestnut-collared longspur. Grassland bird point counts were conducted for 4 years (1994–7) consecutively at the refuge. One census reported that 820 individuals and 41 species of grassland birds were detected. Of these years studied there was a steady decline of the chestnut-collared longspurs, grasshopper sparrows, and horned larks.

Many wetland-dependent waterbirds breed at Benton Lake. The most common breeding species included eared grebe, mallard, northern pintail, gadwall, blue-winged teal, cinnamon teal, American wigeon, northern shoveler, redhead, lesser scaup, ruddy duck, Canada geese, American coot, American avocet, Wilson's phalaropes, marbled godwits, Franklin's gull, white-faced ibis, black-necked stilt, and black-crowned night-heron.

Of the relatively common wetland-dependent birds that breed on the refuge, 19 are considered species of concern (table 35). For some species, Benton Lake lies within the core of their breeding range.

Table 35. Migratory bird species of concern that breed at the Benton Lake National Wildlife Refuge, Montana.

Deeper, more permanent water	*Population estimate*	*Population status*	*Benton Lake relative to distribution*	*Benton Lake use relative to total population*
Black-crowned night-heron	not available	Stable	Disjunct	Occurrence at the refuge is <1% of the continental population.
Canvasback	600,000	Stable	Core	
Redhead	1,100,000	Increasing	Core	
Lesser scaup	4,200,000	Decreasing	Core	
Wilson's phalarope	1,500,000	?	Core	
Yellow-headed blackbird	23,000,000	Increasing	Core	
Shallower water	*Population estimate*	*Population status*	*Benton Lake relative to distribution*	
American bittern	not available	Decreasing?	Core	Occurrence at the refuge is <1% of the continental population.
Franklin's gull	1,000,000	Stable	Peripheral	
Mallard	8,400,000	Increasing	Core	
Gadwall	3,000,000	Increasing	Core	
Northern pintail	3,500,000	Decreasing	Core	
American wigeon	2,400,000	Stable	Core	
Blue-winged teal, cinnamon teal	6,300,000	Increasing	Core	
Green-winged teal	3,500,000	Increasing	Core	
American avocet	450,000	Stable	Core	
Black-necked stilt	175,000	Stable	Disjunct	
Willet	250,000	Stable	Core	
Marbled godwit	170,000	Stable	Core	
Long-billed curlew	164,000	Decreasing	Core	

Upland birds	*Population estimate*	*Population status*	*Benton Lake relative todistribution*	*Grass type*	
Ferruginous hawk	23,000	Decreasing?	Core	intermediate	Occurrence at the refuge is <0.05% of the continental population
Upland sandpiper	350,000	Decreasing	Core	intermediate	
Short-eared owl	2,400,000	Stable	Core	tall–dense	
Burrowing owl	2,000,000	Decreasing	Core	open–sparse	
Sprague's pipit	479,000	Decreasing	Core	intermediate	
Baird's sparrow	1,200,000	Decreasing	Core–Peripheral	intermediate	
Grasshopper sparrow	15,000,000	Decreasing	Core	intermediate–open	
McCown's longspur	1,100,000	Decreasing	Core	open–sparse	
Chestnut-collared longspur	5,600,000	Decreasing	Core	open–sparse	

Species = common or uncommon breeders at Benton Lake Refuge that have also been identified as a species of concern at a national or regional level.

Source: Service flyway data; Birds of North America Online; Partners in Flight Landbird Database; other Service publication data.

For others, such as Franklin's gulls, black necked stilts and black-crowned night-herons, the refuge is on the edge of their range or disjunct from the primary breeding habitat.

Planted, nonnative trees in shelterbelts provide habitat for at least 18 bird species that specialize in this type of habitat. Two of these species, loggerhead shrikes and Swainson's hawks, are species of concern and breeding has been documented in refuge shelterbelts.

Little quantitative data are available to determine changes in presence, abundance, and productivity of animal populations at the Benton Lake Refuge over time. Certain data show increasing numbers and production of waterbirds, especially dabbling ducks on the refuge in the late 1960s to late 1970s, when the refuge was initially flooded and units were managed for more prolonged water regimes (USFWS 1961–99). During this period annual duck production was reported to be high (several thousand ducklings) and included primarily northern shoveler, blue-winged teal, gadwall, cinnamon teal, northern pintail, and mallard. An increasing number of Canada geese also began using Benton Lake at this time and produced several hundred goslings in some years. Staff observations show that the number of breeding waterbirds have declined on Benton Lake in the last two decades. This may be due to the reduction in the amount of permanent and prolonged flooding of units in summer to manage botulism, below normal precipitation and runoff from 1998–2008, reduced productivity from the static hydroperiod created with annual pumping or may be an artifact of changes in staff and survey methods (USFWS 1961–99). Large numbers of migrant waterbirds also use Benton Lake during spring and fall migration. In recent years, up to 30,000 ducks, 400 tundra swans, and 2,000 Canada geese regularly use the lake and region each fall, with somewhat lower numbers in the spring.

Currently on the refuge, three predator-trapping locations using live-traps are supported from mid-April through July to reduce predation of nesting birds. Over the last 4 years, six predators (raccoons and skunks) were trapped. During the same period, eight nontarget animals were trapped and released.

Botulism

Avian botulism outbreaks, caused by the ingestion of a toxin produced by the bacterium *Clostridium botulinum*, have occurred at Benton Lake at least since the mid-1960s (USFWS 1961–99). Occurrence of botulism at Benton Lake before the 1960s is unknown (no records or monitoring data are available), but documentation of historic outbreaks in other large wetland basins in the western U.S. suggest it probably occurred at least in some years (for example, Wetmore 1915, Giltner and Couch 1930, Kalmbach 1930, Wobeser 1981).

Peak waterbird mortality caused by botulism at Benton Lake occurred in 1970–2 when more than 18,000 birds (17,127 ducks) died in 1970 and more than 10,000 birds died in 1971 and 1972 (USFWS 1970–99) (table 36). The years 1971 and 1972 were very dry years and water levels in units that had been managed for higher summer water levels to support duck broods (Units 3, 4c, and 5) receded quickly contributing to the die-off. In 1971, the Benton Lake Refuge was ranked highest in North America for known botulism losses (USFWS annual report, 1971). Waterbird mortality from botulism at the refuge declined during the remainder of the 1970s when water levels were high in the wetland basin, caused by increased precipitation and natural runoff from Lake Creek.

Table 36. Annual mortality of ducks caused by botulism at Benton Lake National Wildlife Refuge, Montana.

Year	*Number of ducks*
1970	17,127
1971	10,778
1972	10,081
1973	1,602
1974	884
1978	812
1979	1,148
1987	83
1988	597
1989	2,025
1990	509
1991	3,743
1997	88

Source: USFWS 1970–90; USFWS unpublished files.

Since the 1980s, botulism mortality at the refuge has been relatively low (less than 500) in most years except 1989 and 1991, when 2,025 and 3,743 ducks died, respectively. Generally, botulism outbreaks at the refuge have been greatest in Units 3, 4c, and 5 when they had greater amounts of flooding and rapid drawdown in late summer.

Over time, refuge managers have learned to allow Units 3–6 to dry during July, which has coincided with a significantly lower incidence of major botulism die-offs on the refuge. Units 1 and 2 can be kept full for brood water during July, as these units have not had a history of botulism. Concern for avoiding the conditions that created high botulism mortality (high water levels in lower units and hot, dry weather in summer) constrains water management options on the refuge.

Cultural Resources

The historical landscape in the Benton Lake basin contained vast expanses of grasslands, undulating topography, a few intermittent streams and forested riparian corridors, and scattered wetland basins, with Benton Lake being the largest. This area was inhabited by Native Americans for at least 10,000 years before European settlement. The Blackfeet, Cheyenne, and Crow tribes lived in the Plains region, but had mobile lifestyles and they apparently had relatively little influence on the Plains landscape, with the exception of occasionally setting fires. A few French trappers apparently visited areas along the nearby Missouri River in the mid-to-late 1700s, but the area was not explored until 1805 when members of the Lewis and Clark expedition viewed the Great Falls of the Missouri River and Black Eagle Falls. These Lewis and Clark explorers spent about 3 weeks in the area and recorded in their journals descriptions of the falls and surrounding area, which would eventually fuel interest in settlement. Expedition members returned to the area in 1806 and reported large numbers of bison, elk, deer, and pronghorn in the area along with grizzly bear and mountain lions. After 1807, trappers and fur traders became active in the region; the American Fur Company built Fort Benton on the Missouri River in 1847.

The United States received most of what is now Montana as part of the Louisiana Purchase in the early 1800s, and the northwestern part of the State was gained by treaty with Great Britain in 1846. In 1862, prospectors found gold in southwest Montana and many settlers moved to the State thereafter. The area around Benton Lake was not a source of gold, however, and only occasional trappers, hunters, and gold seekers occupied the area. Threats of Indian aggression also deterred European settlement in the region until the 1870s. Consequently, the physical and ecological nature of the Benton Lake basin remained essentially unchanged from its historical condition until about 1880, when settlers increasingly moved to the Missouri River Valley. Between 1880 and 1890 the population of Montana grew from about 39,000 to nearly 143,000. In 1884, Paris Gibson founded the city of Great Falls at the confluence of the Sun and Missouri Rivers and the city was incorporated in 1888 (Yuill and Yuill 1984). The Mullan Road, a common western pathway built in the early 1860s for pioneers and settlers traveling from Fort Benton by way of Coeur d' Alene to the Pacific northwest wound around the north end of Benton Lake (Cascade County Historical Society 1999). Interestingly, another early road near Benton Lake, running north of Great Falls from the current Highway 87 to Canada, was heavily used to carry bootlegged liquor to Great Falls and other towns further south during the Prohibition Era from 1920 to 1933. Named Bootlegger Trail, it crossed the old Mullan Road and homesteaders along the trail near Benton Lake augmented their income by allowing bootleggers to use their barns to layover during the daytime.

Beginning in the early 1900s, efforts to increase opportunity for small grain farming in the region began with the initiation of the Sun River Reclamation Project, later known as the Sun River Irrigation Project. This Sun River project was authorized by the Secretary of the Interior in 1906 and contains more than 100,000 acres of potentially irrigated land along the Sun River and its tributaries west of Benton Lake (Knapton et al. 1988). The Sun River project contains two major divisions, the Fort Shaw Irrigation Division that borders the Sun River contains about 10,000 acres and the Greenfields Irrigation Division, contains about 83,000 acres.

Construction of the Fort Shaw Division began in 1907, and the first water was delivered to division farmlands in 1909 (Knapton et al. 1988). Construction of facilities within the Greenfields Irrigation Division began in 1913 and the first water was delivered to area grain farmers in 1920. The main storage structure, Gibson Reservoir was constructed on the upper Sun River during 1922–9. Approximately 300 miles of canals and lateral distribution ditches distribute water across the Greenfields Bench.

The development of the Greenfields Irrigation Division dramatically changed the landscape within large parts of the district and influenced land use near the Benton Lake Refuge. During this time, native grassland was converted to irrigated cropland, mostly wheat and barley, and pasture–hayland. The advent of increased small grain production in the region and accompanying storage, transportation, and milling facilities encouraged grain production outside of the irrigation division also. Much of the native grassland was converted from native grassland to dryland cropland. The predominant crops grown in this area until the 1980s were wheat, barley, oats, and flax using crop–fallow rotations where alternating linear fields were either cropped or kept fallow (free of vegetation using tillage or chemical treatments) for 1–2 years. Since the mid-1980s, more than 60 percent of the cropland in the Greenfields Division has been contracted for growing malting barley, which has improved the financial sustainability of cropping lands in the area and has provided more than $20 million annual return.

Visitor Services

Visitors to the refuge enjoy a variety of wildlife-dependent, public use activities such as hunting, fishing, wildlife observation, photography, environmental education, and interpretation (figure 25). In general, national wildlife refuges are closed to all public use until specifically opened. Existing and proposed uses of national wildlife refuges, need to be evaluated for appropriateness and compatibility (See chapter 4, section 4.6 for a full description and definitions of these terms).

Hunting

Hunting on the refuge begins with the opening of the State waterfowl season and runs through November 30. Benton Lake Refuge is open for the youth waterfowl season, which typically occurs the weekend before the opening of the general waterfowl season. Hunting on Benton Lake is confined to Units 5, 6 and parts of Unit 4C. Ducks, geese, coots, swans (by permit), sharp-tailed grouse, gray partridge, and ring-necked pheasants can be hunted on the refuge. Hunting of all other species is prohibited. State seasons apply within the refuge framework. Hunting is on a first-come, first served basis. One disability accessible hunting blind is available in Unit 5 through special use permit.

Fishing

The refuge offers no fishing opportunities on the main part of the refuge due to a lack of sport fish. The Pump House Unit (147 acres) is open for walk-in access to Muddy Creek, which provides trout-fishing opportunities.

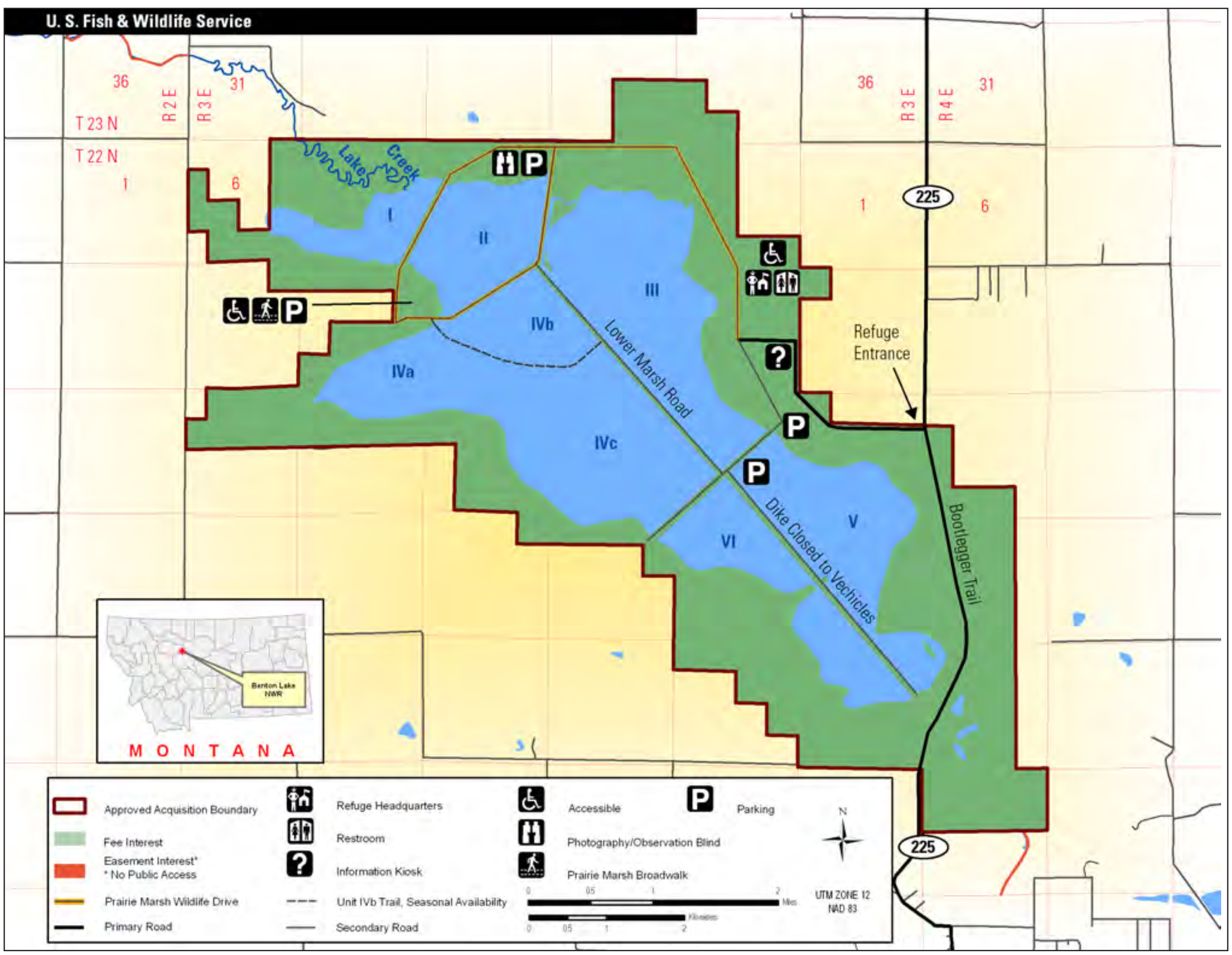

Figure 25. Public use at the Benton Lake National Wildlife Refuge, Montana.

Wildlife Observation and Photography

The most popular recreational activity on the refuge is wildlife observation and photography. The auto tour route, Prairie Marsh Boardwalk, Lower Marsh Road, and the sharp-tailed grouse blind are the most popular observation areas. In addition, a photography blind constructed in Unit 1 is available.

Environmental Education and Interpretation

The Benton Lake Refuge has the potential to provide an extraordinary environmental education and interpretation program. The refuge is located 12 miles from Great Falls, a city of 60,000 people, in north-central Montana. The population of Cascade County, where the refuge is located, is 82,000. The refuge staff has never included an environmental education position. Management staff has given occasional tours to school groups and nongovernmental organizations. The environmental science department of the GFPS brings all third graders (800–900 students) to the refuge each year in May and June for a basic introduction to prairie grasslands and wetlands. Refuge staff greet the buses and give a very brief overview of the Refuge System and provide refuge-specific information. Occasional youth hunting clinics are held at the refuge with help from MFWP staff. Becoming an Outdoor Woman workshops have also been held occasionally on the refuge. Refuge Staff also take part in the STEM Expo to help foster community-based participation by youth in the career fields of science and mathematics. The program includes both a community expo and mentoring program.

Interpretive panels have been updated and are displayed in the visitor kiosk located on the office entrance road. More panels are being developed for display on the Prairie Marsh Boardwalk.

Refuge Management Activities

The Service manipulates habitat through several management activities that are carried out under specific, prescribed conditions to meet the needs of wildlife. Water management on the refuge is described above. Prescribed fire has been used regularly on the refuge. Since 2004, the refuge has burned an average of 2,000 acres per year. In the recent past, cooperative farming and grazing have not been used on the refuge. Haying has been used to a limited extent on tame grass fields. For a complete description of these tools please see chapter 4.8.

Socioeconomic Environment

Benton Lake Refuge is located in north-central Cascade County. The refuge shares a partial border with Chouteau County, and lies near the border of Teton County. Visitors travel to the refuge for wildlife observation, photography, migratory and upland gamebird hunting. Great Falls, the closest city to the refuge, is about 12 miles south of the refuge. Unlike other cities with a history of boom and bust cycles of mining, Great Falls was a planned city. By the late 1800s, the city was connected to the railroad and had a growing number of businesses and agricultural production. Great Falls was never dominated by a single industry, which helped to continue its steady growth throughout the 1900s. With the arrival of Malmstrom Air Force Base in 1939 Great Falls boasted a diverse economy of manufacturing, agriculture, military and retail (Big Sky Fishing, 2011). Great Falls is a growing tourist destination as it provides access to a wide variety of outdoor recreation opportunities. Visitors come to Great Falls for its rich Western history and impressive parks and open spaces (Great Falls Visitor Information Center, 2011). Great Falls is one of the many gateways to Glacier, Yellowstone and Grand Teton National Parks, as well as Showdown, Teton Pass, and Great Divide ski resorts (Great Falls Visitor Information Center, 2011).

For a description of the socioeconomic setting in the 12-county area of the refuge complex, please see chapter 4.

Staff and Funding

The refuge complex headquarters is located on Benton Lake Refuge. Service operations consist of the staff, facilities, equipment, and supplies needed to administer resource management and public use programs throughout the refuge complex, which is located across a 12-county area covering more than 2,700 square miles. Within this area, the Service is responsible for the protection of 163,304 acres of lands and waters.

Staff

Currently, the refuge complex staff is comprised of 9.5 permanent full-time employees (table 10 in chapter 4, section 4.5). Of these, staff assigned to the management of Benton Lake Refuge include: a part of the wildlife refuge manager for the refuge complex, the deputy wildlife refuge manager, an administrative officer, part-time generalist, a term-seasonal biological technician and a complete FTE of wildlife refuge biologist and maintenance worker. The wetland district manager and wildlife refuge specialist (assigned to the Rocky Mountain Front) often help with refuge support as well. The refuge has seen a reduction in staff since 2000.

Since 1998, the refuge complex has lost three positions—one full-time law enforcement position, one permanent biological science technician and a permanent maintenance worker. The current staff level remains well below the minimum prescribed in the "June 2008 Final Report—Staffing Model for Field Stations" (USFWS 2008e), which recommended 8 more staff including a GS–13 refuge manager, GS–12 wildlife refuge specialist, GS–9 park ranger (visitor services specialist), GS–9 park ranger (law enforcement), GS–12 wildlife biologist, WG–8 maintenance worker, and GS–6 biological science technician (0.5 full-time equivalent employee).

Facilities and Infrastructure

Significant infrastructure exists on the refuge to primarily support water management activities. This includes 11.5 miles of dikes and ditches that divide the wetland basin into 8 units and 9 water control structures. In addition, the interunit canal (a 2.2 mile long and approximately 50 feet wide channel) delivers water to the lower units. The dikes also provide a roadway for the Prairie Marsh Drive Auto Tour Route and Lower Marsh Road Auto Tour Route. A pump house with 3 pumps and a water control structure that impounds flows of Muddy Creek also aides in water management.

The refuge office has been expanded to accommodate housing complex employees as well as other regional refuge programs. Recently constructed support infrastructure included a wind generator and photovoltaic system that provides electrical needs for the office building.

Visitor and Employee Safety and Resource Protection

A collateral duty officer (wildlife refuge specialist) is assigned to the district and conducts all law enforcement duties at Benton Lake Refuge.

7.12 Alternatives Analysis

Management actions are prescribed in the alternatives as a means for achieving the vision and goals for the refuge, while responding to issues raised by Service managers, the public and governmental partners. Because management would differ for each alternative, the environmental and social effects resulting from implementation would likely differ as well. The effects are evaluated at several levels including whether they are adverse or beneficial and whether the effects are direct, indirect, or cumulative with other independent actions. In addition, the duration of effects is used in the evaluation of environmental consequences

The five alternatives for the refuge are listed below. The effects of each of the five alternatives are described under the major resource topics described throughout this document.

In addition, table 53 in section 7.20 following the description of consequences summarizes the alternatives' actions and the associated consequences as described below.

Elements Common to All Alternatives

The following potential effects would be similar for each of the five alternatives:

- Implementation of the management direction (goals, objectives, and strategies) would follow the refuge complex's best management practices.
- Management activities and programs would avoid and reduce adverse effects on federally threatened and endangered species, to the extent possible and practicable.
- The refuge staff, contractors, researchers, and other consultants would acquire all applicable permits, such as those for future construction activities.

The sections below describe in more detail other effects expected to be similar for each alternative.

Regulatory Effects

As described in chapter 1 of this draft CCP, the Service must follow Federal laws, administrative orders, and policies in the development and implementation of its management actions and programs. Among these mandates are the Improvement Act, the ESA, the Clean Water Act of 1977, and compliance with Executive Order 11990–Protection of Wetlands and Executive Order 11988–Floodplain Management. The implementation of any of the alternatives described in this draft CCP and EA would not lead to a violation of these or other mandates.

Environmental Justice

Within the spirit and intent of Executive Order 12898–Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations, no actions being considered in this draft CCP and EA would disproportionately place any adverse environmental, economic, social, or health effects on minority or low-income populations when compared with the public.

The Service is committed to ensuring that all members of the public have equal access to the Nation's fish and wildlife resources, as well as equal access to information that would enable them to take part meaningfully in activities and policy shaping.

Cultural Resources

All of the alternatives would enhance cultural resources through protection of existing resources and extension of protection to newly discovered cultural resources.

There have been limited cultural resource surveys performed on the refuge, so more surveys would be required before any new construction or excavation to fully satisfy provisions of the Archeological Resources Protection Act and other applicable acts and policies related to historical and archaeological resources.

Potentially negative effects from construction of trails or facilities would require review by the Region 6 archaeologist and consultation with the Montana State Historic Preservation Office.

7.13 Consequences of Alternative A1 (Current Management –No Action)

Most staff time and efforts are directed toward providing migration and breeding habitat every year for wetland-dependent wildlife, primarily waterfowl. The opportunity for waterfowl hunting every fall is provided. Water management within the wetland units on the refuge is similar each year so that units are flooded at approximately the same time and depths consistently creating a dominance of semipermanent wetland habitat. This water regime favors species dependent upon semipermanent water sources such as wading birds and waterfowl. Management efforts strive to reduce the dynamic shifts and variability in hydro-periods which cause fluctuations in water levels. Risk of botulism is reduced due to seasonal drying of lower units. The effects from the extended dry cycles are cut. Selenium accumulation and toxicity hazard to wildlife will continue to increase. Wetland health continues to decline and issues pertaining to selenium contamination hazard, nonnative or single-species dominance of vegetation communities are not addressed. The ability to absorb perturbations in the system is likely compromised. Over the life of the plan, wildlife-dependent recreation is estimated at 5,625 hunting visits; 750 fishing visits; 114,750 wildlife observation and photography visits; and 26,625 visits for interpretive programming. Over the life of the plan, the total cost to carry out wetland basin management (operations and maintenance, pumping, monitoring, and prescriptive habitat treatment) is estimated to be $1,785,000. Staffing dedicated to refuge include: a part of the wildlife biologist, deputy complex wildlife refuge manager, maintenance worker, part-time generalist, and term biological technician with more support from the complex manager, wetland district manager, wildlife refuge specialist, assistant fire management officer, administrative officer, and budget analyst.

Grasslands

Native Grasslands

Protection of native grasslands through easement programs continues to be a high priority throughout the refuge complex. New and expanded project areas and more money sources provide the potential for protecting great expanses of native prairie. However, with annual additions to easement acres and contracts, supporting the current level of proactive easement enforcement and landowner contact would eventually be compromised. Preserving and managing native prairie landscapes reduces soil erosion, supports water quality, effectively sequesters carbon and increases resiliency and resistance to disturbances such as climate change (Bangsund et al. 2005).

Refuge management of native grasslands would continue extensively, but imprecisely, using a coarse, generic approach because of limited resources for staff, money and long-term monitoring. Native grassland health, composition and native plant diversity are managed using fire and rest cycles on the refuge. Noxious weeds would continue to be treated using IPM and EDRR and the low presence of these species would likely continue. Cool-season, exotic grasses such as Japanese brome, Kentucky bluegrass and crested wheatgrass, have invaded significant areas of the refuge. With current management and resource allocation, these infestations would likely continue to expand and further degrade the quality of the native prairie. The invasion by nonnative species can extend beyond the displacement of native species and the reduction of diversity and include the alteration of energy and nutrient flows within the prairie ecosystem (Christian and Wilson 1999). This could also affect reproductive success of grassland-nesting birds. For example, chestnut-collared longspurs, which are a common species of concern on the refuge, have been shown to have lower nest success, slower nestlings growth, and nestlings with smaller final mass in crested wheatgrass compared to native prairie (Lloyd and Martin 2005).

Tame Grasslands

Management of tame grass on the refuge strives to support the health and longevity of stands with periodic disturbance using fire or haying in a rotational system within specific management units. Tame grass on the refuge is typically taller and denser than native prairie, providing more structural diversity which meets habitat requirements for a wide variety of grassland-dependent species. However, tame grass plantings consist of only three or four introduced plant species. Compared to native grasslands the diversity of soil invertebrate species and nutrient cycling processes would be vastly simplified. Tame grasslands are markedly less efficient in capturing and transferring solar energy, sequestering carbon and resisting disturbances such as invasive species (Bangsund et al. 2005).

Nonnative Tree Plantings

Currently there are no specific management activities in regard to tree plantings. Nonnative tree plantings contribute to fragmentation, depredation and parasitism, which negatively affect grassland-dependent migratory birds (Bakker 2003). Some of these bird species include species of concern, such as marbled godwits and chestnut-collared longspurs (unpublished records on file at Benton Lake Refuge).

Nonnative tree plantings consist of a handful of introduced species that are far less diverse than native grassland communities compromised by their establishment. Tree plantings can also contribute to and provide opportunities for invasive noxious weed infestations.

Nonnative tree plantings provide an unnatural change to the vegetative structure of the prairies. This allows some species to nest where they otherwise would not. The result is an increase in local species diversity, but with negative impacts to regional biological diversity.

Wetlands and Riparian Areas

Water Quantity and Timing

Units 1 and 2 would be flooded year-round. The lower units (Units 3–6) would be shallowly flooded all year except for July. A water budget model was developed with refuge staff and USGS to assess effects on changes in water management on the refuge (Nimick et al. 2011). This model is based on refuge water use records, precipitation, evaporation and runoff from 1970–2006. If the next 30 years were similar to the last 30 years, in a wet cycle, the refuge wetland basin would be greater than 50-percent full 4 years out of 15 and would never be less than 7-percent full. In a dry cycle, the refuge wetland basin would be 10-percent or less full most years, but never completely dry (Nimick et al. 2011).

Infrastructure

With current infrastructure, the ability to channel water to all units for management objectives is available. However, the system is constrained in that all water that enters from Lake Creek must pass through Units 1 and 2 before moving to the lower units. The lower units (Units 3–6) are difficult to dewater, which limits options for management, especially botulism. In the lower units, water first enters extensive 1- to 3-foot deep ditches before it spreads across the wetlands. This reduces sheet flow which decreases the quantity and quality of flooded acres within the wetland (see wetland productivity section).

Collectively, the dikes, roads and ditches have disrupted natural waterflow patterns into and through Benton Lake, affected wind- and water-related soil erosion and deposition patterns, and changed public access and disturbance of many areas on the refuge (Heitmeyer et al. 2009). For example, sheet flow that quickly moves across a wetland basin and shallowly floods the greatest area, which would warm quickly and make invertebrates, in particular, available to many birds, is delayed and altered by ditches that line each dike within the Benton Lake wetland. The dikes and ditches also create sediment traps altering the soil chemistry and microbial processes that support wetland function (Euliss et al. 2008). Holding water behind control structures changes the ecology of the wetlands. For example, mineral and organic nutrients that promotes a proliferation of plant life, especially algae, accumulate which then reduces the dissolved oxygen content and can cause the extinction of other organisms (Jarworski and Raphael 1978, Brix 1993). Impoundments favor anoxia and inhibit the release of nutrients that could contribute to pulses in primary production by slowing mineralization (Brix 1993, Wetzel 2001, Mitsch and Gosselink 2007). Scouring of sediment and transportation of mineralized nutrients are reduced due to impoundments (Euliss et al. 2008). Water control structures also affect salinity and selenium accumulation by trapping and concentrating contaminants, and in the case of selenium, potentially preventing adequate soil oxygenation to volatilize the contaminant (Seiler et al. 1999, Euliss and Mushet 2004, Nelson and Reiten 2006).

Water Quality

Extensive research on selenium contamination and loading has been conducted on Benton Lake Refuge (Lambing et al. 1994, Nimick et al. 1996, Nimick 1997, Zhang and Moore 1997, Henney et al. 2000). Because this alternative would continue current management, the average total load of selenium deposited on the refuge annually would be expected to be the same as has occurred over the last 30 years (151 pounds/ year, table 31). The total pounds of selenium that enter Benton Lake annually from pumped versus natural runoff would be highly variable among years depending on the relative amounts of water flowing to the lake from natural runoff in the Lake Creek watershed versus water pumped from Muddy Creek. On average, approximately 61 percent of the selenium comes from natural runoff and 39 percent from pumped water. Pumping increases the total selenium load to the refuge and prevents long-term dry cycles, which could remove selenium from the system.

A selenium cycling model, developed specifically for Benton Lake Refuge in 1997, predicted that Units 1 and 2 would become a toxic threat sufficient to cause complete, or nearly complete, reproductive failure in sensitive species of aquatic birds in 9 and 17 years, respectively (Zhang and Moore 1997, Lemly 1995, 2002). As of 2008, selenium levels in Unit 1 had not yet reached the toxic threshold. This appears to be because selenium inputs from natural runoff were 86-percent below the long-term average used in the original calculations. It is expected that when natural runoff, and associated selenium inputs, increase during the next wet cycle, which appears to have begun in 2009, units 1 and 2 may again have as little as 9–17 years, respectively, before they become highly toxic, under current management. It may even be fewer years, because the selenium in the upper 0.8 inch of sediment of Unit 1 was 60-percent higher in 2008 than the original model values in 1994 (Zhang and Moore 1997). If this occurred, drying out Unit 1 for more than 10 years would likely be necessary to try to remove selenium via volatilization (Zhang and Moore 1997). The new inlet wetland would likely be Unit 2, (due to infrastructure constraints), which if it continued to be flooded year-round for brood habitat, would likely cross the toxic threshold in 9 years. Due to the annual drying of the lower units, Units 3, 5, and 6 would never cross the toxic threshold. Unit 4, because of adjacent saline seeps, is predicted to cross the threshold in 67 years or less despite annual drying.

If both Units 1 and 2 accumulated selenium levels in the sediment more than 4 µg/g, there may be only two choices left to protect wildlife—destroy the wetland to limit access by wildlife (as was done at Kesterson National Wildlife Refuge) or remove selenium contaminated sediment from the wetland and start over, which is an extremely costly endeavor (Zhang and Moore 1997).

It is not currently known if phosphorous and other agrichemical nutrients are elevated in Benton Lake. Given the extensive conversion of native upland vegetation to farm production (wheat and barley) and farm practices such as crop and fallow farming in both the Muddy Creek and Lake Creek watersheds, it is a concern. Phosphorous and agrichemical nutrients further exacerbate and accelerate eutrophication (Craft and Richardson 1993a, b). Pumping would increase loads of these contaminants, but may also dilute concentrations.

Wetland Productivity

This alternative likely would continue to result in lower wetland productivity at potentially all levels of the food chain. Before 1961, Benton Lake experienced highly variable flooding and drying. After pumping began in 1962, refuge reports show that the wetland was very productive, as indicated by high waterfowl use. When a wetland refloods after a dry period, there is a pulse of nutrients that stimulates productivity in invertebrates, and some plants, which provides important food resources for waterfowl and other wetland-dependent wildlife (Magee 1995). Since this time, however, Benton Lake has experienced relatively stable water conditions with much less variability in flooding and drying. Stable water conditions negatively impact nutrient cycling in wetlands by creating anaerobic conditions and denitrification which can alter plant and invertebrate communities (Gosselink and Turner 1978, Magee 1995, Mitsch and Gosselink 2007, Malson et al. 2008, Euliss et al. 2008, Anteau 2012).

Variable flooding and drying conditions are key to sustaining complex interactions that create diversity and abundance in resources, such as invertebrates, that wetland-dependent wildlife require for migration and breeding (Schneider 1999, Murkin and Ross 1999, Anteau 2012). In general, greater diversity and abundance of invertebrates in wetlands supports a greater diversity of birds (Murkin and Ross 1999). When water conditions become more stable, optimal conditions for only a select suite of species are provided, plant and animal diversity is reduced and single species begin to dominate. However, the benefits for these species are likely to be short term and not sustainable if stable water conditions continue (Euliss et al. 2008, Anteau 2012). Although long-term, rigorous studies on invertebrates and other indicators of productivity have not been conducted at Benton Lake, the decreasing diversity of plant communities and waterfowl use observed by staff are likely to be primarily the result of stable water conditions.

The continuation of adding at least 4,000 acre-feet of pumped water into the refuge every year would increase erosion along Lake Creek and the load of sediment and contaminants being washed into the basin over and above the amount coming in with natural runoff, thus compounding the negative effects of these inputs. Given that this has already been occurring for 50 years, another 15 years is likely to be even more detrimental to productivity, as hydrology in the wetland has been stabilized for many years (Murkin et al. 1997, van der Valk and Davis 1978).

Wetland Vegetation

Flooding the units to approximately the same level, at the same time, every year would likely cause existing stands of monotypic vegetation, such as alkali bulrush, cattails and invasive Garrison creeping foxtail to continue to expand or become denser, especially in a dry cycle. This is because pumped water would be creating consistent water levels that favor the expansion of these species rather than allowing drier conditions where these species would be replaced by vegetation that is more competitive during drought. A wet cycle, with significant flooding, may create more open areas where current vegetation is drowned out (van der Valk 1981, Murkin et al. 1997, Frederick and Ogden 2001, Heitmeyer et al. 2009).

Water Resources

Water rights would be supported by continuing to use all water rights on an annual basis.

Visitor Services

A variety of visitor services opportunities exist. In FY 2011, approximately 10,000 visits occurred at the refuge. The most popular use continues to be wildlife observation (7,250 visits) followed with environmental education (1,700 participants), wildlife photography (400 visits), hunting (375 visits), interpretation (75 visits), and fishing (50 visits). Visits would be similar, with potential reductions, if habitat conditions continue to decline, which may affect usage of wildlife that attract refuge visitors. In addition, wet years with peak runoff, some uses would increase such as waterfowl hunting.

Limited law enforcement patrols are needed to manage this use at the present level; however, if use increases more demands for staff time are possible. There is a potential for conflict between user groups.

Hunting

A water budget model was developed with refuge staff and USGS to assess effects on changes in water management on the refuge (Nimick et al. 2011). This model is based on refuge water use records, precipitation, evaporation and runoff from 1970–2006. If the next 30 years are similar to the last 30 years, in a wet cycle, the refuge would be greater than 50-percent full 4 years out of 15 and would never be less than 7-percent full. In a dry cycle, the refuge would be 10-percent, or less, full most years, but never completely dry (Nimick et al. 2011). During the wet years, waterfowl hunting may increase significantly for 1 to 2 years. This has been documented in fall of 2011, in which hunter use nearly doubled during a peak runoff year. During the dry cycle, hunter numbers are expected to be similar to hunter usage

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Kingsbury Waterfowl Production Area. One of the many wetland habitats on the refuge complex.

recorded in past 10 years, which average approximately 300 visits annually. Over the past 15 years, waterfowl hunting peaks opening weekend with approximately 40 individual hunters. Weekends, until big game season opener, are about half the level of opening weekend with a peak of three to six hunting parties daily during the week. Just before freeze up, less than 6 hunting parties are generally using the refuge each day during the weekend. Over the life of the plan, the total waterfowl hunting visits are estimated to be 4,500 visits.

In addition to opportunity is a measure of quality of hunting experience. The quality of the hunt would continue to be marginal (as described by hunters at refuge open houses). Available open water would continue to decline over time with single species dominating such as alkali bulrush or invasive Garrison creeping foxtail. Extreme wet events such as that documented in 2011 would help set back the Garrison, but it may rapidly return. Solidification of sediment is not addressed, so it would still be a difficult hunting experience for hunters due to the muck buildup in refuge units including hunt units. A quality hunt experience also includes availability of waterfowl. If habitat is marginal, this reduces bird use and limits species availability for hunting, lowering the quality of the hunting experience.

Upland gamebird hunting is expected to remain relatively stable at 75 visits per year currently occurring, throughout the life of this plan totaling approximately 1,125 visits. No significant improvements would be expected in upland grasslands, so no increase in availability of birds for hunting is expected. Existing grasslands would continue to decline, which could affect bird numbers available to hunters.

Total hunting visits annually would be approximately 375 visits with an estimated total for the life of the plan at 5,625 visits.

Wildlife Observation and Photography

Primary focus of the wildlife observation and photography use is along the auto tour route, Boardwalk Prairie Marsh Trail, Lower Marsh Road, and grouse blind. No changes would occur at these facilities, except the possibility of another grouse blind being established due to repeated requests to enhance this opportunity since demand exceeds supply. This would result in a modest increase in visitor usage by approximately 100 visits per year.

Wildlife observation and photography account for 73 percent of overall annual visitation to the refuge. The number of visits are not expected to experience significant annual changes throughout the life of the plan; however, a slight decline from current usage is a possibility. Wildlife availability is not expected to change rapidly; however, not addressing serious management concerns such as selenium accumulation, lack of management of grassland habitat, and vegetative shifts resulting in single species dominance including invasive species would cause continued decline of wetland health and productivity. This, in turn, would result in steady reduced usage by wildlife. Visitors participating in wildlife observation and photography, which depend on the presence of wildlife, would be affected due to these declines. Although diversity of wildlife species (wetland and grassland-dependent species) is not expected to change, the number of individual species would continue to decline, which may affect observation numbers. If selenium levels result in toxic levels, significant declines in bird production would be expected, resulting in potential capping of the refuge and removal of observation opportunity and significant loss of species usage.

Current use is very limited on some roads that are already open to motor vehicles. Waterbirds may be slightly disrupted from this use. The time of year that these activities take place and the extremely limited level of use would cause very little negative effect on wildlife or habitat. Users may gain knowledge of the Refuge System and the refuge. There is a potential for conflict between user groups.

Environmental Education and Interpretation

We would expect no significant changes in the number of environmental education participants on the refuge, which is about 1,700 annually. Most of these participants would be Great Falls public schools third graders, STEM Expo participants, and the Montana Envirothon Event. These opportunities enhance the communities understanding of the Refuge System and mission of the Service, enhance environmental ethics, and develops advocacy of youth for natural resources.

Staff and Funding

Total costs for pumping ($960,000) and operations and maintenance ($825,000) through the life of the plan is estimated to cost $1,785,000.

Operations and maintenance for managing water requires staff to manage the water movement, record and produce annual water use reports. Support and run the pump house, and perform regular maintenance on the infrastructure associated with water management. The cost of operations and maintenance at the FY 2011 rates is expected to average $55,000 per year. For the life of the plan, operations and maintenance is estimated to cost $825,000. The price per acre-feet of pumped water varies significantly year to year. Based on the last 10 years, costs per-acre feet have ranged from $13.13 to $23.60. In addition to cost per-acre feet variable by year so is the amount of pumped water due to variations in natural runoff. In the past 10 years, the amount of pumped water has ranged from 2,849 to 5,082 acre-feet. The average acre-feet pumped per year and the cost per acre-feet used for costs estimates is $16 per acre-feet with an average pumped acre-feet of water of 4,000 acre-feet. Electricity expenses for pumping are estimated to cost $960,000 over 15 years. If energy prices go up, which is considered likely, either total cost would be higher, or less water could be pumped.

Under current management, inventory and monitoring is completed primarily by the wildlife biologist, seasonal biological technician, and through the help of the deputy refuge complex manager. Selenium sampling has occurred and water usage is documented.

No prescriptive habitat treatment is actively occurring within the wetland units.

Staff limitations under current management would remain and be stretched thinner with each added conservation easement in the three approved conservation areas. Easement contracts, evaluations, and preliminary acquisition work—inherently district manager's responsibilities—are supported by a temporally shared full-time position. Other easement programs (Farmers Home Administration, grassland, wetland) would continue to be administered but with little to no time to cultivate interest for acquisition.

Management of native prairie tracts would be ongoing but limited staff time does not allow site specific, quantitative monitoring of species composition and vegetative trends. This information is necessary to evaluate the success of current management regimes.

Farming and reseeding degraded tame grass stands have been considered but shortages of resources has prevented any concerted efforts. As tame grass stands continue to degrade over time into poor habitat conditions, the initial resources to address these habitat needs grows substantially.

Currently there are no specific management activities in regard to tree plantings.

Current predator control efforts require 60 staff hours over 4 months. Added costs for bait, traps, and fuel are a few hundred dollars per year.

Resource Protection

Currently, law enforcement patrols are limited to managing visitor services and resource protection.

7.14 Consequences of Alternative B1

Most staff time and efforts would be directed toward providing migration and breeding habitat every year for wetland-dependent wildlife, primarily waterfowl. A 50-percent reduction in the amount of brood habitat compared to alternative A1 is expected. Management within the wetland units includes short-term dry cycle and application of intensive prescriptive habitat treatment. Risk of botulism could be elevated over alternative A1 if summer flooding in lower units becomes necessary. Compared to alternative A1, selenium input into the wetland may be reduced and increase in removal of accumulated selenium may occur. Reduction in the toxic hazard to wildlife is expected, but less certain than the other alternatives. Short-term improvement in the health and sustainability of the wetland units is expected from reducing selenium contaminant levels, controlling nonnative vegetation, and stimulating productivity. The ability to absorb perturbations in the system is expected to improve over alternative A1, but is not self-sustainable. Over the life of the plan, wildlife-dependent recreation is estimated to be similar to alternative A1 for fishing visits; wildlife observation and photography visits; and interpretation and environmental education programming visits. Hunting visits are expected to increase 10-percent over alternative A1. Over the life of the plan, the total cost to carry out wetland basin management (operations and maintenance, pumping, monitoring, and prescriptive habitat treatment) is estimated to range from $2,641,000 to $2,829,000. Compared to alternative A1, an increase of a term biological technician, two seasonal biological technicians, and a maintenance worker dedicated to the refuge and a proportion of supervisory wildlife biologist, generalist, and law enforcement officer assigned to the complex are necessary to carry out this alternative.

Grasslands

Native Grasslands

Same as alternative A1, plus, with the increased effort to manage Benton Lake wetlands, there may be more declines in biological diversity, ecological integrity and environmental health of the refuge native grasslands.

Tame Grasslands

Same as alternative A1.

Nonnative Tree Plantings

Same as alternative A1.

Wetlands and Riparian Areas

Water Quantity and Timing

Either Unit 1 or 2 would be flooded year-round through the life of the plan to provide brood habitat. Each of the lower units would be dried out one at a time for at least 3 years. It is assumed that 3 years would be sufficient to get enough drying, but this may end up being longer (4–6+ years). Flooded units would still be allowed to dry during July. In a wet cycle, the refuge would be greater than 50-percent full 3 years out of 15 and would never be less than 5-percent full. In a dry cycle, the refuge would be 10 percent, or less, full most years, but never completely dry (Nimick et al. 2011). However, during a wet cycle, intended drying rotations may be delayed by high levels of natural runoff.

Infrastructure

Same as alternative A1.

Water Quality

Initially, Unit 1 would be dried out to reduce the selenium contamination in the sediments to less than 2 µg/g, a level where selenium may be slightly elevated in one or more ecosystem components, but no imminent toxic threat exists (Lemly 1995, 2002). Based on current selenium concentrations in the sediment of Unit 1, and a sediment volatilization rate estimated for Benton Lake (Zhang and Moore 1997), the Service estimates at least 8 years of drying to reduce selenium in Unit 1 to an average of less than 2 µg/g. During this time, natural runoff and pumped water would enter into Unit 2 (via the old Lake Creek channel in Unit 1), which would now accumulate selenium at a higher rate (Zhang Moore 1997). If using the old Lake Creek channel is not successful, a diversion channel may be constructed. If the next 15 years are dry, alternating every 2 years between Units 1 and 2, after the initial 8 years of drying, may keep selenium contamination at an acceptable level. Conversely, in a wet cycle, with increased natural runoff, the selenium levels in Unit 2 would rise more quickly during the drying of Unit 1, and it may not be possible to keep both units below the 2 µg/g threshold. However, if reductions in inputs could be achieved through work in the Lake Creek watershed described under Partnerships for Conservation, this concern could be reduced.

In Units 3-6 have lower starting concentrations of selenium than Units 1 and 2 in the sediment. Rotating short-term dry cycles (3+years), as well as annual drying in July, should keep these units below the toxic threshold.

The potential for improving any contamination from phosphorous, nitrogen and agrichemicals is unknown and would need monitoring.

Wetland Productivity

The overall effect on wetland productivity is uncertain in this alternative. The rotation of short-term dry cycles across units will increase the variability in flooding and drying that stimulates productivity (Frederickson and Reid 1995). However, the annual variation will not be the same as historic flooding and drying cycles. Productivity, for example in invertebrates, would likely be reduced because these species may not be adapted to these short term flooding and drying cycles (Magee et al. 1999). This alternative is not a self-sustaining system and would need significant management action intervention to stimulate diversity of plant and animal communities and improve productivity (Euliss et al. 2008).

Although a dry cycle would be implemented at the scale of an individual impoundment, the effects of long-term (10-20 year) wet and dry cycles at the scale of the entire refuge and the landscape would not be emulated with management. Long-term cycles at the refuge and landscape scale stimulate cycles of invertebrate communities, plant communities, and mammalian predators that create complex interactions that are not emulated by managing at the individual impoundment level. For example, some invertebrates are able to exploit newly flooded wetlands because they hold over in dry wetland sediments. This creates a window of opportunity to be very productive before other invertebrates, that must find the wetland by flying from distant wetlands, arrive and compete for resources. After an extended dry cycle, with few if any nearby flooded wetlands, this could take some time. In this alternative, this early window will not exist because newly flooded units will be immediately invaded from an adjacent flooded unit (Murkin and Ross 1999). Similarly, landscape-wide dry cycles that historically reduced communities of predators that prey on nesting birds will not occur under this alternative because Benton Lake will always have water somewhere that attracts prey for these predators (for example, Krapu et al. 2004).

Wetland Vegetation

Introducing at least a 3-year drying cycle rotation is expected to increase wetland vegetation diversity across the wetland basin. As units dry, monotypic stands of emergent vegetation, such as alkali bulrush, cattails and Garrison creeping foxtail, would die and give way to drier, terrestrial vegetation. How quickly this happens would likely depend on weather, the existing seedbank, any potential subirrigation from neighboring units and more management actions such as prescribed fire or discing. This may also create newly exposed mudflats that could provide opportunities for nonnatives such as Canada thistle to become established.

Once a unit is reflooded, it would transition from flooded grasses and annual forbs, to more open water as these plants die, to eventual reestablishment of alkali bulrush, cattails and possibly, Garrison creeping foxtail. During the flooding phase, these plants would likely continue to expand and reform dense, monotypic stands, as in alternative A1. In addition, in units that are not immediately dried, the emergent vegetation would continue to expand, as well as the nonnative Garrison creeping foxtail. A more aggressive drying rotation could be implemented by having more units in the dry cycle and fewer in the wet cycle. This would start reducing the emergent vegetation and reset the vegetation cycle (described above) on more of the refuge. Conversely, a wet cycle, with significant flooding, may create wetlands with large open areas where current vegetation is drowned out (van der Valk 1981, Murkin et al. 1997, Heitmeyer et al. 2009).

Water Resources

Same as alternative A1.

Visitor Services

A variety of visitor services opportunities would occur, with wildlife observation the dominant use. Overall visits for wildlife observation and hunting may increase slightly compared to alternative A1 due to improvement within individual units from management efforts to emulate natural processes such as drying. Some restrictions in the availability of use may occur due to rotation of units through variety of management prescriptions. The quality of visitor use experiences may improve as habitat quality improves based on the management prescriptions.

Hunting

Overall hunter numbers are expected to remain stable with slight increases (approximately 10 percent) possible, and the quality of the experience is expected to improve. The long-term trend at Benton Lake has been an overall decline in hunter numbers; however, the Service expects stable numbers with perhaps a modest increase from alternative A1.

A decrease in waterfowl hunters in individual units exposed to drying is expected. Units may be dry between 3 and 4 years eliminating waterfowl hunting opportunity during the treatment phase. This loss of opportunity is expected to be compensated by an increase in open water available to hunters in other units already receiving prescriptive management. Annually, waterfowl hunting visits are projected to be 330 visits per year, with approximately 4,950 waterfowl hunting visits expected over the life of the plan.

The short-term dry cycles are expected to improve habitat conditions of wetlands, which in turn, may improve the overall quality of hunting for waterfowl hunters over alternative A1. Available open-water habitat is expected to increase and improve over time. Over time, management actions are expected to reduce the Garrison creeping foxtail, alkali bulrush, and cattail stands. Solidification of the wetland sediments is expected to improve access for waterfowl hunters in the hunt units. Prescriptive habitat treatments are expected to improve habitat and in turn increase the availability of waterfowl, improving the hunting experience. These benefits are greatest in the years immediately following drying, prescriptive treatment, and flooding and would eventually diminish over time with subsequent stable water management.

The individual wetland unit would be the focus of restoration efforts. In addition, due to the rotational system some units would not receive treatment until toward the end of the 15-year planning process. In turn, these improvements in habitat that are linked to hunting experience may not occur immediately and be spread across the latter half of the planning process (years 8–15). Units experiencing treatment are expected to improve more rapidly. If habitat objectives are not met, more drying would be implemented throughout the units, which may reduce the availability of fall water for hunting waterfowl.

To administer a rotational system would require shifting the available hunting units. This could lead to confusion by hunters, especially if these changes occur on an annual basis. This may require hunters to annually refresh themselves on the rules and regulations associated with hunting on the refuge. This would take greater effort from refuge staff as well to clearly communicate the changes and expectations of refuge hunters through open houses and other outreach efforts. Although unlikely, the rotational system may contribute to access challenges for hunters based on closed area restrictions.

An increase in upland gamebird hunter visits due to the expansion of available habitat is expected. The annual upland hunting visits is estimated to be 83 visits and over the life of the plan 1,245 upland gamebird-hunting visits is expected.

Total estimated annual hunting visits for waterfowl and upland gamebird is 413 visits and 6,195 visits over the life of the plan. This is a 10-percent increase over alternative A1, which is the highest expected hunting visits of any of the alternatives.

Wildlife Observation and Photography

Same as alternative A1, plus the improvements in habitat would be expected to result in healthier wildlife populations than alternative A1, which would include greater diversity of species and more opportunity for wildlife observation and photography.

The auto tour route, and the opening of other interior roads (after July 15), may vary due to rotation and changes in the closed area. By changing water management within the units, waterbirds may become less habituated to traffic and therefore may be more disrupted with bicyclists or hikers passing by or stopping to observe. Visitors may have difficulty telling which roads are open and which are closed on a yearly basis. Maintenance of roads would cost more and would need to be conducted more frequently if use increases.

Environmental Education and Interpretation

Same as alternative A1, plus opportunities for wetland based interpretation and education would still exist although potentially in different locations. Under alternative A1, Unit 2 has been used by the GFPS as the location for the segment of the third grade visits that deals with wetlands. Under this alternative, Unit 2 may be dry. If this occurs, the onsite sampling location could easily be moved to another location within the wetland basin.

Staff and Funding

Expenses associated with pumping would be the same as alternative A1, plus this alternative would need increases in money and staff to support the intense prescriptive management and rotational dry cycle per unit. Staff increases to accomplish this alternative include: a large part of the supervisory biologist assigned to the complex to supervise biological activities associated with the refuge and help the deputy complex manager manage the water movement, record, and produce annual water use reports, support and run the pump station; 1.0 FTE biological technician and two 0.8-FTE seasonal biological technicians to watch selenium, botulism, vegetation, nest success, and bird use; and 1.0 FTE maintenance worker to help manage, support the pump house and infrastructure and conduct some of the prescriptive management treatments. In addition, the addition of full time law enforcement officer assigned to the complex would provide approximately 25 percent of their time helping with issues on the refuge.

Over the life of the plan, the total expenses for operations and maintenance, pumping, monitoring, and prescriptive habitat management are estimated to range from $2,641,000 to $2,829,000.

Operations and maintenance expenses are estimated to be similar to alternative A1 ($825,000 over the life of the plan).

Pumping expenses can vary due to how much natural runoff is received and how much pumping is necessary. Due to this variability estimates were calculated on whether a wet cycle is encountered or a dry cycle. Pumping could range between $991,000 to $1,048,000 over the life of the plan, a slight increase from alternative A1.

Ensuring that results toward meeting selenium, vegetation, and wetland health objectives are occurring, would require significant monitoring efforts

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Students from Centerville, Montana, identify birds at the visitor center at Benton Lake National Wildlife Refuge.

over alternative A1. Monitoring costs are estimated to be $45,000 per year totaling $675,000 over the life of the plan.

Prescriptive management (such as discing, grazing, prescribed fire, or mowing) will predominately be accomplished in-house through Maintenance Action Teams or staff. The costs are expected to vary based on seasonal conditions from $150,000-$281,000 over the life of the plan.

Redirecting permanent staff from other units within the refuge complex would be necessary to help meet the pumping, operations and maintenance, monitoring, and habitat treatment expenditures. If pumping costs continue to raise this would need an added proportion of staff time and discretionary money to cover the expenditure or reduction in the amount of pumped acre-feet of water.

Monitoring refuge-wide nest success as part of the predator-trapping effort would need a substantial increase in staff time compared to alternative A1. Past nest success monitoring conducted on the refuge required at least 3 staff people for 2 months. In addition, preplanning, data entry, analysis and summary would need another month of the biologist's time. Added cost for equipment would likely be less than $1,000 per year.

One-time costs associated with this alternative include diversion channel. The structure has been suggested as a possible enhancement of water movement by diverting water from Units 1 and 2. Costs for constructing the channel were estimated at $100,000 in 2005.

Resource Protection

Law enforcement patrols commitments would be increased to make sure users understand changes in visitor access necessary to accommodate efforts to improve habitat. Preventative law enforcement efforts such as signing, news releases, informational open houses and notice posting would be increased over alternative A1 to help reduce confusion and increase compliance of visitors to refuge rules and regulations.

7.15 Consequences of Alternative B2

Initial dry period and application of intensive prescriptive habitat treatment basin-wide is expected to improve the health and sustainability of the wetland basin and reduce selenium contaminant levels, control nonnative vegetation, and stimulate productivity. This alternative will provide will provide for a wide suite of migratory bird species (shorebirds, waterfowl, and grassland birds) over the life of the plan, and if pumping is resumed, migration and breeding habitat for wetland-dependent wildlife would occur more frequently than under a natural hydro-period. Compared to alternative B1, selenium input into the wetland is expected to be reduced at least 15-20 percent and removal of accumulated selenium will increase. A reduction in the toxic hazard to wildlife is expected. Short-term improvements in wetland health with long-term sustainability improved over alternatives A1 and B1, but it is not expected to be self-sustainable. Improvement in grassland habitats expected from conversion up to 207 acres of tame grass and removal up to 3.5 miles of shelterbelt habitat. The ability to absorb perturbations in the system is expected to improve over alternative B1 due to initial dry period, but is not self-sustainable once flooding resumes Over the life of the plan, wildlife-dependent recreation is estimated to be similar to alternative A1 for fishing visits; wildlife observation and photography visits; and interpretation and environmental education programming visits. Over the life of the plan, hunting visits are expected to decrease 15 percent over alternative A1. Over the life of the plan, the total cost to carry out wetland basin management (operations and maintenance, pumping, monitoring, and prescriptive habitat treatment) is estimated to range from $1,816,000 to $2,263,000. One-time implementation costs for grassland restoration are expected to total $36,000. Staffing to carry out the alternative are the same as alternative B1.

Grasslands

Native Grasslands

During the initial, basin-wide drying period, more complex resources would be available to protect and manage grasslands as described for alternative C1. If pumping is reintroduced, intensive management would resume and effects would be the same as alternative B1.

Tame Grasslands

During the initial, basin-wide drying period, up to 207 acres of degraded tame grass stands would be planted back to native grass species where proper and feasible. This would be followed with prescribed fire and grazing management to emulate historical processes and gradually recover soil mycorrhizae, invertebrate diversity and symbiotic relationships.

The associated nutrient cycles would be largely improved in comparison to mining the soil nutrients through rotational haying systems used to manage tame grass. Once native grass species are reestablished, soil erosion potential should be negligible, with permanent plant cover breaking the cropping cycle of tame grass. Carbon sequestration and nutrient cycling would be significantly greater in a more floristically diverse community.

Nonnative Tree Plantings

The strategic removal of 3.5 miles of nonnative tree plantings on the refuge would restore contiguous grassland habitat and reduce negative effects of fragmentation, predation and parasitism to grassland-dependent migratory birds (Bakker 2003). Distance to a wooded edge has been shown in many studies to increase nest predation and displace grassland species (Bakker 2003). This makes grassland habitat around tree plantings either unavailable or less desirable for grassland species. The distance varies by study area and species, but the Service estimates that between 65 and 750 acres of grassland habitat would become available or more desirable to grassland species by removing these trees (Bakker 2003). The highest priority plantings for removal are those that bisect large tracts of native prairie.

There may be a decrease in the diversity of migratory and resident bird species that depend on planted tree habitats. However, there would still be 15.5 miles of nonnative tree plantings on the refuge in addition to other nearby habitats, including the Missouri River riparian areas and neighboring agricultural tree plantings.

Wetlands and Riparian Areas

Water Quantity and Timing

The refuge would stop pumping for an initial period (approximately 8 years). During this time, all wetland units would only receive natural run-off. Once wetland objectives are met, pumping may be phased back in slowly with careful monitoring (with a rotational system similar to alternative B1). Long-term and recent weather patterns suggest the next 15 years are likely to be a wet cycle, so the success of this approach is highly uncertain. To be successful in this alternative, the period of not pumping will need to coincide with a natural dry cycle which may not occur during the initial years of this plan.

Infrastructure

Same as alternative A1.

Water Quality

As described in alternative B1, Unit 1 is estimated to take at least 8 years of drying to reduce selenium in the sediment to levels where flooding with pumped water could be reintroduced. Since both Units 1 and 2 will be drying simultaneously in this alternative, the selenium levels in both units will be decreasing during the initial drying period, which will make it easier to keep the units below toxic thresholds if pumping is reintroduced. The initial drying phase will also reduce selenium inputs over the life of the plan by 15-20 percent compared to alternative B1. The initial drying phase, with the associated reduction in resources needed to manage water, would also provide an opportunity to work more intensely in the Muddy Creek and Lake Creek watersheds to reduce selenium inputs. This may make pumping more sustainable if it is reintroduced and reduce some of the negative effects of altering the natural hydrology described for alternative B1.

Wetland Productivity

Following the initial, basin-wide drying period, the wetland productivity should improve as described for alternative C1. If pumping is reintroduced, intensive monitoring would be needed to support improvements and prevent or reduce negative effects of altering the natural hydrology described for alternatives A and B1.

Wetland Vegetation

During the initial, basin-wide drying period, a reduction in monotypic stands of emergent vegetation such as cattail and alkali bulrush would be expected. In addition, Garrison creeping foxtail may decline more rapidly than alternative B1 because there will not be the potential of subirrigation from adjacent flooded units and the seedbank will be decreasing across the whole basin. If pumping is reintroduced, intensive monitoring would be needed to support improvements and prevent or reduce negative effects of altering the natural hydrology described for alternatives A and B1.

Water Resources

Same as alternative C1. Water rights should be preserved as long as pumping occurs within an 8-year time period (USFWS Solicitor). However, if objectives are not met and more drying is necessary, this may risk the Muddy Creek rights if challenged by other users. No changes or risk of loss is expected for Lake Creek water rights for they would be exercised throughout the life of the plan by capturing natural run-off.

Visitor Services

A variety of wildlife-dependent recreational opportunities would be available. There would be an initial drying period until habitat objectives are met, with subsequent flooding on a regular basis as long as habitat objectives were supported. This would result in a mixture of effects on visitor services by reflecting a drying period similar to alternative C1 and a flooding regime similar to alternative B1.

Hunting

An increase in the number of waterfowl hunting visits is expected over alternatives C1 and C2 and a decrease from alternatives A1 and B1. The exact amount of time needed for drying is uncertain, and the exact number of years of pumping is not known. For these estimates, the Service assumed there would be nearly an even split between the number of years of pumping and drying. However, long-term hydrographs suggest we are currently in year 2 of a potential 5-year wet cycle, and it is likely that it would not be possible to begin a dry period for 3–5 years.

If pumping is reinstated, waterfowl hunting annually visits could be as much as alternative B1 with an average 330 visits per year. During nonpumping years, the projected average annual use of 120 visits per year should be similar to alternatives C1 and C2. If the Service assumes 8 years of dry and 7 years of pumping, the number of waterfowl-hunting visits over the life of the plan is estimated to be up to 3,375 visits.

The improvements in habitat condition are expected to improve waterfowl hunting experience similar to alternative B1; plus these improvements will be significant especially during the waterfowl hunting season following an extended dry period.

Improvements in the grasslands habitats may occur, but are not expected until the later years of the plan (years 10–15). Improvement to grasslands includes the planned conversion of 207 acres of tame grassland to native prairie and the removal of interiorly placed shelterbelts (3.5 miles). This may negatively affect some of the nonnative upland game species (pheasants and Hungarian partridges) and to a lesser extent native sharp-tailed grouse that are accustomed to using nonnative grasslands and shelterbelts for shelter and food. This reduction in usage of upland gamebirds may affect upland hunters.

During the dry period, more habitat would be available to hunt upland gamebirds. In addition, the upland gamebird hunting season will be expanded, which would provide more hunting opportunities. This is expected to result in an increase in upland gamebird visits. Upland gamebird-hunting visits have been estimated by averaging alternatives B1 and alternative C1, which totals 1,380 visits over the life of the plan. This exceeds upland game hunting visits for alternatives A1 and B1 and is less than alternatives C1 and C2.

Total hunting visits on a yearly basis is estimated to be 317 visits per year and 4,755 visits over the life of the plan. This is a 15-percent decrease from alternative A1.

Wildlife Observation and Photography

Same as alternative B1, plus during the reset dry period, the ability to observe certain water-dependent wildlife would be more variable. Water modeling suggests that there would be water on the refuge in March–May in 22 years out of 30. This means that there would continue to be an opportunity to see water-dependent wildlife most years, although in some years it may be limited to migrating, as opposed to breeding birds. Refuge staff are committed to continuing to provide wildlife observation opportunities and are interested in hearing ideas from the public on ways that the upland wildlife viewing could be expanded. While grassland birds can be more challenging to observe, they are a group of birds of high conservation concern due to their continental population declines, and the refuge would like to increase education and awareness of these species.

Environmental Education and Interpretation

Same as alternative A1, plus an emphasis on interpretation and education relating to the restoration efforts to meet habitat objectives and wetland health and productivity would begin.

Staff and Funding

Staff necessary to accomplish this alternative would be the same as alternative B1; however, slight shifts in proportion of staff time spent on the refuge versus other complex units are expected to change slightly. This includes reduction of time by supervisory biologist, wetland district manager, wildlife refuge specialist, and an increase in time by the complex's Assistant Fire Management Officer to conduct more prescribe fires.

Over the life of the plan, the total expenses for operations and maintenance, pumping, monitoring, and prescriptive habitat management are estimated to range from $1,816,000 to $2,263,000. This is less than alternative B1 and slightly higher than alternative A1. Operations and maintenance costs would vary from nonpumping years ($5,000 per year) to pumping years ($55,000 per year). Operations and maintenance costs for the life of the plan are estimated to total $425,000, which is less than alternatives A1 and B1. Pumping would not occur during the initial drying phase (8 plus years), but would resume if habitat objectives are met and supported. Pumping expenses are estimated to occur annually once the initial drying period resets the system. Pumping costs across the life of the plan are estimated to range from $434,000 to–$729,000, depending on how much natural runoff is received.

Monitoring would be a significant expense and is estimated to be the same as alternative B1. Intense monitoring during the initial drying period and annually, if pumping is resumed, would be necessary to make sure habitat objectives are being met. Monitoring expenses are estimated to total $45,000 per year and $675,000 for the life of the plan.

During the initial drying period, all units would be undergoing rapid prescriptive habitat treatment; this exceeds management expenditures compared to all other alternatives. It is expected to require not only in-house staffing to accomplish, but contracted help as well. This very intensive treatment is expected to set back the accumulated negative effects that the lack of drying has caused from the last 50 years of repetitive water level management. Management treatments are estimated to total $282,000 to$434,000 depending on the natural runoff.

Added one-time costs associated with this alternative include: shelterbelt restoration of 3.5 miles and up to 207 acres of tame grass conversion to native species. Forestry cutters are available within Region 6 and maybe reserved in advance for specific projects; such as shelterbelt restoration. The tree removal work could be accomplished by existing staff in the fall and winter months. Costs to remove 3.5 miles of planted trees would be approximately $1,000 and include: fuel, maintenance of the equipment (replacing teeth and fluids, repairing breakdowns, and herbicide treatment for two growing seasons, and grass reseeding. The conversion of up to 207 acres of tame grass is estimated to cost $35,000. This would be completed over multiple years. These projects are expected to be completed during the extended drying period.

Resource Protection

Same as for alternative B.

7.16 Consequences of Alternative C1 (Proposed Action)

The long-term sustainability of the whole refuge will be restored which will help a wide suite of migratory bird species (waterfowl, shorebirds, and grassland birds) over the life of the plan. Compared to alternative A1, selenium input into the wetland is expected to be reduced at least 40 percent and removal of accumulated selenium will be maximized. A reduction in the toxic hazard to wildlife is expected. Restoring the full extent of the dry cycle improves the wetland health with long-term sustainability over alternatives A1, B1, and B2, and is expected to be self-sustainable. Improvement in grassland habitats expected from conversion up to 728 acres of tame grass and removal up to 19 miles of shelterbelt habitat. The ability of wetlands and grasslands to absorb perturbations in the system is expected to greatly improve over alternatives A1, B1 and B2 since resistance and resiliency is strengthened from the restoration of natural processes. Over the life of the plan, wildlife-dependent recreation is estimated to be similar to alternative A1 for fishing visits with an increase of 25 percent for wildlife observation and photography visits and interpretation and environmental education programming visits. Over the life of the plan, hunting visits are expected to decrease 41 percent over alternative A1. Over the life of the plan, the total cost to carry out wetland basin management (operations and maintenance, pumping, monitoring, and prescriptive habitat treatment) is estimated to range from $809,000 to $941,000. One-time implementation costs for grassland restoration are expected to total $118,500. Restoration of the wetland basin could range from $0 to $4,000,000 if complete removal of water management infrastructure is necessary. Compared to alternative A1, an increase of a term biological technician and seasonal biological technician dedicated to the refuge and a proportion of supervisory wildlife biologist, generalist, law enforcement officer, and park ranger assigned to the complex are necessary to carry out this alternative.

Grasslands

Same as alternative B2 during the initial drying phase, plus more resources would be available to manage and improve the quality of native prairie in the uplands. In addition, more acres of tame grass (up to 728) are likely to be replanted to native prairie and the associated benefits, as described under alternative B2, realized on more acres.

Approximately half of the refuge is native, mixed-grass prairie. While some areas have been invaded by nonnative grasses such as crested wheatgrass, Japanese brome and cheatgrass, it remains a major block of nearly 6,000 acres of native grassland habitat in a larger landscape where most of this valuable resource has been lost.

The refuge has tremendous value to grassland birds, the group of birds that have experienced the most severe population declines in recent history. For example, chestnut-collared longspurs and grasshopper sparrows are abundant and the Sprague's pipit, which is a candidate for listing under the ESA, regularly occurs on the refuge. The refuge sharp-tailed grouse viewing blind is extremely popular with the public. Even in dry years, the refuge would have value to wildlife and meet its purpose as a refuge and breeding ground for birds.

The removal of the nonnative tree plantings (up to 19 miles) established in native grasslands would occur. This would have the same effects as described for alternative B2, plus the most acreage of grassland habitat would become available or more desirable to grassland bird species by removing the trees (Bakker 2003). Up to 18 species of migratory birds that nest primarily in trees and shrubs may no longer nest on the refuge. However, there are many tree plantings that surround the refuge and some of these species may still use the refuge for feeding and resting. The loss of nesting habitat for loggerhead shrikes and Swainson's hawks on the refuge would not be expected to have a significant negative effect on the overall populations of these species. The cost to remove all nonnative tree plantings would increase over those described in alternative B2 to approximately $3,500 and 40 days of staff time.

Wetlands and Riparian Areas

Water Quantity and Timing

The hydrology of the basin would be restored with flooding and drying cycles decided by natural runoff. In a wet cycle, the wetland basin would be greater than 50-percent full 3 years and could be dry 7 years out of 15. In a dry cycle, the refuge would be dry most years (Nimick et al. 2011). Historical records over the last century show that the refuge went through wet periods in the early 1920s, late 1930s, late 1950s, mid-1970s and early 1990s, or about every 10–20 years, with dry periods inbetween (Heitmeyer et al. 2009). Precipitation and runoff have increased in the last 2 years, which may be suggesting that over the initial 3–8 years of this plan, it may be a wet cycle.

Infrastructure

The Service would use an adaptive management approach to removing the wetland infrastructure.


Jeff Van Tine

A long-billed curlew with a wide-prairie view on the refuge complex.

Refuge staff would start with the smallest modifications necessary and only proceed to full removal if it is necessary because monitoring results show that sufficient progress is not being made toward the refuge objectives. By just restoring the natural hydrology, and decreasing the frequency and duration of flooding, subsurface and surface moisture gradients would be improved (Euliss et al. 2008). Unless infrastructure is modified; however, it may prevent full restoration of these gradients that directly influence vegetative and macro invertebrate distribution within the wetland basin.

Modifications may also be necessary to restore natural waterflow patterns into and through Benton Lake and wind- and water-related soil erosion and deposition patterns (Heitmeyer et al. 2009). For example, to restore the benefits of sheet flow that quickly moves across a wetland basin shallowly flooding the greatest area and warming quickly to make invertebrates, in particular, available to many birds, some or all of the ditches in the wetland may need to be filled. The dikes and ditches also create sediment traps altering the soil chemistry and microbial processes that support wetland function, can drive the system toward eutrophy, may prevent the scouring of sediment and transportation of mineralized nutrients as well as favor anoxia and inhibit the release of nutrients that may not be corrected for by just restoring the hydrology (Jarworski and Raphael 1978, Brix 1993, Euliss et al. 2008).

Water Quality

The restoration of Units 1 and 2 to wet meadow wetlands would almost completely preclude future selenium loading in this area as most water would be in Lake Creek and only occasionally overflow across the old units. However, selenium that has accumulated in sediment is not readily removed through volatization and can take several years (Zhang and Moore 1997). Added management actions, such as prescribed fire, may help (Zhang and Moore 1997).

The primary way to decrease selenium accumulation at Benton Lake is to decrease inputs (Zhang and Moore 1997). By ceasing pumping, the refuge would realize an automatic 40-percent decrease in selenium inputs over the long term and as much as a 75-percent decrease during dry years (Nimick et al. 1996) at no cost. Furthermore, the area where Lake Creek would again enter the refuge, and selenium deposition would expected to be highest, would be one of the first areas to dry out as waters recede. With reduced inputs and increased drying, the refuge would reach an equilibrium below the 2 µg/g threshold. Pre-1961 selenium levels were only 0.2–0.3 µg/g in Unit 3, even though crop–fallow agriculture had been widespread in the watershed for more than 40 years (Zhang and Moore 1997, Heitmeyer et al. 2009). In 1994, levels had only increased to 0.4–0.5 µg/g, which suggests that returning to a pre-1961 hydrological cycle (no pumping) should support selenium levels below toxic thresholds. Again, prescribed fire to support wetland vegetation health, may also help keep selenium levels low in the restored inlet area. However, intensive wetland management methods would not be necessary to reduce selenium.

Wetland Productivity

Overall wetland productivity would improve over alternatives A, B1 and B2, especially during wet cycles, but it will be more variable over time. Restoring the full variability in the wet–dry cycle should have a positive effect on ecosystem processes and increase nutrient cycling (Gosselink and Turner 1978, Mistsch and Gosselink 2007, Malson et al. 2008, Euliss et al. 2008). As wetland restoration progresses, wetland productivity in the Benton Lake ecosystem would likely follow long-term dynamics of production in other northern prairie systems as vegetation, invertebrate, and nutrient cycling changes when wetlands dry, reflood, reach peak flooding extent, and then begin drying again (for example, Murkin et al. 2000, Anteau 2012).

Dry conditions would be recurring and often last for several years in a 10 to 20 year cycle. During this time, the area of wetland vegetation and the vigor of wetland plants would be reduced while the extent of terrestrial plants would expand. Wetland-dependent species richness would be low for this period, but upland species would likely move into the basin and use grassland habitat. Once drought conditions are broken, the basin may flood rapidly when sufficient precipitation or spring runoff occurs. When a wetland refloods after a dry period, there is a pulse of nutrients that stimulates productivity in invertebrates, and some plants, which provides important food resources for waterfowl, shorebirds and other wetland-dependent wildlife (Magee 1995, Anteau 2012). These wet periods may occur for 1 to 3-plus years in the 10 to 20 year cycle (Heitmeyer et al. 2009). As precipitation declines, water levels would decline from evaporation, and vegetation would shift from wetland to a more terrestrial phase.

Restoring annual and long-term variability in the wetland basin would increase plant and animal diversity over the long term while providing optimal conditions for different suites of species at different times. Single species would be less likely to become dominant or the extent or length of monotypic conditions would be reduced (Euliss et al. 2008). Densities of certain species of macroinvertebrates may decline; however, species diversity should increase

(Collinson et al. 1995). For example, invertebrates that need a dry period during winter would be able to complete their life cycle and provide important food for avian spring migrants and breeders (Schneider 1999, Murkin and Ross 1999, Anderson and Smith 2000). This increase in variability and diversity should increase long-term sustainability (Peterson et al. 1998, Euliss et al. 2008).

The flooding and drying cycles would be synchronized at the refuge and the landscape scales. Long-term cycling at the refuge and landscape scale stimulate invertebrate communities, plant communities, and mammalian predators that create complex interactions that are not emulated by managing at the individual impoundment level (Schneider 1999, Murkin and Ross 1999, Krapu et al. 2004, Anteau 2012). The potential for reductions in wetland-dependent invasive species and mammalian predators during drought cycles would be greater than in alternatives A, B1 and B2.

Wetland Vegetation

Over the life of the plan, the precise distribution of wetland vegetation species groups would vary over time as surface water coverage and depth change with wet and dry cycles (for example, van der Valk and Davis 1978, van der Valk 1989). In general, a reduction in the coverage of robust, emergent vegetation such as cattail and alkali bulrush would be expected. Extended drying would be expected reduce Garrison creeping foxtail as well, but the duration and extent of these reductions is less certain. This vegetation would be replaced with wetland species adapted to more seasonal and temporary flooding cycles such as occurred historically on the refuge (see section 7.10).

The lowest elevations in the Benton Lake basin (about 73 acres) would contain some surface water throughout most years and supported open-water aquatic plant communities surrounded by concentric bands of robust emergent vegetation including cattail and hardstem bulrush. The width of this emergent vegetation band would vary depending on the extent and duration of flooding and chronological position of the long-term hydrological cycle. Submergent aquatic plants such as pondweeds, naiads, coontail, wigeon grass, and milfoil may be present in the deepest open areas along with rich algal blooms.

Semipermanently flooded sites that are slightly higher in elevation, next to cattail and bulrush zones, would support diverse sedge and rush species. These sedge–rush communities include diverse herbaceous wetland plants including alkali bulrush, three-square rush, Nuttall's alkaligrass, beaked sedge, Nebraska sedge, and water smartweed. This sedge–rush community may expand during wet periods to even higher elevation edges of the basin and then contract to lower elevations during extended dry periods. The periodic flooding and drying of these vegetation zones could cause moderate alkaline soil conditions.

Seasonally flooded areas would likely contain diverse annual and perennial herbaceous plants and wet-prairie meadow grasses such as spikerush, lambsquarter, annual smartweeds, prairie cordgrass, and saltgrass. Spikerush would be expected in relatively narrow bands along yearly flooded stream and tributary sites and the margins of the lake. Whereas, saltgrass would be common in more saline or alkali sites including areas where seeps flow into Benton Lake and in some overflow areas next to Lake Creek.

The highest elevation edges of Benton Lake would have short duration seasonal flooding regimes in the transition zone from wetland to upland grassland plant communities. Foxtail barley would occur on the higher, annually drawn down, margins of the lake basin and in some ephemeral depressions. Foxtail barley would likely gradually grade to western wheatgrass on terraces next to the lake.

If restoring the hydrology is not sufficient to achieve the expected vegetation communities, infrastructure will be modified or removed to facilitate this process.

Water Resources

The Service's solicitor suggested that the water rights for Muddy Creek will be kept by pumping the minimum amount required. This is expected to be at least once every 8 years. However, no indications of interest in the Service's right from other water users has occurred. The water right for Lake Creek would be supported.

Visitor Services

Opportunities to inform the public about restoration efforts would be featured in educational and interpretive programming. Outreach efforts with the community would increase due to the establishment of a position to address visitor services programming. Wildlife-dependent recreation for wetland species would be tied to natural runoff events. A decrease in late summer and fall standing water is expected to affect some recreational user groups.

Hunting

The availability of water for waterfowl hunting would depend on natural runoff. The water budget model developed by refuge staff and USGS to assess effects on changes in water management on the refuge (Nimick et al. 2011) is based on 30 years of data collection. Under the assumption that the next 30 years would be similar to the last 30 years, inferences about water conditions during waterfowl season (fall) can be extrapolated. Conservatively, the model suggests that for the life of the plan (15 years), 3–5 years should result in fall water exceeding 2,127 acres (greater than 50 percent of the managed wetland basin), 3 years of fall water levels varying from at least 0–97 acres of water, and 8 years of no water. Historical hydrographs suggest that wet cycles occur over a 5-year window. These wet cycles saturate the soils and result in portions of the wetland basin containing surface water year-round.

For the past 2 years, the refuge has experienced runoff characteristic of a wet cycle. It is expected that the next 2–3 years would also be wet in the fall with a gradual reduction in surface water in the basin for the next 5 years. During these wet years, hunter use has been documented to double over earlier levels (alternative A1). Approximately 600 visits annually during a wet cycle, can be expected for about 3 years. During 4 years of less than 97 acres of water, the ability to provide a waterfowl hunt will be evaluated on an annual basis. During the dry cycle (8 years), no waterfowl hunting is expected to occur. This would result in an estimated 1,800 waterfowl hunter use-days for the life of the plan. This is a 60-percent reduction in use compared to alternative A1; a 64-percent reduction in use compared to alternative B1; a 47-percent reduction in use compared to alternative B2; and similar use for alternative C2.

Waterfowl hunting experience is expected to be similar to the experiences currently occurring on the waterfowl production areas. In addition to the presence of water, waterfowl hunting experience is also influenced by the quality of the hunt based on bird availability and habitat condition. Improvements in habitat conditions would occur throughout the basin, which would provide open water, solidified sediment, vegetative diversity, increased forage and seed availability, and resulting increase in bird use.

Upland gamebird-hunting visits per year would increase over alternatives A1, B1, and B2 due to extending the refuge season to corresponded with the State designated season, increase in upland gamebird habitat during dry years, and promotion of upland hunting opportunities by the visitor services program during dry years. When the wetland basin is dry, a greater proportion of the refuge is available for upland gamebird habitat compared to alternatives A1 and B1.

Improvements in the grasslands habitats are expected to occur. Improvement to grasslands would involve the planned conversion of up to 728 acres of tame grassland to native prairie and the removal of shelterbelts (19 miles). This may negatively affect some of the nonnative upland gamebird species (pheasants and Hungarian partridges), and to a lesser extent native sharp-tailed grouse, that are accustomed to using nonnative grasslands and shelterbelts for shelter and food. This reduction in usage of nonnative habitats may affect upland gamebird hunting; however, the increase in hunting area and extended late season opportunities are expected to offset the effect of grassland restoration efforts.

Under this alternative, 1,500 upland gamebird hunter visits are expected over the life of the plan which is greater than alternatives A1, B1, and B2.) The expectation of 100 visits per year is not unrealistic, and actual usage may exceed this estimate as well. Upland gamebird hunter use is expected to be same as alternative C2.

Decisions would be made on a year-by-year basis about the location of open and closed areas for waterfowl hunting. Changes in the hunting area could lead to confusion for hunters and require increased awareness of regulations. An increase in communication efforts by staff to provide annual information and post hunt area would be necessary. In addition, modifications occurring to infrastructure such as dikes and ditches may create access challenges for hunters. All attempts would be made by refuge staff to reduce access issues whenever possible.

Total hunting visits over the life of the plan are expected to be the same as alternative C2 (3,300 vis-


Neal Mischler

Yellow-bellied marmot.

its), 47-percent less than alternative B1, 41-percent less than alternative A1, and 31-percent less than alternative B2.

Wildlife Observation and Photography

The ability to observe certain water-dependent wildlife would be more variable. Water modeling suggests that there would be water on the refuge during March–May in 22 years out of 30. This means that there would continue to be an opportunity to see water-dependent wildlife most years, although in some years it may be limited to migrating, as opposed to breeding birds. Refuge staff would expand upland wildlife observation opportunities. While grassland birds can be more challenging to observe, they are a group of birds of high conservation concern due to their continental population declines, and the refuge would like to increase education and awareness of these species.

The hiring of a park ranger to address visitor services issues would increase awareness of the refuge and wildlife observation and photography opportunities, restoration activities, ecological functions of wetlands, unique attributes of native prairies, and perils of grassland-dependent bird species. This increased exposure is estimated to increase visitation to the refuge 25 percent over alternative A1 for a total of approximately 143,440 visits over the life of the plan.

Modifications to the Prairie Marsh Drive and Lower Marsh Road auto tour routes may occur due to restoration efforts. More nature trails are expected to offset any visitation losses that could occur from the modifications.

The habitat restoration efforts would increase the health and vigor of wetland and grassland habitats resulting in the increase diversity and abundance of wildlife species for wildlife enthusiast to enjoy. Wildlife observation and photography are expected to continue to be the dominant recreational use occurring on the refuge.

Environmental Education and Interpretation

The addition of a park ranger to address visitor services issues on the refuge complex would increase environmental education and interpretive programming an estimated 25 percent over alternative A1, for a total of approximately 33,280 visits over the life of the plan. The focus would include such issues as restoration efforts, appreciation of native prairie habitats, wetland health and productivity. The understanding by the community of the refuge's purpose and importance of conserving management, and restoring healthy functioning ecosystems would be increased. The Service would communication more widely the importance of natural hydroperiods in wetlands. The communities' awareness and appreciation for the refuge and refuge complex would be enhanced beyond alternatives A, B1 and B2.

Staff and Funding

Staff necessary to accomplish this alternative would be the same as alternative B2; plus, slight shifts in the proportion of staff time spent on the refuge versus other complex units are expected to reduce slightly. This includes reduction of time by wetland district manager, wildlife refuge specialist, and maintenance worker. In addition, there would be the reduction of two, 0.8 biological technician positions and a full time maintenance worker. Under alternative C1; 50 percent of a park ranger position would be focused on the refuge while the remaining percentage would be spread across the complex units.

Over the life of the plan, the total expenses for operations and maintenance, pumping, monitoring, and prescriptive habitat management are estimated to range from $809,000 to $941,000. This is less than alternatives A1, B1 and B2 and slightly higher than alternative C2. As the system becomes more self-sustaining, resources would be allocated toward other units in the refuge complex such as conservation areas. Operations and maintenance is closely tied to pumping. Since this alternative includes limited pumping during the life of the plan, operations and maintenance expenses are expected to be extremely low compared to alternatives A1, B1 and B2. During nonpumping years, operations and maintenance expenses are estimated to total $5,000 per year. Operations and maintenance expenses throughout the life of the plan are estimated at $75,000.

Alternative C1 includes extremely limited pumping to support water rights (pumping once every 8 years) or as a habitat management tool. Because it is expected to be used minimally under this alternative, pumping expenses are estimated to be $20,000 over the life of the plan. This is less than alternatives A1, B1, B2, and higher than alternative C2.

During the course of restoration, monitoring the effects of management actions would be critical to figure out the next response as part of the ARM approach. Monitoring to document changes and progress toward meeting objectives for vegetation, selenium, macroinvertebrates, water quality and other factors would be occurring. Monitoring is estimated to cost $45,000 annually for the first 5 years while intensive monitoring evaluates the success of management actions and figures out the next management response. From years 6–15, monitoring is estimated to be reduced to $35,000 each year. Over the life of the plan, monitoring is estimated to total $575,000.

Prescriptive habitat treatment is expected to be reduced and primarily focused on invasive species control, prescribed fire, and grazing. Management treatments would be applied basin-wide to get the full effect of restoration efforts. Prescriptive habitat treatment throughout the life of the plan is estimated to range from $139,000 to $271,000 depending on natural runoff. This is less than alternatives B1 and B2, and same as alternative C2.

One-time costs associated with the alternative include the expenses made toward the restoration of the basin. These are estimated to range from $0 to $4,000,000 if full-restoration is necessary. Restoration efforts could include the removal of dikes, creating low water crossings, recontouring of the wetland basin, removal of riprap, filling of ditches and channels, and reestablishment of the Lake Creek channel. Restoration costs may be less than the entire amount if during the ARM approach it is found that only minor alternations are necessary versus complete removal of structures such as water control structures or dikes.

Added one-time costs associated with this alternative include: shelterbelt restoration of 19 miles and up to 728 acres of tame grass conversion to native species. Costs to remove 19 miles of planted trees would be approximately $3,500 and the conversion of up to 728 acres of tame grass is estimated to cost $115,000. This would be completed over multiple years.

Resource Protection

Due to changes in hunting area, increase patrol presence would be necessary along with preventative law enforcement efforts to reduce hunter confusion and violations.

7.17 Consequences of Alternative C2

The long-term sustainability of the whole refuge will be restored which will help a wide suite of migratory bird species (waterfowl, shorebirds, and grassland birds) over the life of the plan. Compared to alternative A1, selenium input into the wetland is expected to be reduced at least 40 percent and removal of accumulated selenium will exceed all other alternatives. A reduction in the toxic hazard to wildlife is expected. Restoring the full extent of the dry cycle and completely restoring the wetland basin improves the wetland health with long-term sustainability over all other alternatives, and is self-sustainable. Removal of wetland infrastructure would be irreversible and reduce management flexibility permanently. Improvement in grassland habitats expected from conversion up to 728 acres of tame grass and removal up to 19 miles of shelterbelt habitat. The ability of wetlands and grasslands to absorb perturbations in the system is maximized over all other alternatives, since resistance and resiliency is optimized from the restoration of natural processes. Over the life of the plan, wildlife-dependent recreation will be the same as alternative C1. Over the life of the plan, the total cost to carry out wetland basin management (operations and maintenance, pumping, monitoring, and prescriptive habitat treatment) is estimated to range from $601,000 to $733,000. One-time implementation costs for grassland restoration are expected to total $118,500. Restoration of the wetland basin is expected to range from $1,200,000 to $4,000,000 and complete removal of water management infrastructure including the decommissioning of the pump house will be completed within the first half of the life of the plan. Staffing to carry out the alternative are the same as alternative C1, except one less seasonal biological technician.

Grasslands

During the restoration phase, refuge complex resources may be focused on restoration of the Benton Lake basin, which could reduce efforts to manage and protect grasslands. However, after restoration, the effects would be the same as described in alternative C1.

Wetlands and Riparian Areas

Water Quantity and Timing

Same as alternative C1.

Infrastructure

Same as alternative C1, except any potential benefits from removing infrastructure would occur more quickly. Conversely, unnecessary and irreversible changes to the infrastructure could also occur.

Water Quality

Same as alternative C1, except any potential benefits from removing infrastructure would occur more quickly. However, without the infrastructure, the Service loses some management flexibility and possible tools to address unexpected problems.

Wetland Productivity

Same as alternative C1, except any potential benefits from removing infrastructure would occur more quickly. For example, infrastructure can alter moisture gradient diversity which directly influences vegetative and macroinvertebrate distribution within the wetland basin (Euliss et al. 2008). However, without the infrastructure, the Service loses some management flexibility and possible tools to address unexpected problems.

Wetland Vegetation

Same as alternative C1, except any potential benefits from removing infrastructure would occur more quickly. However, without the infrastructure, the Service loses some management flexibility and possible tools to address unexpected problems. For example, if deep flooding will decrease invasive plants more quickly than drying, this will not be a possible tool under this alternative.

Water Resources

The water rights for Muddy Creek could be lost if challenged in court for nonuse. The water right in Lake Creek would be kept.

Visitor Services

Hunting

Same as alternative C1, plus habitat improvements could occur more rapidly and across entire basin at relatively simultaneously improving habitat conditions at a faster pace than alternative C1.

Wildlife Observation and Photography

Same as alternative C1.

Environmental Education and Interpretation

Same as alternative C1.

Staff and Funding

Staff necessary to accomplish this alternative would be the same as alternative C1; plus, a slight shift in proportion of staff time spent on the refuge versus other complex units are expected to reduce slightly for the supervisory biologist. In addition, there would be the reduction of a 0.8 biological technician position.

Over the life of the plan, the total expenses for operations and maintenance, monitoring, and prescriptive habitat management are estimated to range from $601,000 to $733,000. This is less than alternatives A1, B1, B2 and C1. It is the most cost effective alternative. As the system becomes more self-sustaining, resources would be allocated toward other units in the refuge complex such as conservation areas.

Operations and maintenance is closely tied to pumping. Since this alternative does not include pumping, during the life of the plan, operations and maintenance expenses are estimated to be extremely low compared to alternatives A1, B1 and B2 and 50-percent less than C1 as well. Operations and maintenance expenses are estimated to total $5,000 per year, and totaling $37,500 over the life of the plan.

Under this alternative, no pumping will occur.

Monitoring is estimated to cost $35,000 annually for years 1–5 and $25,000 per year for years 6–15 for a total estimated monitoring cost for the life of the plan at $425,000. This is the least amount across the alternatives.

Prescriptive habitat treatments are estimated to be the same as alternative C1, ranging from $139,000 to $271,000.

One-time costs associated with the alternative include the complete restoration efforts. This is expected to occur rapidly within the first 6 years of the plan implementation. This would require an estimated $1,200,000 to $4,000,000 from the onset of plan implementation. Applying money saved from not pumping and the subsequent savings from operations and maintenance could be applied to other priority management actions and programs in the refuge complex like the conservation easement program more quickly than alternative C1.

Added one-time costs associated with this alternative include: shelterbelt restoration of 19 miles and up to 728 acres of tame grass conversion to native species same as alternative C1.

Resource Protection

Same as alternative C1.

7.18 Socioeconomic Environment

Impacts from Refuge Revenue Sharing

Under provisions of RRS, local counties receive an annual payment for lands that have been purchased by full fee simple acquisition by the Service. Payments are based on the greater of 75 cents per acre or 0.75 percent of the fair market value of lands acquired by the Service. The exact amount of the annual payment depends on congressional appropriations, which in recent years have tended to be less than the amount to fully fund the authorized level of payments. In FY 2010 (FY10), actual RRS payments were 21 percent of authorized levels. FY10 Benton Lake Refuge RRS payments (made in 2011) were: $338 to communities in Cascade County; $8 to communities in Chouteau County; and $235 to communities in Teton County for a total payment of $581. Table 37 shows the resulting economic impacts of RRS payments under all alternatives. Accounting for both the direct and secondary effects, RRS payments for alternatives A1, B1, B2, C1, and C2 would generate total annual economic impacts $200 in labor income and $300 in value added in the local three-county impact area.

Table 37. Annual impacts from refuge revenue sharing payments for all alternatives for Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time jobs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Alternatives A1, B1, B2, C1, and C2			
Direct effects	< 1	$0.2	$0.2
Secondary effects	< 1	$0.0	$0.1
Total economic impact	< 1	$0.2	$0.3

Impacts from Public Use and Access Management

Benton Lake National Wildlife Refuge Visitor Expenditures in Local Economy

The overarching goal of the Benton Lake Refuge public use program is to enhance wildlife-dependent recreation opportunities and access to quality visitor experiences while managing units to conserve fish, wildlife, plants, and their habitats. A variety of recreational opportunities are associated with the "Big-Six" wildlife-dependent uses: wildlife observation and photography, interpretation, environmental education, hunting, and fishing. Ducks, geese, coots, sharp-tailed grouse, gray partridge, and ring-necked pheasants can be hunted on Benton Lake Refuge. Hunting of all other species is prohibited. Benton Lake Refuge does not offer fishing opportunities on the main part of the refuge due to a lack of sport fish. The Pump House Unit is open for walk-in access to Muddy Creek which provides trout fishing opportunities. In FY11, approximately 300 waterfowl hunting visits, 75 upland game hunting visits, and 50 fishing visits occurred at Benton Lake Refuge.

The most popular recreational activity on the refuge is wildlife observation and photography. The Auto Tour Route, Prairie Marsh Boardwalk, Lower Marsh Road, and the sharp-tailed grouse blind are popular observation areas. In addition, Benton Lake Refuge has the potential to expand the environmental education and interpretation program. In FY11, approximately 9,425 nonconsumptive related visits occurred at Benton Lake Refuge including; wildlife observation (7,250 visits), environmental education (1,700 visits), wildlife photography (400 visits), and interpretation (75 visits).

This section focuses on the regional economic impacts associated with Benton Lake Refuge visitation. Annual visitation estimates for the refuge are based on several refuge statistic sources including: visitors entering the visitor center or office and general observation by refuge personnel. Annual visitation estimates are on a per visit basis. Visitor spending profiles are estimated on an average per day (8 hours) basis. Because some visitors only spend short amounts of time visiting the refuge, counting each refuge visit as a full visitor day would overestimate the economic impact of Benton Lake Refuge visitation. To properly account for the amount of spending, the annual number of refuge visits were converted to visitor days. Refuge personnel estimate that anglers and upland game hunters spend approximately 4 hours (1/2 a visitor day) on the refuge, while waterfowl hunters spend approximately 6 hours (3/4 a visitor day). Visitors that view wildlife or take part in other wildlife observation activities typically spend 4 hours (1/2 a visitor day).

To figure out the local economic impacts of visitor spending, only spending by persons living outside of the local three-county area are included in the analysis. The rationale for excluding local visitor spending is twofold. First, money flowing into the local three-county area from visitors living outside the local area (hereafter referred to as nonlocal visitors) is considered new money injected into the local economy. Second, if residents of the local three-county area visit Benton Lake Refuge more or less due to the management changes, they will correspondingly change the spending of their money elsewhere in the local area, resulting in no net change to the local economy. These are standard assumptions made in most regional economic analyses at the local level. Refuge personnel found out the percentage of nonlocal refuge visitors. Table 38 shows the estimated percent of current refuge visits and visitor days by visitor activity.

The refuge staff anticipates that the number of fishing visitors will remain constant for all the alternatives. Nonconsumptive use visitation will remain similar to current estimates for alternatives A1, B1, and B2 but is anticipated to increase by 25 percent under alternatives C1 and C2. The expected increase in visitation is due to the hiring of a Park Rangerwho will specialize on developing and enhancing educational, observation, and interpretative programming by tapping into the resources of Great Falls. Upland game hunting is expected to remain the same under alternative A1 but increase 10 percent under alternative B1, increase 23 percent under alternative B2, and increase 25 percent under alternatives


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Greater short-horned lizard.

Table 38. Estimated current annual visitation for Benton Lake National Wildlife Refuge, Montana.

Visitor Activity	*Total annual number of visits*	*Number of hours spent at Refuge*	*Total annual number of visitor days**	*Percentage of nonlocal visits (%)*	*Number of nonlocal visitor days**
Fishing	50	4	25	0%	0
Waterfowl Hunting	300	6	225	25%	56
Upland Game Hunting	75	4	38	10%	4
Non consumptive visitors: wildlife observation, photography, education, and interpretation	9,425	4	4,713	42%	1,980
Total Visitation	*9,850*		*5,001*		2,039

* One visitor day = 8 hours.

C1 and C2 due to extended season, increase in available hunt area offered during dry cycle years, grassland restoration efforts, and promotion of upland hunting experience by the visitor services program during dry years.

Waterfowl hunting visitation is expected to remain similar to current estimates for alternative A1. Under alternative B1, the refuge staff anticipates waterfowl hunting to increase slightly (10 percent) compared to alternative A1. The anticipated increase is due to improvement within individual units from management efforts to mimic natural processes such as drying. Under alternative B2, the refuge staff anticipates that there would be a split between the number of years of pumping and nonpumping. During the pumping period, annual waterfowl hunting use is anticipated to be similar to annual use under alternative B1 (on average 330 visits per year), and during nonpumping years, annual use is anticipated to be similar to alternatives C1 or C2 (on average 120 visits per year). Therefore, the number of waterfowl hunting visits over the life of the plan are estimated to be 3,375 visits which would equate to an annual average of 225 visits for alternative B2.

Under alternative C1, the availability of water for waterfowl hunting would be dependent upon natural run-off and would vary over the 15-year life of the plan. For the past 2 years, the refuge has experienced run-off characteristic of a wet cycle. It is expected that the next 2-3 years will also be wet in the fall with a gradual reduction in surface water in the basin for the next 5 years. During these wet years, the refuge has experienced a 100-percent increase in hunter use from alternative A1. This same usage (600 visits annually during a wet cycle) can be expected under alternative C1 for an estimated 3 years. During the anticipated 4 years of approximately 97 acres of water, the small surface area would likely result in very little area available for hunting. During this time period hunter use was conservatively estimated as the same as dry cycle. During the dry cycle of 8 years, no waterfowl hunting would occur. This would result in an estimated total of 1,800 waterfowl hunting use days for the life of the plan with a range of zero hunters to 600 waterfowl hunting visits (for 3 years). This reflects a 60-percent reduction in waterfowl hunting use compared to alternative A1; a 64-percent reduction in use compared to alternative B1; a 47-percent reduction in use compared to alternative B2; and similar use for alternative C2.

Table 39 summarizes the average annual estimated visits and visitor days by type of activity for all alternatives. For the purposes of the economic impact analysis, visitation over the 15 year life of the CCP must be converted to an average annual basis (as shown in table 18). The number of waterfowl hunters have the potential to fluctuate between 0 to 600 visits for the anticipated pumping and nonpumping years for alternatives C1, and C2. The economic impacts for the anticipated range of waterfowl hunters for pumping and nonpumping years will also be estimated. The anticipated 600 waterfowl hunting visits in pumping years would equate to 450 annual waterfowl hunter visitor days of which 113 visitor days would be from nonlocal waterfowl hunters.

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Wilson's phalarope on the refuge complex.

Table 39. Annual average number of visits and visitor days by activity and alternative for Benton Lake National Wildlife Refuge, Montana.

	Alternative A1	*Alternative B1*	*Alternative B2*	*Alternative C1*	*Alternative C2*
Total Visits					
Fishing	50	50	50	50	50
Waterfowl Hunting	300	330	225	120	120
Upland Game Hunting	75	83	92	94	94
Non consumptive visitors: wildlife observation, photography, education, and interpretation	9,425	9,425	9,425	11,781	11,781
Total Annual Visits	9,850	9,888	9,792	12,045	12,045
Total Visitor Days					
Fishing	25	25	25	25	25
Waterfowl Hunting	225	248	169	90	90
Upland Game Hunting	38	41	46	47	47
Non consumptive visitors: wildlife observation, photography, education, and interpretation	4,713	4,713	4,713	5,891	5,891
Total Visitor Days	5,000	5,026	4,952	6,053	6,053
Nonlocal Visitor Days					
Fishing	0	0	0	0	0
Waterfowl Hunting	56	62	42	23	23
Upland Game Hunting	4	4	5	5	5
Non consumptive visitors: wildlife observation, photography, education, and interpretation	1,979	1,979	1,979	2,474	2,474
Total Nonlocal Visitor Days	2,039	2,045	2,026	2,501	2,501

A visitor usually buys a wide range of goods and services while visiting an area. Major expenditure categories include lodging, restaurants, supplies, groceries, and recreational equipment rental. In this analysis we use average daily visitor spending profiles from the Banking on Nature report (Carver and Caudill, 2007) that were derived from the 2006 National Survey of Fishing, Hunting, and Wildlife Associated Recreation (FWS, 2008). The National Survey reports trip related spending of state residents and nonresidents for several different wildlife-associated recreational activities. For each recreation activity, spending is reported in the categories of lodging, food and drink, transportation, and other expenses. Carver and Caudill (2007) calculated the average per-person per-day expenditures by recreation activity for each FWS region. We used the spending profiles for nonresidents for FWS Region 6 (for the purposes of the analysis in the Banking on Nature report, Region 6 includes Montana), and updated the 2006 spending profiles to 2011 dollars using the Consumer Price Index Inflation Calculator. Average daily spending profiles for nonresident visitors to Region 6 for upland game hunting ($176.03 per-day) and waterfowl hunting ($75.88 per-day), were used to estimate nonlocal visitor spending for refuge fishing and hunting related activities. The average daily nonresident spending profile for nonconsumptive wildlife recreation (observing, feeding, or photographing fish and wildlife) was used for nonconsumptive wildlife viewing activities ($157.62 per-day).

Total spending by nonlocal refuge visitors was figured out by multiplying the average nonlocal visitor daily spending by the number of nonlocal visitor days at the refuge. The economic impacts of each alternative were estimated using IMPLAN. Table 40 summarizes the total economic impacts associated with current nonlocal visitation by activity and alternative. Under alternative A1, nonlocal Benton Lake Refuge visitors would spend approximately $316.9 thousand in the local economy annually ($312 thousand in spending by nonconsumptive visitors, $4.3 thousand by waterfowl hunters, and $700 by upland game hunters). This spending would directly account for 3 jobs, $75.6 thousand in labor income, and $123.8 thousand in value added in the local economy. The secondary or multiplier effects would generate 1 job, $39.9 thousand in labor income, and $70.8 thousand in value added. Accounting for both the direct and secondary effects, spending by nonlocal visitors for alternative A1 would generate total economic impacts of 4 jobs, $115.5 thousand in labor income, and $194.6 thousand in value added. As shown in table 40, almost all (98.5 percent) of the nonlocal impacts are generated by nonconsumptive visitors.

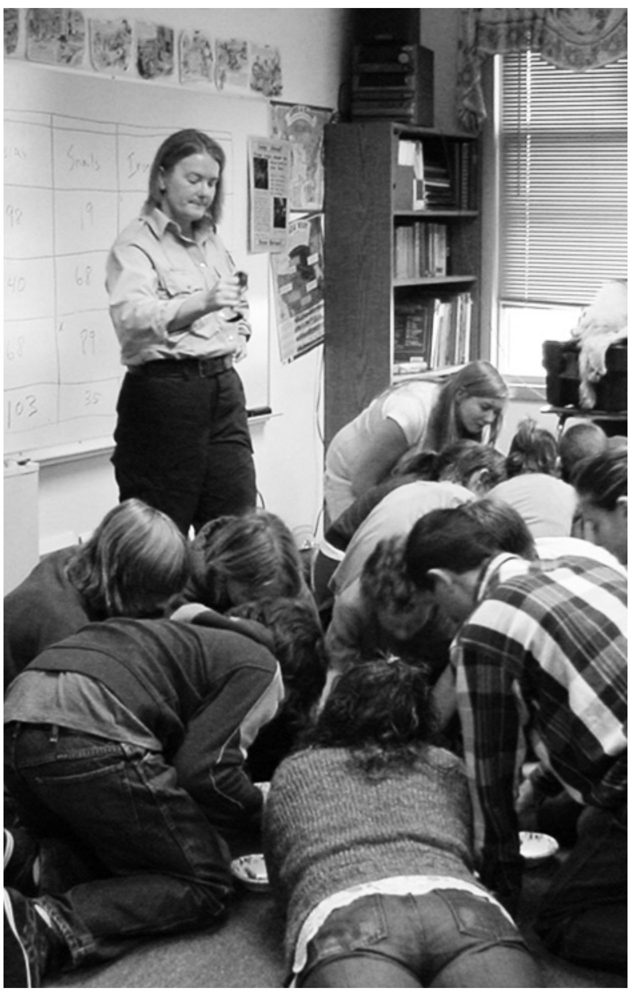
Under alternative B1, nonlocal Benton Lake Refuge visitors would spend approximately $317 thousand in the local area annually. Accounting for both the direct and secondary effects, average annual total spending by nonlocal visitors for alternative B1 would generate total economic impacts of 4 jobs, $115.7 thousand in labor income, and $195.3 thousand in value added. The total annual average economic impacts for alternative B2 would be similar to alternative A1.

Table 40. Average annual impacts of nonlocal visitor spending by activity and alternative for Benton Lake National Wildlife Refuge, Montana.

	Nonlocal Waterfowl Hunting			*Nonlocal Upland Game Hunting*			*Nonlocal Nonconsumptive Visitation*			*Total Nonlocal Visitation*		
	Employment	Labor Income	Value Added	Employment	Labor Income	Value Added	Employment	Labor Income	Value Added	Employment	Labor Income	Value Added
	(# full and part time jobs)	(Thousands, $2011)		(# full and part time jobs)	(Thousands, $2011)		(# full and part time jobs)	(Thousands, $2011)		(# full and part time jobs)	(Thousands, $2011)	
						Alternative A1						
Direct effects	< 1	$1.0	$1.6	< 1	$0.1	$0.2	3	$74.5	$122.0	3	$75.6	$123.8
Secondary effects	< 1	$0.5	$0.8	< 1	$0.1	$0.1	1	$39.4	$69.8	1	$39.9	$70.8
Total effect	*< 1*	$1.5	$2.4	*< 1*	$0.2	$0.4	*4*	$113.9	$191.8	4	$115.5	$194.6
						Alternative B1						
Direct effects	< 1	$1.1	$1.8	< 1	$0.2	$0.3	3	$74.5	$122.4	3	$75.8	$124.4
Secondary effects	< 1	$0.5	$0.9	< 1	$0.1	$0.2	1	$39.4	$69.8	1	$39.9	$70.9
Total effect	*< 1*	*$1.6*	*$2.6*	*< 1*	$0.3	$0.4	*4*	$113.9	$192.2	4	$115.7	$195.3
						Alternative B2						
Direct effects	< 1	$0.8	$1.2	< 1	$0.2	$0.3	3	$74.5	$122.4	3	$75.5	$123.9
Secondary effects	< 1	$0.3	$0.6	< 1	$0.1	$0.2	1	$39.4	$69.8	1	$39.8	$70.6
Total effect	*< 1*	*$1.1*	*$1.8*	*< 1*	$0.3	$0.5	*4*	$113.9	$192.2	4	$115.2	$194.5
						Alternatives C1 and C2						
Direct effects	< 1	$0.4	$0.6	< 1	$0.2	$0.3	4	$93.1	$153.0	4	$93.7	$154.0
Secondary effects	< 1	$0.2	$0.3	< 1	$0.1	$0.2	1	$49.2	$87.3	1	$49.5	$87.8
Total effect	*< 1*	$0.6	$1.0	*< 1*	*$0.3*	*$0.5*	*5*	*$142.3*	*$240.3*	5	$143.2	$241.7

Under alternatives C1 and C2, nonlocal Benton Lake Refuge visitors would spend more than $390 thousand in the local area annually. Accounting for both the direct and secondary effects, spending by nonlocal visitors for alternatives C1 and C2 would generate total economic impacts of 5 jobs, $143.2 thousand in labor income, and $241.7 thousand in value added.

The economic impacts for the anticipated range of waterfowl hunters for pumping and nonpumping years for alternatives C1 and C2 are shown in table 20. In nonpumping years, waterfowl hunting will not occur and therefore, there would be no economic impacts. In pumping years, it is anticipated that there would be 600 annual waterfowl hunting visits (450 visitor days of which 113 are nonlocal visitor days). Nonlocal waterfowl hunters would spend approximately $8.6 thousand in the local area annually. Accounting for both the direct and secondary effects, average annual spending by nonlocal waterfowl hunters during pumping years would generate total economic impacts $2.9 thousand in labor income, and $4.8 thousand in value added (table 41).



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Benton Lake National Wildlife Refuge staff regularly conduct educational outreach in local communities such as at the Ulm School in Ulm, Montana.

Table 41. Range of annual impacts of nonlocal waterfowl hunter spending for pumping and nonpumping years under alternatives C1 and C2 for Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time jobs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Nonpumping years			
Direct effects	0	$0	$0
Secondary effects	0	$0	$0
Total economic impact	0	$0	$0
Pumping years			
Direct effects	< 1	$2.00	$3.20
Secondary effects	< 1	$0.90	$1.60
Total economic impact	< 1	$2.90	$4.80
Average annual impacts over life of plan			
Direct effects	< 1	$0.4	$0.6
Secondary effects	< 1	$0.2	$0.3
Total economic impact	< 1	$0.6	$1.0

Neal Mischler

White-tailed jackrabbit.

Impacts from Benton Lake National Wildlife Refuge Administration

Staff–Personal Purchases

Benton Lake Refuge employees reside and spend their salaries on daily living expenses in the local area, thereby generating impacts within the local economy. Household consumption expenditures consist of payments by individuals/households to industries for goods and services used for personal consumption. The IMPLAN modeling system contains household consumption spending profiles that account for average household spending patterns by income level. These profiles allow for leakage of household spending to outside the region. Several members of the refuge complex staff work at Benton Lake Refuge as well as other areas on the refuge complex. For the purposes on the economic analysis, the FWS provided the percentage split of staff time spent working at Benton Lake Refuge for each position. Table 42 illustrates staffing and time spent working at Benton Lake Refuge (as well as working on Benton Lake Refuge-related issues) for each alternative. Under alternative A1, salary would total $465.2 thousand for that part of time 13 of the refuge complex staff members spent working on Benton Lake Refuge. Table 42 shows the changes in positions, time spent working, and total salary amounts for Benton Lake Refuge staffing by alternative.

Table 42. Staffing and percent of time allocated for working by alternative on Benton Lake National Wildlife Refuge, Montana.

Positions by Alternative	Full Time Equivalent	Percent of Time Spent Working on Benton Lake Refuge				
		Alternative A1	Alternative B1	Alternative B2	Alternative C1	Alternative C2
Administrative Officer	1	40%	40%	40%	40%	40%
Assistant Fire Management Officer	1	35%	25%	35%	35%	35%
Bio-Science Technician	0.8	90%	90%	90%	90%	90%
Bio-Science Technician	0.5	75%	90%	90%	75%	75%
Bio-Science Technician	0.5	0%	0%	0%	0%	0%
Bio-Science Technician	0.8	0%	100%	100%	100%	0%
Bio-Science Technician (2 positions)	0.8	0%	100%	100%	0%	0%
Budget Analyst	1	20%	20%	20%	20%	20%
Refuge Complex Manager	1	50%	60%	60%	60%	60%
Deputy Refuge Manager	1	50%	60%	60%	60%	60%
Generalist	0.5	40%	50%	50%	50%	50%
Generalist	0.5	20%	40%	40%	40%	40%
Law Enforcement Officer	1	0%	25%	25%	25%	25%
Maintenance Worker	1	75%	90%	90%	75%	75%
Maintenance Worker	1	0%	100%	100%	0%	0%
Maintenance Worker	1	0%	0%	0%	0%	0%
Park Ranger	1	0%	0%	0%	50%	50%
Supervisory Wildlife Biologist	1	0%	80%	70%	70%	60%
Wetland District Manager	1	25%	35%	25%	15%	15%
Wildlife Biologist	1	75%	90%	90%	90%	90%
Wildlife Refuge Specialist	0.5	0%	20%	0%	0%	0%
Wildlife Refuge Specialist	1	10%	25%	20%	0%	0%
Wildlife Refuge Specialist	0.5	0%	0%	0%	0%	0%
Wildlife Refuge Specialist	1.0	0%	0%	0%	0%	0%
Total Salary		$465,200	$851,800	$822,700	$701,500	$644,700

Refuge personnel estimate that annual salaries total around $465.2 thousand for alternative A1 and would increase under all other alternatives. Table 43 shows the economic impacts associated with spending of salaries in the local three-county area by Benton Lake Refuge employees under all alternatives. For alternative A1, salary spending by Benton Lake Refuge personnel would generate the secondary effects of 3 more jobs, $108.1 thousand in added labor income, and $198.7 thousand in value added in the local economy. Alternative B1 would have the largest increase in impacts, generating secondary effects of 6 jobs, $198.0 thousand in labor income, and $363.9 thousand in value added in the local economy. As shown in table 43, impacts for alternatives B2, C1, and C2 are slightly less than alternative B1 but higher than alternative A1.


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Ducks on Benton Lake.

Table 43. Annual local impacts of salary spending by personnel by alternative for Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time jobs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Alternative A1			
Direct effects	0	$0.0	$0.0
Secondary effects	3	$108.1	$198.7
Total economic impact	3	$108.1	$198.7
Alternative B1			
Direct effects	0	$0	$0
Secondary effects	6	$198.0	$363.9
Total economic impact	6	$198.0	$363.9
Alternative B2			
Direct effects	0	$0	$0
Secondary effects	6	$191.2	$351.5
Total economic impact	6	$191.2	$351.5
Alternative C1			
Direct effects	0	$0	$0
Secondary effects	5	$163.1	$299.7
Total economic impact	5	$163.1	$299.7
Alternative C2			
Direct effects	0	$0	$0
Secondary effects	4	$149.8	$275.4
Total economic impact	4	$149.8	$275.4

Work-related Purchases

A wide variety of supplies and services are purchased for refuge operations and maintenance activities. Refuge purchases made in the local three-county area contribute to the local economic impacts associated with the Benton Lake Refuge. Major local expenditures include: supplies and services related to annual maintenance costs; small equipment; auto repairs, parts, and fuel; and utilities. Average annual Benton Lake Refuge nonsalary expenditures are anticipated to be $240.3 thousand for alternative A1,

$336.9 thousand for alternative B1, $329.6 thousand for alternative B2, $299.3 thousand for alternative C1, and $285.1 thousand for alternative C2. According to refuge records, approximately 70 percent of the annual nonsalary budget expenditures are spent on goods and services purchased in the local three-county area. Table 44 shows the economic impacts associated with work related expenditures in local communities near the Benton Lake Refuge. For alternative A1, work related purchases would generate a total economic impact of 2 jobs, $52.2 thousand in labor income, and $83.4 thousand in value added. Work related purchases under alternative B1 would generate the largest total economic impact of 3 jobs, $73.2 thousand in labor income, and $116.9 thousand in value added. As shown in table 44, impacts for alternatives B2, C1, and C2 are less than alternative B1 but higher than alternative A1.

Table 44. Local economic impacts by alternative of purchases related to Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time jobs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Alternative A1			
Direct effects	2	$35.2	$52.4
Secondary effects	< 1	$17.1	$30.9
Total economic impact	2	$52.2	$83.4
Alternative B1			
Direct effects	2	$49.3	$73.5
Secondary effects	< 1	$23.9	$43.4
Total economic impact	3	$73.2	$116.9
Alternative B2			
Direct effects	2	$48.2	$71.9
Secondary effects	< 1	$23.4	$42.4
Total economic impact	3	$71.6	$114.4
Alternative C1			
Direct effects	2	$43.8	$65.3
Secondary effects	< 1	$21.3	$38.5
Total economic impact	3	$65.1	$103.9
Alternative C2			
Direct effects	2	$41.7	$62.2
Secondary effects	< 1	$20.3	$36.7
Total economic impact	2	$62.0	$98.9

In addition to the annual local purchases of supplies and services to support general refuge operations, one-time costs related to wetland management and restoration may occur under alternatives B1, B2, C1, and C2. Under alternative B1, a $100 thousand diversion structure may be constructed within the first few years of the 15-year CCP planning timeframe. Under alternative B2, up to 3.5 miles of shelterbelts could be removed and up to 207 acres of tame grass could be converted to native grasses at an estimated total cost of $35 thousand over five years. Under alternatives C1and C2, up to 19 miles of shelterbelts may be restored and up to 728 acres of tame grass may be converted to native grasses at an estimated cost of $115 thousand over the life of the plan. In addition, wetland infrastructure may be incrementally modified or remove to achieve target contaminant, vegetation, and wetland health and productivity levels under alternative C1 with an estimate cost ranging from $0 to $4 million over the life of the plan. Under C2, full basin restoration would occur with an estimated cost ranging from $1.2 to $4 million and would likely be completed within the first six years of the plan.

Restoration activities, particularly under alternatives C1, and C2, would generate economic activity in the region surrounding the refuge. Portions of the restoration work, especially under alternative C2, are expected to be contracted to local businesses for services such as construction and environmental and engineering consulting, and most of the materials required for the restoration would be purchased within the local economy. This economic activity would increase demand for services and materials and would support jobs and generate income in the local economy. Furthermore, the restored ecosystem would help local communities well beyond the completion of the restoration projects by mitigating human and wildlife health hazards.

Table 45 summarizes the direct and total economic impacts in the three-county area of refuge management activities for alternative A1. Under alternative A1, Benton Lake Refuge management activities directly related to refuge operations generate an estimated 5 jobs, $111.0 thousand in labor income, and $176.5 thousand in value added in the local economy. Including direct, indirect, and induced effects, all Benton Lake Refuge activities generate a total economic impact of 9 jobs, $276.1 thousand in labor income, and $477.0 thousand in value added. In 2009, total labor income was estimated at $2.3 billion and total employment was estimated at 60 thousand jobs for the local three-county area, according to IMPLAN 2009 data. Thus, total economic impacts associated with Benton Lake Refuge operations under alternative A1 represent less than .01 percent of total income and total employment in the overall three-county area economy. Total economic effects of refuge operations play a larger role in the communities near Benton Lake Refuge where most of the refuge related expenditures and public use related economic activity occurs.

Table 45. Summary of all management activities for alternative A1 for Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time obs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Revenue Sharing and Refuge Administration*			
Direct effects	2	$35.3	$52.6
Total Effects	5	$160.6	$282.4
Nonlocal Public Use Activities			
Direct effects	3	$75.6	$123.8
Total Effects	4	$115.5	$194.6
Aggregate Impacts			
Direct effects	5	$111.0	$176.5
Total effects	9	$276.1	$477.0

**Staff salary spending and work related purchases*

Table 46 summarizes the direct and total economic impacts in the three-county area of refuge management activities for alternative B1. Under alternative B1, Benton Lake Refuge management activities directly related to refuge operations generate an estimated 5 jobs, $125.2 thousand in labor income, and $198.2 thousand in value added in the local economy. Including direct, indirect, and induced effects, all Benton Lake Refuge activities generate a total economic impact of 13 jobs, $387.1 thousand in labor income, and $676.4 thousand in value added. In 2009, total labor income was estimated at $2.3 billion and total employment was estimated at 60 thousand jobs for the local three-county area, according to IMPLAN 2009 data. Thus, total economic impacts associated with Benton Lake Refuge operations under alternative B1 represent less than .01 percent of total income and total employment in the overall three-county area economy. Total economic effects of refuge operations play a larger role in the communities near Benton Lake Refuge where most related expenditures and public use-related economic activity occurs.

Table 46. Summary of all management activities for alternative B1 for Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time jobs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Revenue Sharing and Refuge Administration*			
Direct effects	2	$49.5	$73.7
Total Effects	9	$271.4	$481.1
Nonlocal Public Use Activities			
Direct effects	3	$75.8	$124.4
Total Effects	4	$115.7	$195.3
Aggregate Impacts			
Direct effects	5	$125.2	$198.2
Total effects	13	$387.1	$676.4

**Staff salary spending and work related purchases*

Table 47 summarizes the change in economic effects associated with Benton Lake Refuge operations under alternative B1 as compared to alternative A1. Due primarily to increases in refuge administration, alternative B1 would generate 3 more jobs, $111.0 thousand more in labor income, and $199.4 thousand more in value added as compared to alternative A1.

Table 47. Change in economic impacts under alternative B1 compared to alternative A1 for Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time jobs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Revenue Sharing and Refuge Administration*			
Direct effects	(+) < 1	(+) $14.1	(+) $21.1
Total Effects	(+) 3	(+) $110.9	(+) $198.7
Nonlocal Public Use Activities			
Direct effects	no change	(+) $0.1	(+) $0.6
Total Effects	no change	(+) $0.2	(+) $0.7
Aggregate Impacts			
Direct effects	(+) < 1	(+) $14.3	(+) $21.7
Total effects	(+) 3	(+) $111.0	(+) $199.4

**Staff salary spending and work related purchases*

Table 48 summarizes the direct and total economic impacts in the three-county area of refuge management activities for alternative B2. Under alternative B2, Benton Lake Refuge management activities directly related to refuge operations generate an estimated 5 jobs, $123.8 thousand in labor income, and $196.1 thousand in value added in the local economy. Including direct, indirect, and induced effects, all refuge activities generate a total economic impact of 13 jobs, $387.3 thousand in labor income, and $660.7 thousand in value added. In 2009, total labor income was estimated at $2.3 billion and total employment was estimated at 60 thousand jobs for the local three-county area, according to IMPLAN 2009 data. Thus, total economic impacts associated with Benton Lake Refuge operations under alternative B2 represent less than .01 percent of total income and total employment in the overall three-county area economy. Total economic effects of refuge operations play a larger role in the communities near Benton Lake Refuge where most of the related expenditures and public use-related economic activity occurs.

Table 48. Summary of all management activities for alternative B2 for Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time jobs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Revenue Sharing and Refuge Administration*			
Direct effects	2	$48.4	$72.1
Total Effects	8	$263.1	$466.2
Nonlocal Public Use Activities			
Direct effects	3	$75.5	$123.9
Total Effects	4	$115.2	$194.5
Aggregate Impacts			
Direct effects	5	$123.8	$196.1
Total effects	13	$378.3	$660.7

**Staff salary spending and work related purchases*

Table 49 summarizes the change in economic effects associated with Benton Lake Refuge operations under alternative B2 as compared to alternative A1. Due primarily to increases in refuge administration, alternative B2 would generate 3 more jobs, $102.2 thousand more in labor income, and $183.7 thousand more in value added as compared to alternative A1.

Table 49. Change in economic impacts under alternative B2 compared to alternative A1 for Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time jobs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Revenue Sharing and Refuge Administration*			
Direct effects	(+) < 1	(+) $13.1	(+) $19.5
Total Effects	(+) 3	(+) $102.5	(+) $183.8
Nonlocal Public Use Activities			
Direct effects	no change	(-) $0.2	(+) $0.1
Total Effects	no change	(-) $0.3	(-) $0.1
Aggregate Impacts			
Direct effects	(+) < 1	(+) $12.9	(+) $19.6
Total effects	(+) 3	(+) $102.2	(+) $183.7

**Staff salary spending and work related purchases*

Table 50 summarizes the direct and total economic impacts in the three-county area of refuge management activities for alternative C1. Under alternative C1, Benton Lake Refuge management activities directly related to refuge operations generate an estimated 6 jobs, $137.7 thousand in labor income, and $226.1 thousand in value added in the local economy. Including direct, indirect, and induced effects, all Benton Lake Refuge activities generate a total economic impact of 12 jobs, $371.5 thousand in labor income, and $707.9 thousand in value added. In 2009, total labor income was estimated at $2.3 billion and total employment was estimated at 60 thousand jobs for the local three-county area, according to IMPLAN 2009 data. Thus, total economic impacts associated with Benton Lake Refuge operations under alternative C1 represent less than .01 percent of total income and total employment in the overall three-county area economy. Total economic effects of refuge operations play a much larger role in the communities near Benton Lake Refuge where most of

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Prescribed fire.

the related expenditures and public -elated economic activity occurs.

Table 50. Summary of all management activities for alternative C1 for Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time jobs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Revenue Sharing and Refuge Administration*			
Direct effects	2	$44.0	$72.1
Total Effects	7	$228.3	$466.2
Nonlocal Public Use Activities			
Direct effects	4	$93.7	$154.0
Total Effects	5	$143.2	$241.7
Aggregate Impacts			
Direct effects	6	$137.7	$226.1
Total effects	12	$371.5	$707.9

** Staff salary spending and work related purchases*

Table 51 summarizes the change in economic effects associated with Benton Lake Refuge operations under alternative C1 as compared to alternative A1. Due to increases in refuge visitation and administration, alternative C1 would generate 3 more jobs, $95.4 thousand more in labor income, and $230.9 thousand more in value added as compared to alternative A1.

Table 51. Change in economic impacts under alternative C1 compared to alternative A1 for Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time jobs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Revenue Sharing and Refuge Administration*			
Direct effects	(+) < 1	(+) $8.6	(+) $19.5
Total Effects	(+) 2	(+) $67.8	(+) $183.8
Nonlocal Public Use Activities			
Direct effects	(+) 1	(+) $18.1	(+) $30.1
Total Effects	(+) 1	(+) $27.7	(+) $47.2
Aggregate Impacts			
Direct effects	(+) 1	(+) $26.7	(+) $49.6
Total effects	(+) 3	(+) $95.4	(+) $230.9

**Staff salary spending and work related purchases*

Table 52 summarizes the direct and total economic impacts in the three-county area of refuge management activities for alternative C2. Under alternative C2, Benton Lake Refuge management activities directly related to refuge operations generate an estimated 6 jobs, $135.6 thousand in labor income, and $226.1 thousand in value added in the local economy. Including direct, indirect, and induced effects, all Benton Lake Refuge activities generate a total economic impact of 12 jobs, $355.2 thousand in labor income, and $664.4 thousand in value added. In 2009, total labor income was estimated at $2.3 billion and total employment was estimated at 60 thousand jobs for the local three-county area, according to IMPLAN 2009 data. Thus, total economic impacts associated with Benton Lake Refuge operations under alternative C2 represent less than .01 percent of total income and total employment in the overall three-county area economy. Total economic effects of refuge operations play a larger role in the communities near Benton Lake Refuge where most of the related expenditures and public use-related economic activity occurs.

Table 52. Summary of all management activities for alternative C2 for Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time jobs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Revenue Sharing and Refuge Administration*			
Direct effects	2	$41.9	$72.1
Total Effects	7	$212.0	$466.2
Nonlocal Public Use Activities			
Direct effects	4	$93.7	$154.0
Total Effects	5	$143.2	$198.2
Aggregate Impacts			
Direct effects	6	$135.6	$226.1
Total effects	12	$355.2	$664.4

**Staff salary spending and work related purchases*

Table 53 summarizes the change in economic effects associated with Benton Lake Refuge operations under alternative C2 as compared to alternative A1. Due to increases in refuge visitation and administration, alternative C2 would generate 3 more jobs, $79.1 thousand more in labor income, and $187.4 thousand more in value added as compared to alternative A1.

Table 53. Change in economic impacts under alternative C1 compared to alternative A1 for Benton Lake National Wildlife Refuge, Montana.

	Employment (# full and part time jobs)	*Labor income (Thousands, $2011)*	*Value Added (Thousands, $2011)*
Revenue Sharing and Refuge Administration*			
Direct effects	(+) < 1	(+) $6.6	(+) $19.5
Total Effects	(+) 2	(+) $51.5	(+) $183.8
Nonlocal Public Use Activities			
Direct effects	(+) 1	(+) $18.1	(+) $30.1
Total Effects	(+) 1	(+) $27.7	(+) $3.6
Aggregate Impacts			
Direct effects	(+) 1	(+) $24.6	(+) $49.6
Total effects	(+) 3	(+) $79.1	(+) $187.4

** Staff salary spending and work related purchases*

7.19 Cumulative Impacts

Resource redistribution would be necessary to accomplish objectives under alternative A1 due to the intensity of management actions, monitoring, operations, and maintenance on Benton Lake. This redistribution would affect other refuge complex programs such as the conservation easement program. As a result, there would likely be a reduction in the capacity to protect native grasslands and wetlands.

Cumulative impacts for alternative B1 would be the same as for alternative A1, plus increasing partnership efforts should lead to improvements in water quality in both the Muddy Creek and Lake Creek watersheds.

Cumulative impacts for alternative B2 would be the same as for alternative B1, plus any dry years during the initial drying phase may cause localized changes in bird distribution as migratory birds adapt to the presence or absence of water. On a continental population level, no effects would be expected to migratory bird species that typically use the refuge (personal communication, USFWS, Region 6 Migratory Bird Program, Kathleen Burchett, Vanessa Fields, Toni Griffin).

On a very localized scale, effects on migratory gamebird hunting would occur during dry periods under alternative B2; however, other locations do exist to accommodate user groups. For example, opening weekend of 2011, a dramatic decline occurred in the number of hunters using the Freezeout Wildlife Management Area (121 hunters compared to average of 227 hunters). Interestingly, the Benton Lake Refuge experienced nearly the exact same increase in hunter use (94 hunters compared to average of 40 hunters). Many hunters stated that they went to the Benton Lake Refuge instead of Freezeout Wildlife Management Area this year due to increased water levels. Migratory gamebird hunt-

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This boardwalk is part of the infrastructure available for visitor use at Benton Lake National Wildlife Refuge.

ers generally have a variety of sites to select from within the landscape due to unpredictable climatic conditions.

During the drying phase when pumping is suspended, effects on the Muddy Creek watershed under alternative B2 would be expected. When pumping is suspended, the refuge would no longer reduce flows in Muddy Creek by 24 cfs. This increase in flows is estimated to increase sedimentation by 4,500 tons per year (personal communication, Alan Rollo).

Through implementation of alternatives C1 or C2, overall wetland protection would be increased. Once the basin's self-sustaining ecological functions return, the intensity of management actions would be reduced, allowing reallocation of resources. These resources can be applied to other refuge complex programs such as the conservation easement program. A result of this would be an increase in the capacity to protect native grasslands and wetlands. These effects would be realized on a landscape level rather than a locally.

There would be localized changes in bird distribution as migratory birds adapt to the presence or absence of water. On a continental population level, no effects are expected (personal communication, Region 6 Migratory Bird Program, Kathleen Burchett, Vanessa Fields, Toni Griffin).

On a very localized scale, impacts to migratory gamebird hunting under alternatives C1 or C2 would occur during dry periods; however, other locations do exist to accommodate user groups. For example, opening weekend of 2011, a dramatic decline occurred in the number of hunters at Freezeout Wildlife Management Area (121 hunters compared to average of 227 hunters). Interestingly, the refuge experienced nearly the exact same increase in hunter use (94 hunters compared to average of 40 hunters). Many hunters stated that they went to Benton Lake instead of Freezeout this year due to increased water levels.

Impacts to the Muddy Creek watershed would be expected under alternatives C1 or C2. Currently, Muddy Creek's erosion is low when flows are under 150 cfs. During the spring and fall when Benton Lake would normally be pumping (alternatives A1, B1, B2), average flows are at this target of 150 cfs (personal communication, Alan Rollo). The refuge would no longer reduce flows in Muddy Creek by 24 cfs when the pumps were run in spring or fall. This increase in flows is estimated to increase sedimentation by 4,500 tons/year (personal communication, Alan Rollo). Recent work by the Muddy Creek watershed group have found that for every 2 cfs reduction in flows, the project cost is approximately $100,000.

Alternatives C1 or C2 should be more effective in counteracting the impacts of wetland loss across the landscape on migratory birds than alternatives A1, B1 and B2. By shifting management of Benton Lake from intensively managed semipermanent water, to a wetland driven by natural hydrology, more complex resources can be directed to protecting the most vulnerable wetlands on the landscape. The Service's HAPET office has identified temporary and seasonal wetlands, often less than 1 acre in size, and totally or partially embedded in cropland, as the highest risk for conversion. The pressure to drain and fill these wetlands for tillage agriculture puts these basins at higher risk of conversion than those with more permanent water or embedded in grassland. At the same time, the value of these wetlands to the waterfowl resource is great. According to HAPET, for every ten 1-acre wetlands in the PPPLCC's Prairie Pothole Region, there would predictably be 20 breeding pairs of ducks; whereas, one 10-acre wetland would likely support only seven duck pairs. Managing Benton Lake as a semipermanent wetland does not provide the same resources as would managing most of the lost wetlands across the landscape. Protecting and restoring these vulnerable wetlands would be of greater benefit to migratory birds.

Although the Service is working to improve wetland health and sustainability in its impounded and managed wetlands across the Refuge System, few refuges have the opportunity or possibility to fully restore their wetlands. Many refuge impoundments are too highly modified or subject to forces beyond the Service's control, which make restoration impossible. In these systems, understanding the underlying hydrogeomorphology is still critical to long-term sustainability, but emulating natural processes may be all that is possible. Benton Lake Refuge is relatively unique in that simply restoring the hydrology is not only possible, but is likely to have a significant, positive impact on the health and long-term sustainability of the wetland. A fully functional, large, seasonal wetland basin that is protected, as proposed under alternatives C1 or C2, is a relatively rare and special wildlife resource on the Montana landscape.

7.20 Summary of the Alternatives' Actions and Consequences

Table 54 summarizes the actions of each alternative (detailed in sections 7.5–7.9) and the consequences of those actions (sections 7.13–7.17).

Table 54. Summary of the actions and consequences of the management alternatives for the Benton Lake National Wildlife Refuge, Montana.

Alternative A1—(No Action)	*Alternative B1*	*Alternative B2*	*Alternative C1—(Proposed action)*	*Alternative C2*
Grasslands—actions				
Protection of native grasslands through easements is a high priority in the complex; refuge grasslands managed to sustain health.	Same as alternative A1.	Same as alternative A1, plus: Up to 3.5 miles of nonnative tree plantings would be removed and up to 207 acres of degraded tame grass stands would be planted back to native grass species.	Same as alternative B2, plus: Up to 19 miles of nonnative tree plantings would be removed and up to 728 acres of degraded tame grass stands would be planted back to native grass species	Same as C1.
Grasslands—environmental consequences				
Resources insufficient to manage grasslands precisely. Cool-season, exotic grasses would likely continue to expand and further degrade the quality of the native prairie, which could affect reproductive success of grassland-nesting birds. Nonnative tree plantings provide habitat for wider diversity of birds but contribute to fragmentation, depredation and parasitism, which negatively affects grassland-dependent migratory birds.	Same as alternative A1, except increased focus on refuge wetlands may mean declines in biological diversity, ecological integrity and environmental health of refuge grasslands.	During the initial, drying period, more resources available to manage grasslands and health improved. Between 65 and 750 acres of grassland habitat would become available or more desirable to grassland species by removing nonnative trees.	More resources would be available to manage and improve the quality of native prairie. Up to 18 species of migratory birds that nest in nonnative trees may be displaced.	Same as C1 after basin restoration.
Wetlands and riparian areas—actions				
Pumping is used to supplement natural runoff to provide migration and breeding habitat every year for wetland-dependent wildlife, primarily waterfowl.	Same as A1, except short-term dry cycles of 3–7+ years would be rotated among wetland units. Added treatments of prescribed fire, discing, herbicide or reseeding would be used if needed. Intensive monitoring and annual adjustments made based on progress toward wetland health objectives.	Same as B1, except an initial, basin-wide drying period (8 plus years) would be implemented to “reset” the system. Pumping may be incrementally reintroduced if wetland health objectives are met.	All units on the refuge would be subject to natural hydrologic regimes. Limited pumping may occur to support water rights or for specific restoration purposes only. The pump house will be supported. Infrastructure on the refuge could be modified incrementally if monitoring results show that is necessary to achieve wetland health objectives.	Same as C1 except basin restoration would include the removal of all wetland infrastructure as well as the pumphouse.

Table 54. Summary of the actions and consequences of the management alternatives for the Benton Lake National Wildlife Refuge, Montana.

Alternative A1—(No Action)	*Alternative B1*	*Alternative B2*	*Alternative C1—(Proposed action)*	*Alternative C2*
Wetlands and riparian areas: water quantity and timing—environmental consequences				
Consistent flooding and minimal drying within wetland units; wetland basin is never completely dry.	More variable flooding and drying within wetland units; wetland basin is never completely dry.	Same as B1, except wetland basin may be completely dry during initial drying phase.	The hydrology of the basin would be determined by natural runoff.	Same as C1.
Wetlands and riparian areas: infrastructure—environmental consequences				
With current infrastructure, the ability to channel water to all units for management objectives is available. Infrastructure alters natural flow patterns across the basin, inhibits nutrient release, reduces dissolved oxygen, and traps and concentrates contaminants.	Same as alternative A1.	Same as alternative B1.	Modification of infrastructure may be necessary to decrease contaminants, restore moisture gradients and waterflow patterns, and increase soil oxygenation which directly influence nutrient release, vegetation and macroinvertebrate distribution in the wetland.	Same as alternative C1, except: Potential benefits from removing infrastructure identified under alternative C1 would occur more quickly. Conversely, unnecessary and irreversible changes to the infrastructure could also occur.
Wetlands and riparian areas: water quality—environmental consequences				
The average total load of selenium deposited on the refuge would be 152 pounds/year, (61% from natural run-off 39% from pumped water). Units 1 and 2 would become a toxic threat sufficient to cause complete reproductive failure in sensitive species of aquatic birds in 9 and 17 years.	Same as A1, except selenium levels reduced to minimal levels (no imminent toxic threat) through intensively managed drying rotations, prescriptive wetland treatments, monitoring, partnerships it the watershed and possibly a diversion channel.	Same as B1, except initial drying period will make it easier to keep selenium below minimum levels. Selenium inputs reduced by 15-20% over A1 and B1.	By ceasing pumping, the refuge would realize an automatic 40% decrease in selenium inputs over the long term and as much as a 75% decrease during dry years at no cost. Reduced inputs, coupled with increased drying, should result in an equilibrium well below the toxic threshold.	Same as C1.
Wetlands and riparian areas: wetland productivity—environmental consequences				
Stable water conditions would likely continue to lower wetland productivity at potentially all levels of the food chain.	Within wetland units, short-term dry cycles increase flooding and drying variability that stimulate productivity but is less than historic variability. Long-term wet-dry cycles absent at the refuge and landscape scale that stimulate cycles of invertebrate communities, plant communities, and mammalian predators. Not self-sustaining.	Increased over B1 at the wetland unit, refuge and landscape level. Not self-sustaining.	Increased over B2, especially during wet cycles, but it will be more variable over time. Restoring the full variability in the wet–dry cycle should have a positive effect on ecosystem processes and increase nutrient cycling. Long-term dynamics of production same as other northern prairie systems as vegetation, invertebrate, and nutrient cycling changes when wetlands dry, reflood, reach peak flooding extent, and then begin drying again. Self-sustaining.	Same as C1.

Table 54. Summary of the actions and consequences of the management alternatives for the Benton Lake National Wildlife Refuge, Montana.

Alternative A1—(No Action)	*Alternative B1*	*Alternative B2*	*Alternative C1—(Proposed action)*	*Alternative C2*
Wetlands and riparian areas: wetland vegetation—environmental consequences				
Stable water would likely cause existing stands of monotypic vegetation, such as alkali bulrush, cattails and invasive Garrison creeping foxtail to continue to expand or become denser, especially in a dry cycle.	Wetland vegetation diversity increased across the wetland basin. Drying will reduce monotypic stands of emergent vegetation and nonnative Garrison creeping foxtail within units. Nonnatives such as Kentucky bluegrass and Canada thistle may become established in newly exposed mudflats. In addition, in units that are not immediately dried, the emergent vegetation would continue to expand.	Same as B1, but improvements likely to be greater and more widespread across wetland basin.	A reduction in the coverage of robust, emergent vegetation such as cattail, alkali bulrush and Garrison creeping foxtail would be expected. This vegetation would be replaced with wetland species adapted to more seasonal and temporary flooding cycles such as occurred historically. The wetland basin would likely contain diverse annual and perennial herbaceous plants and wet-prairie meadow grasses.	Same as C1.
Water resources—actions				
Muddy Creek and Lake Creek water rights used annually.	Same as alternative A1.	Same as alternative C1.	The water rights for Muddy Creek could be lost unless water is pumped at least once every 8 years. The water right for Lake Creek would be supported.	The water rights for Muddy Creek could be lost if challenged in court for nonuse. The water right in Lake Creek would be kept.
Water resources—environmental consequences				
Annually about 4,000 acre-feet of water is pumped from Muddy Creek and runoff from the Lake Creek drainage is captured within the wetland basin.	Same as alternative A1, except: The total acre feet pumped would depend on progress toward wetland objectives.	Same as B1, except pumping water would not occur during the initial dry period and future pumping is less certain.	Only natural runoff would be captured on a regular basis. Pumping would be very rare.	Same as C1, except no pumping.
Visitor services: hunting—actions				
Hunting for waterfowl and upland gamebird would continue in designated areas. Hunt units do not change. Wetland hunt units flooded annually. Big game hunting, other wildlife species, including furbearers, would continue to be prohibited.	Same as alternative A1, except: the area open for waterfowl hunting could change annually.	Same as alternative C1 during initial drying phase; Same as alternative B1 when adequate water (pumping/run-off); Upland gamebird hunting would be expanded to the close of the State season (usually January 1).	During years with adequate water, the location and size of waterfowl Hunt Area could change depending on water conditions. Upland gamebird season would be same as alternative B2.	Same as alternative C1.

Table 54. Summary of the actions and consequences of the management alternatives for the Benton Lake National Wildlife Refuge, Montana.

Alternative A1—(No Action)	*Alternative B1*	*Alternative B2*	*Alternative C1—(Proposed action)*	*Alternative C2*
Visitor services: hunting—environmental consequences				
Total hunting visits over the life of the plan projected to be 5,625 visits, possibly less if habitat conditions decline. Waterfowl and upland gamebird hunting opportunities every year.	Total hunting visits over the life of the plan projected to be 6,195 visits. Overall hunter numbers may increase slightly (<10%) over A1, and the quality of the experience may improve. Annual changes in the waterfowl hunt area could be confusing. This would take greater effort from refuge staff to clearly communicate.	Total hunting visits over the life of the plan projected to be 4,755 (15% less than A1). Waterfowl-hunting visits greater than C1 and C2, but less than A1 and B1. Annual changes in the waterfowl hunt area could be confusing. This would take greater effort from refuge staff to clearly communicate.	Total hunting visits over the life of the plan projected to be 3,300 (41% less than A1). Waterfowl hunting experience similar to currently on waterfowl production areas in the complex. Annual changes in the waterfowl hunt area could be confusing. This would take greater effort from refuge staff to clearly communicate.	Same as C1.
Visitor Services: wildlife observation and photography—actions				
The Prairie Marsh Wildlife Drive would be open year-round. Lower Marsh Road would be open from July 15 until the opening day of waterfowl-hunting season. Annual grouse viewing would continue by reservation. Photographic blinds, Prairie Marsh Boardwalk, spotting scopes and interpretive panels supported.	Same as alternative A1, except the auto tour routes may be adjusted as needed due to changes in water management.	Same as alternative A1 during initial drying period,. Same as alternative B1 if pumping resumes.	Same as A1, except parts of the existing auto tour route could be changed and more hiking trails may be established if interior roads are modified/removed for habitat management purposes.	Same as C1.
Visitor services: wildlife observation and photography—environmental consequences				
Total visits over the life of the plan are projected to be 114,750. This use would continue to account for 73% of total visitor use. May be slight increase if another grouse blind is established. Opportunities would be negatively impacted if habitat conditions decline.	Same as the alternative A1, by changing water management within the units waterbirds may become less habituated to traffic. Annual changes in road closures could be confusing to visitors. This would take greater effort from refuge staff to clearly communicate.	Same as alternative B1, except during the initial dry period, the ability to observe certain water-dependent wildlife would be more variable. Opportunities to observe and photograph upland wildlife may be expanded.	Total visits over the life of the plan are projected to increase 25% over Al, for a total of 143,440. The ability to observe certain water-dependent wildlife would be more variable and occur primarily in spring. Upland wildlife observation opportunities expanded. The hiring of a park ranger would increase awareness of opportunities on the refuge. More nature trails would offset any visitation losses that may occur from modifications to the auto tour route.	Same as C1.

Table 54. Summary of the actions and consequences of the management alternatives for the Benton Lake National Wildlife Refuge, Montana.

Alternative A1—(No Action)	*Alternative B1*	*Alternative B2*	*Alternative C1—(Proposed action)*	*Alternative C2*
Visitor services: environmental education and interpretation—actions				
Partnership with the Great Falls Public Schools to provide an opportunity for all third graders to visit the refuge. Support Envirothon, STEM expo, MFWP clinics and other educational opportunities.	Same as alternative A1, plus: interpretive materials to explain the purpose of short-term dry cycles and any resulting changes to public use.	Same as alternative B1 plus: Interpretive panels and maps would also explain the purpose of initial drying period.	Same as alternative B1, except curriculum may be adapted to reflect changes in habitat from restoration efforts. Hire park ranger.	Same as C1.
Visitor services: environmental education and interpretation—environmental consequences				
Total visits over the life of the plan are projected to be 26,625.	Opportunities for interpretation and education would be similar to A1, although potentially in different locations.	Same as alternative A1, plus an emphasis on interpretation and education relating to the restoration efforts to meet habitat objectives and wetland health and productivity would begin.	Total visits over the life of the plan are projected to increase 25% over A1 and be 33,280. Increased environmental education and interpretive programming, particularly in relation to the importance of natural hydroperiods in wetlands.	Same as C1.
Staff and funding—actions				
5.5 FTE currently assigned to refuge management; Maintenance of pumphouse and wetland infrastructure; Pump an average of 4,000ac-ft annually.	Increase permanent staff by 2.8 FTE and 2 seasonal biological technicians. Maintenance of pumphouse and wetland infrastructure. Money for a diversion channel possibly needed.	Increase permanent staff by 2.7 FTE and 2 seasonal biological technicians. Maintenance of pumphouse and wetland infrastructure.	Increase permanent staff by 2.3 FTE. Maintenance of pumphouse and possible removal/modification of some wetland infrastructure.	Increase permanent staff by 1.5 FTE. Decommission pumphouse and all wetland infrastructure.
Staff and funding—environmental consequences				
Total costs for pumping and operations and maintenance over the life of the plan are estimated to total $1,785,000.	Total costs (water level management, pumping, operations, maintenance, prescriptive habitat treatment, and monitoring) over the life of the plan are predicted to range between $2,641,000 and $2,829,000, depending on how much natural runoff is received and how much pumping is necessary.	Total costs (water level management, pumping, operations, maintenance, prescriptive habitat treatment, grassland restoration and monitoring) over the life of the plan vary from $1,816,000 to $2,263,000 depending on how much natural runoff is received and how much pumping occurs.	Total costs (operations, maintenance, pumping, prescriptive habitat treatment, grassland restoration and monitoring) over the life of the plan vary from $809,000 - $941,000. The restoration of the basin could cost between $0–4 million dollars depending on modifications to infrastructure.	Total costs (operations, maintenance, prescriptive habitat treatment, grassland restoration and monitoring) over the life of the plan vary from $601,000 - $733,000. The restoration of the basin is projected to cost between $1.2–4 million dollars

Table 54. Summary of the actions and consequences of the management alternatives for the Benton Lake National Wildlife Refuge, Montana.

Alternative A1—(No Action)	*Alternative B1*	*Alternative B2*	*Alternative C1—(Proposed action)*	*Alternative C2*
Resource protection—actions				
Law enforcement patrols are limited to managing visitor services and resource protection.	Law enforcement patrols commitments would be increased. Preventative law enforcement efforts such as signing, news releases, informational open houses and notice posting would be increased.	Same as alternative B	Same as alternative B1	Same as alternative B1
Resource protection—environmental consequences				
Staff time for any particular activity would be limited.	Users would better understand changes in visitor access necessary to accommodate efforts to improve habitat. User confusion would be reduced and compliance with refuge rules and regulations would increase.	Same as alternative B	Same as alternative B1	Same as alternative B1

7.21 Management Direction

This section contains the specific objectives and strategies that would be used to carry out the Service's proposed action (alternative C1) for the Benton Lake Refuge. The Service recommends this as the alternative that could best achieve the refuge's purposes along with the refuge complex's vision and goals while helping to fulfill the Refuge System mission.

If the Regional Director selects alternative C1 as the preferred alternative, the objectives and strategies presented in this chapter would become the final plan to be carried out over the next 15 years. Once approved, the preferred alternative for Benton Lake Refuge, along with the preferred alternative for all the other management aspects of the refuge complex (refer to chapters 3 and 6), would become the final plan. The Service would publish a notice of availability in the Federal Register and send copies of the final CCP or CCP summary to individuals and groups on the mailing list.

The CCP would serve as the primary management document for the refuge complex until it is formally revised. The Service would carry out the final CCP with help from partner agencies, organizations, and the public. The management direction presented in this chapter would meet the purposes, vision, and goals of the refuge complex.

The Service is proposing alternative C1 as the most effective and safest way to manage Benton Lake Refuge. This section discusses goals, objectives, and strategies that serve as the steps needed to achieve the CCP vision. While a goal is a broad statement, an objective is a concise statement that describes what is to be achieved, the extent of the achievement, who is responsible, and when and where the objective should be achieved—all to address the goal. The strategies are the actions needed to achieve each objective. Unless otherwise stated, the refuge complex staff would carry out the actions in the objectives and strategies. The rationale for each objective provides context such as background information, assumptions, and technical details.

The goals and objectives for the Benton Lake Refuge are the same as those for the refuge complex and are not repeated here unless they have strategies specific to the refuge. Objectives and strategies specific to the refuge are described below.

Habitat Goal

Actively conserve, restore, and manage upland and wetland habitats across the northern prairies and intermountain valleys of the refuge complex through management strategies that perpetuate the integrity of ecological communities.

Grasslands Objective 1

Within the first 5 years of the plan, complete rangeland assessments on fee-title native grassland tracts greater than 80 acres in size. (Same as Grasslands Objective 1, chapter 6.)

Strategies
In addition to the refuge complex strategies (Grasslands Objective 1, chapter 6):

- Evaluate 5,014 acres of native grass on the refuge for existing native plant communities in comparison to the HCPC for that specific ecological site using NRCS ecological site description.

Rationale
Interpreting Indicators of Rangeland Health Technical Reference 1734–6 Version 4 (Pellant et al. 2005), is recognized by range professionals as the basis for inventory and assessment of rangeland health. This publication was a collaborative effort between the BLM, NRCS, the Agricultural Research Service and the USGS's Forest and Rangeland Ecosystem Science Center. The publication promotes the concept of rangeland heath as an alternative to range condition and assessing rangelands through ecological status concepts. These principles combined with NRCS Ecological Site Descriptions, provide the best available science for assessing the 5,014 acres of native prairie on the refuge.

Grasslands Objective 3

Within 15 years of the approved plan, convert up to 728 acres of tame grassland on Benton Lake Refuge to native-dominant perennial herbaceous cover including several species of native forbs.

Strategies
Same as the refuge complex strategies (Grasslands Objective 3, chapter 6).

Conducting vegetation sampling on the Benton Lake National Wildlife Refuge.

Rationale
Same as the refuge complex rationale (Grasslands Objective 3, chapter 6).

Grasslands Objective 5

Within 15 years, remove up to 19 miles of nonnative tree plantings, starting with high-priority large native prairie tracts.

Strategies
Same as the refuge complex strategies (Grasslands Objective 5, chapter 6).

Rationale
The strategic removal of up to 19 miles of nonnative tree plantings on the refuge would restore contiguous grassland habitat and reduce negative effects of fragmentation, depredation and parasitism to grassland-dependent migratory birds (Bakker 2003). Distance to a wooded edge has been shown in many studies to increase nest predation and displace grassland species (Bakker 2003). This makes grassland habitat around tree plantings either unavailable or less desirable for grassland species. The distance varies by study area and species, but the Service estimates that between 65 and 750 acres of grassland habitat would become available or more desirable to grassland species by removing these trees (Bakker 2003). The highest priority plantings for removal are those that bisect large tracts of native prairie.

At the expense of grassland-obligate species, nonnative tree plantings provide an unnatural change to the vegetative structure of the prairies. This allows some species to nest where they otherwise would not. The result is an increase in local species diversity, but with negative impacts to regional biological diversity. As many as 18 other bird species occur on the refuge as a result of nonnative tree plantings (unpublished records on file at Benton Lake Refuge). Some of these include species of concern, such as loggerhead shrikes and Swainson's hawk (unpublished records on file at Benton Lake Refuge). These species have other nearby habitat including the Missouri River riparian area and neighboring tree plantings. Tree plantings may also contribute to and provide opportunities for invasive noxious weed infestations.

Wetlands and Riparian Areas Objective 1

Over the next 15 years, manage and protect water quality for wetlands and riparian habitats on fee-title lands within the refuge complex such that there is minimal hazard to wildlife from contaminants. (Same as Wetlands Objective 1, chapter 6.)

Strategies
In addition to the strategies for the refuge complex (Wetlands Objective 1, chapter 6):

- Cease pumping water to the refuge to reduce selenium loading and increase selenium volatilization. During dry cycles, use prescribed fire to increase selenium volatization from vegetation and exposed sediments

- Check selenium levels every 1–3 years depending on severity level.

- Identify the seeps next to Lake Creek and its tributaries to assess their discharge, and use this information to set clean-up priorities.

- Assign staff member to work with the Lake Creek watershed group, the Montana Salinity Control Association, USDA and other organizations to reduce selenium loading in natural runoff to the refuge.

Rationale
Same as the refuge complex rationale (Wetlands Objective 1, chapter 6), plus selenium has been a potentially serious problem on the Benton Lake Refuge. The refuge has a history of moderate to high hazard levels (Nimick et al. 1996, Zhang and Moore 1997, refuge unpublished data 2006). Recent monitoring data, combined with predictive models, show that the refuge could reach selenium levels that are associated with complete or nearly complete reproductive failure in sensitive wildlife species in as little as 10 years (Zhang and Moore 1997). Selenium enters the refuge in natural runoff from the surrounding Lake Creek watershed and from water pumped from the Muddy Creek watershed. While natural runoff has contributed most of the selenium loading on the refuge over the last 35 years, the pumped water has contributed approximately 40 percent of the total selenium load (Nimick et al. 1996). Furthermore, the addition of pumped water has reduced drying of the wetland sediments, which is the primary mechanism for selenium to leave the refuge. Dry periods also create opportunities to use prescribed fire, which may volatize more selenium from wetland vegetation (Zhang and Moore 1997).

The toxic threat to wildlife from selenium is based on the degree of contamination present and the extent of exposure. "Minimum hazard" level is defined as the concentration of selenium in various ecosystem components for which "no imminent toxic threat is identified" (Lemly 1995, 2002). For water this is less than 2 µg/l, sediment less than 2 µg/g, macroinvertebrates less than 3 µg/g, and aquatic bird eggs less than 5 µg/g. These values can be combined to create an overall hazard assessment for a given area, such as the wetland basin on the refuge (Lemly 1995, 2002).

For some fee-title wetlands, streams and rivers on the refuge complex, contaminants may be coming from offsite sources that are not directly under Service management. In these situations, partnerships with neighboring landowners, watershed groups and other government agencies may be necessary. This is particularly important for Benton Lake Refuge. While the elimination of pumped water alone is expected to reduce selenium levels to below the minimum hazard, the Service is still interested in working with partners in the Lake Creek watershed. A contaminant action planned developed by the refuge in 1991 (USFWS 1991), identified actions to further reduce selenium inputs in natural runoff such as working with landowners, the Montana Salinity Control Association and USDA farm programs to promote seep reclamation and encourage perennial planted cover. Improving the watershed condition, along with changes in refuge management, offer the best long-term protection of water quality on the refuge.

Wetlands and Riparian Areas Objective 2

Over the next 15 years, restore the natural hydrologic processes (wet–dry cycles) for the site-specific hydrogeomorphic condition of wetlands and riparian areas. (Same as Wetlands Objective 2, chapter 6.)

Strategies

In addition to the refuge complex strategies (Wetlands Objective 2, chapter 6):

- Cease pumping to the refuge from Muddy Creek except as necessary to support water rights. Support pumphouse in working condition.
- Restore Units 1 and 2 to wet meadow wetland, with water entering the refuge through the old Lake Creek channel and natural diffuse runoff.
- On the refuge, over the next 15 years, check indicators of wetland health to evaluate if removing infrastructure, breaching dikes and filling ditches to facilitate the return of natural sheet flow to the basin is necessary.
- Hire a supervisory refuge biologist to carry out ARM as the restoration proceeds and other duties in the complex as needed
- Hire a seasonal biological technician to help with implementation of ARM.

Rationale

Same as the refuge complex rationale (Wetlands Objective 2, chapter 6), plus an HGM assessment was completed for Benton Lake Refuge in 2009 (Heitmeyer et al. 2009). This analysis identified several significant alterations to the hydrologic cycles at the refuge. During the first 30 years of the refuge's history, the refuge experienced 10- to 20-year wet and dry cycles that sustained wetland health, plant diversity and wildlife diversity. During dry years, contaminants were volatized, sediments were solidified, robust emergent vegetation such as cattails and bulrush died back, and wetland-dependent wildlife used migration, hibernation, burrowing or other strategies to survive. When the wet cycle returned to Benton Lake it experienced a boom of wetland productivity as invertebrates and wetland-dependent wildlife took advantage of the newly available resources. Over the last 50 years, this cycle has been altered by pumped water that reduced or ended the dry cycles and the associated benefits. In addition, wet years are also less productive because the rejuvenating effects of the dry cycle did not occur.

Another important alteration of the hydrologic cycle at Benton Lake is the timing of flooding with pumped water. Historically, Benton Lake received most of its natural runoff and precipitation from spring snowmelt and rain during April-June. Conversely, pumped water is available and used for flooding primarily in the fall. While fall flooding may occur occasionally, repeated, annual fall flooding has likely reduced productivity in the wetlands, especially for spring migrants and breeding birds, by reducing seed availability altering plant germination and reducing invertebrate abundance and diversity (Schneider 1999, Murkin and Ross 1999, Anderson and Smith 2000, Greer et al. 2006).

The physical movement and storage of water on Benton Lake has also been significantly altered. Units 1 and 2 were originally an alluvial fan of Lake Creek and only flooding during high flows, probably during spring (Heitmeyer et al. 2009). Currently, these units are the deepest, most permanently flooded part of the refuge. This has led to selenium contamination and cattail encroachment problems. In addition, the dikes, ditches and canals on the refuge have disrupted the original flooding patterns that alter the microtopography of the wetland basin and ultimately wetland productivity (Heitmeyer et al. 2009; personal communication, L. Frederickson). Unlike many wetlands in the United States, especially on refuges, the hydrogeomorphic conditions of Benton Lake have not been altered to an extent that prevents restoration. While the land surrounding the refuge in the Lake Creek watershed has largely been converted from native prairie to small grain agriculture, much of the remaining influences on the refuge have not changed. In particular, there are no significant alterations to the inputs from Lake Creek to the refuge, and since it is a closed basin, there are no downstream users of the water.

As the restoration progresses, refuge staff would be using ARM and monitoring feedback loops to inform the management decision-making process. An added full-time supervisory biologist and seasonal biological technician would be necessary to achieve this objective. A part of the supervisory biologist's time would be focused on developing, adjusting and providing oversight for the adaptive resource management of the restoration process. The daily implementation of the monitoring for the restoration process would be accomplished with the existing 1 FTE refuge biologist and two seasonal biological technicians, as well as one added technician.

Wetlands and Riparian Areas Objective 5

Within 15 years, begin management of refuge wetland vegetation so that refuge at least 80 percent of wetlands are in good vegetative condition as defined by the MNHP Wetland Condition Assessment method.

Strategies

- Manage wetland vegetation by using grazing, haying, or fire to emulate historical disturbances when natural flooding and drying cycles allow.
- Reduce competition and cover of nonnative vegetation by using discing, prescribed fire, grazing, haying or herbicides.
- Where proper and feasible, native plantings and seeding may be used to restore native vegetation.
- Priority would be given to invasive species management within wetlands using IPM and EDRR.
- Use natural flooding and drying cycle to favor native vegetation and reduce nonnative vegetation where applicable (rest).
- Check vegetation to find out if wetland vegetation is improving or declining.
- Identify and check key wildlife species as added indicators of wetland health and management success.

Rationale

Vegetation is a common indicator of wetland health (Fennessy et al. 2007). Many methods have been developed to try to capture this, but the methods of DeKeyser et al. (2003, 2009), Hargiss et al. (2008), and the MNHP (2010) have been developed on similar wetland basins similar to the refuge.

Objectively determining the breakpoints, or thresholds, for condition classes, such as defining what is a "good" wetland is difficult. The MNHP is currently working on a wetland reference network in Montana that would help clarify this definition. Until this is finished, the Service would use the vegetation metrics identified by the MNHP and strive to have wetlands in the top condition classes for each metric. At a minimum, the Service would conduct the rapid assessment and strive for at least 80-percent cover by native plants, less than 5-percent noxious weeds, less than 25-percent other nonnative or highly tolerant native species, moderate litter accumulation that does not prevent plant recruitment, and no single dominant plant type across entire wetland. For wetlands with active restoration or management, such as Benton Lake, the assessment can be augmented with data on the diversity of native plant species, their Coefficient of Conservatism and overall Floristic Quality Index (Northern Great Plains Floristic Quality Assessment Panel 2001; Montana Natural Heritage Program unpublished data). Reference conditions and cutoff values of "good" may be reassessed after the initial evaluation.

Visitor Services Goal

Provide opportunities to enjoy wildlife-dependent recreation on Service-owned lands and increase knowledge and appreciation for the refuge complex's ecological communities and the mission of the National Wildlife Refuge System.

Hunting Objective

Over the life of the plan, provide a variety of hunting opportunities for approximately 3,300 visits that support sustainable resources and provide participants with an opportunity to appreciate natural environment on Benton Lake Refuge. (Same as Hunting Objective, chapter 6.)

Strategies

In addition to the refuge complex strategies (Hunting Objective, chapter 6):

- Provide waterfowl hunting as conditions allow until November 30.
- Provide upland gamebird hunting at the refuge including increased opportunity by extending the season on the refuge to correspond with the

State season (generally first weekend in October to January 1) and expanding the locations available to hunt on the refuge.

- Provide youth waterfowl and upland gamebird hunting opportunities within State season.
- Annually evaluate and revise hunt location and seasonal availability to synchronize opportunity with water availability and to provide an inviolate sanctuary for migrating waterfowl.

Rationale

Same as the refuge complex rationale (Hunting Objective, chapter 6). Waterfowl and upland gamebird hunting occurs on the refuge. General refuge hunting begins with the opening of the State waterfowl season, with the exception of youth waterfowl and upland gamebird seasons. Waterfowl hunting season closes after November 30^{th} and upland gamebird hunting will close in correspondence with the State season. When waterfowl hunting occurs, the hunting area would be flexible to make sure an inviolate sanctuary exists while concurrently providing for hunting. Decisions would be made on a year-by-year basis about the location of open and closed areas for waterfowl hunting.

Wildlife Observation and Photography Objective

Throughout the life of the plan, continue to provide opportunities for approximately 7,500 visits annually at Benton Lake Refuge to observe and photograph a variety of wildlife species. (Same as Wildlife Observation and Photography Objective, chapter 6.)

Strategies

In addition to the refuge complex strategies (Wildlife Observation and Photography Objective, chapter 6):

- Continue to support observation and photography blinds.
- Install another grouse observation and photography blind.
- Continue to support an information kiosk and Prairie Marsh boardwalk trail with a spotting scope.
- If habitat restoration efforts require it, change or reroute the existing auto tour routes.
- Evaluate locations for more walking trails.
- Restrict foot-traffic, including hiking, snowshoeing, and cross-country skiing, to designated trails; roads open to motorized vehicles; and to the refuge hunt area during the refuge hunting season.
- To provide an accessible alternative to the grouse blind, provide a video in the Visitor Center that shows grouse dancing and make sure that visitors are aware that it is available. Explore the possibility of putting the video on the refuge Web site.

Rationale

Same as refuge complex rationale plus, in 2011, wildlife observation and photography accounted for 7,650 visits to the refuge. The Benton Lake Visitor Center, the Prairie Marsh Drive, Lower Marsh Road, an informational kiosk, the Prairie Marsh Boardwalk with a spotting scope, a photography blind, and a Sharp-tailed Grouse observation blind facilitate wildlife observation and photography opportunities on the refuge.

Environmental Education and Interpretation Objective 1

During the life of the plan, enhance public knowledge and understanding of the restoration efforts and the progress being made. Expand environmental education programs for adults and children on and off the refuge, focusing on the wetland habitat and native prairie habitats and the natural, cultural, and historical resources of the refuge. Programs and activities would promote awareness of and advocacy for refuge resources and management activities for the more than 10,000 visitors and students annually at the Benton Lake Refuge.

Strategies

In addition to the refuge complex strategies (Environmental Education and Interpretation Objective 1, chapter 6):

- Develop a series of environmental outreach programs with specific themes (such as prairie and wetland conservation) as it relates to the restoration process for the refuge.
- Design and install interpretive panels that focus specifically on the restoration efforts and explain the restoration process and the progress.
- Adapt an environmental education curriculum in coordination with the Great Falls Public Schools to reflect the changes throughout the habitat restoration process.

USFWS

Prescribed fire is a managment tool used at Benton Lake National Wildlife Refuge.

- When safety permits, allow visitors access to areas undergoing restoration to highlight activities and restoration effects and resulting benefits to natural resources.

- Consider producing tear sheets on birdlife histories

- Develop a unified, professionally designed exhibit with a central theme for the entire visitor center area

- Provide outreach materials for people with disabilities (large print, audio), and make sure that all refuge environmental education programs are accessible.

Rationale

Same as the refuge complex rationale (Environmental Education and Interpretation Objective 1, chapter 6), plus in FY 2011, refuge staff reached 1,700 participants during on and offsite environmental education programs. Most of which, approximately 850, were third graders in the Great Falls Public School System who visit the Benton Lake Refuge as part of their education curriculum. In addition, 75 participants attended 3 special events and 75 participants attended interpretation programs on and off refuge facilities.

Understanding why the habitat restoration needs to be accomplished would generate more support from sportsmen and women, wildlife observers, and other interested public. Identifying and communicating important messages about natural resources to diverse audiences forges connections between interests of the audiences and develops understanding through appreciation and finally protection. It is essential to help the public become aware of the natural world around them and what they can do to help protect and restore it.

The refuge has the potential to provide an extraordinary environmental education and interpretation program. The refuge is located 12 miles from Great Falls, a city of 60,000 people, in north-central Montana. The population of Cascade County, where the refuge is located, is 82,000. The refuge staff has never included an environmental education position. Management staff has given occasional tours to school groups and nongovernmental organizations, but has not developed and implemented a professional Environmental education program. The environmental science department of the GFPS brings all third graders (800–900 students) to the refuge each year in May and June for a basic introduction to prairie grasslands and wetlands. The enthusiasm and interest found in these young minds provides a foundation on which the Service could build a positive outdoor ethic.

Administration Goal

Provide facilities, strategically allocate staff, and effectively use and develop funding sources, partnerships, and volunteer opportunities to maintain the long-term integrity of habitats and wildlife resources of the refuge complex.

Staff and Funding Objective

Throughout the life of the plan, strive to fill positions identified in the CCP as critical to accomplishing goals and objectives (table 28 in section 6.1).

Strategies

- Conduct site visits and prepare briefing packages for Service and other Federal officials (for example, congressional staff) to showcase complex achievements and potential acquisition growth.
- Use local media throughout the refuge complex to promote habitat improvements, outreach activities, and other accomplishments.
- Continue to cultivate good working relationships with the refuge complex's neighbors, other State and Federal agencies, nongovernmental organizations and other user groups to promote grassroot support and advocacy for refuge complex initiatives.
- Cooperate with organizations like TNC and the Conservation Fund to leverage resources for conservation easement programs.
- Continue to accurately document money and staff needs through memos and reports.
- Prove to neighbors, partners, and local communities the potential benefits of increased money and staff in the refuge complex.
- Establish a Friends group to help support and advocate for the refuge complex.
- Coordinate and take part in multi-agency youth and volunteer programs and initiatives.
- Refine and increase participation in the refuge complex volunteer program.

Rationale

Increases in the size and complexity of lands within the refuge complex require more staff and money. Several new or expanded easement initiatives (Blackfoot Valley, Rocky Mountain Front, and Swan Valley Conservation Areas) would need more staff for monitoring and administration of easements as well as more money to acquire easements.

Current staff and budget levels are not sufficient to complete required administrative functions. In FY 2009, the Refuge System received an increase of $250 million (National Wildlife Refuge Association 2009 Annual Report). Projections show that due to the current state of the economy and the increasing debt and recession, operations money would remain stable to decreasing. With annual inflation, base allocations would erode with the inability to keep up with cost of living adjustments. The Service conservatively estimates a need for annual increases between $18 million and $35.5 million to meet conservation expectations of partners and the U.S. Congress (National Wildlife Refuge Association 2009 Annual Report). Increased operation money is not expected.

However, a significant increase in LWCF appropriations for the Rocky Mountain Front Conservation Area has occurred in recent years. This money is highly variable and directly affects the refuge complex's ability to preserve intact landscapes.

To accomplish the goals and objectives identified in this plan, the refuge complex staff would need to maximize opportunities for in-kind help, both fiscal and human resources, in addition to experiencing increases in base (operations money) allocations. The refuge complex has a rich tradition of maximizing partnerships to meet established goals and objectives. The Service would need to continue these efforts and look for more opportunities to leverage dollars and human capital through partnerships. Creative work force planning, partnerships, and using supplemental money making opportunities are mechanisms to successfully carry out recommendations. Other options are to use maintenance action teams, contracting, seasonal and temporary hires, volunteers, and youth initiatives.

Visitor and Employee Safety and Resource Protection Goal

Provide for the safety, security, and protection of visitors, employees, natural and cultural resources, and facilities throughout the refuge complex.

Resource Protection Objective

Over the life of the plan, strive to limit illegal activity to at or below levels to be figured out within 5 years of plan approval. (Same as Resource Protection Objective 2, chapter 6.)

Strategies

In addition to the refuge complex strategies (Resource Protection Objective 2, chapter 6):

- Increase patrol and preventative law enforcement efforts at the refuge by utilizing the full-time law enforcement officer hired for the refuge complex.

- Organize and distribute information about the changing routes of travel, access areas, designated closures, changes in refuge specific regulations to improve preventative law enforcement efforts.

- Submit news releases to local newspapers and radio stations and post on refuge Web site to increase the public's awareness about annual recreational opportunities, refuge specific regulations, and shifts in open and closed areas to hunting and other wildlife-dependent recreational uses.

- Host an annual hunter orientation "open house" before the hunting season to share refuge specific regulations and changes to the open and closed areas.

Rationale

Same as the refuge complex rationale (Resource Protection Objective 2, chapter 6), plus currently law enforcement support on the refuge consists of help from the collateral duty officer assigned to the wetland management district or the Montana-Wyoming Zone Officer stationed at the complex headquarters. Restoration efforts within the wetland basin may require shifts in open and close areas, auto tour routes, walking trails and other wildlife-dependent recreational activities. Preventative law enforcement efforts can help end or reduce the occurrence of refuge specific violations. Open houses, news releases, posting of regulatory information are effective ways to improve visitor compliance.