AN EVALUATION OF ECOSYSTEM RESTORATION AND MANAGEMENT OPTIONS FOR BENTON LAKE NATIONAL WILDLIFE REFUGE

PREPARED FOR:

U. S. FISH AND WILDLIFE SERVICE
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EXECUTIVE SUMMARY

Benton Lake National Wildlife Refuge (NWR) contains 12,383 acres on the western edge of the Northern Great Plains about 12 miles north of Great Falls, Montana. The dominant feature on the NWR is the 5,600 acre shallow lake bed, known as Benton Lake, created during the last Pleistocene glacial period. This large wetland is hydrologically closed; most natural runoff in the Benton Lake Basin drains to Benton Lake proper and the basin has no natural outlet.

Although established in 1929, Benton Lake NWR was not developed or staffed until the early 1960s. Prior to development, water levels in Benton Lake historically fluctuated seasonally and annually depending on annual patterns of precipitation and runoff. During wet years Benton Lake contained more extensive surface water area and supported large numbers of breeding and migrating waterbirds, especially dabbling ducks. In contrast, during dry years, less water was present and fewer birds were present. Because of a desire to support more predictable and frequent flooding, and waterbird abundance, during summer, Benton Lake NWR constructed extensive water source, conveyance, and management systems. These developments and other hydrological and topographic alterations on Benton Lake NWR and surrounding lands have gradually altered this ecosystem by increasing concentrations of contaminants, especially selenium; siltation and alteration of the topography of the historic lake bed, altered vegetation communities and increased presence of invasive species;

periodic outbreaks of botulism; and decreased presence and productivity of waterbirds.

In 2009, the U.S. Fish and Wildlife Service began preparation of a Comprehensive Conservation Plan for Benton Lake NWR. This planning process is being facilitated by a contemporary evaluation of ecosystem restoration and management options using Hydrogeomorphological Methodology (HGM). This report uses the HGM approach to obtain and use historic and current information about: 1) geology and geomorphology, 2) soils, 3) topography and elevation, 4) hydrology, 5) plant and animal communities, and 6) physical anthropogenic features of NWRs and surrounding landscapes with the following objectives:

1. Identify the pre-European settlement ecosystem condition and ecological processes.

2. Evaluate changes in the Benton Lake ecosystem from the pre-settlement period.

3. Identify restoration and management options and ecological attributes needed to successfully restore specific habitats and conditions in the area.

The Benton Lake Basin, including the Benton Lake bed depression, was formed during the last Pleistocene glacial period when ice sheets dammed the ancestral Missouri River and formed glacial Lake Great Falls. Glacial drift associated with this ice sheet was deposited northeast of Benton Lake and created a hydrologically closed basin where most surface water ultimately flowed into Benton Lake and no outlet was present. Gently dipping sedimentary bedrock underlies the Benton Lake deposits; this bedrock is mostly seleniferous marine shale of the Cretaceous Colorado Group. Most geomorphic surfaces at Benton Lake are Quaternary Lake deposits, with secondary alluvium-colluvium deposits at the mouths of Lake Creek (the primary drainage into Benton Lake) and other small tributaries. Quaternary terraces adjoin Benton Lake and high ridges contain older Cretaceous outcrop deposits. Soils at Benton Lake are mostly clays and silt clays

deposited in lacustrine conditions. Topography at Benton Lake NWR reflects dominant geomorphic surfaces including the relatively flat historic lake bed, alluvial fans, and older terraces and ridges.

The Benton Lake Basin is semiarid with 70-80% of annual precipitation and runoff occurring April to September. Historic water levels in Benton Lake were strongly unimodal, with peaks in early summer followed by gradual declines to low stable levels in fall and winter. In addition to strong seasonal patterns of flooding, Benton Lake had evidence of long recurring 15-20 year patterns of peaks and lows in regional precipitation, runoff, and water levels. Natural water inputs to Benton Lake come primarily (65-70%) from the Lake Creek watershed.Deeper ground water beneath Benton Lake is confined to the aquifer within the Colorado Shale formation, which is poor quality. Historically, low annual precipitation was captured quickly and used by native grassland; little water moved deeply into soil and subsoil layers. Consequently, deposition of salts and elements, including selenium, from Cretaceous formations did not historically accumulate to high levels in Benton Lake.

Historic vegetation communities at Benton Lake ranged from dense emergent wetland species in low elevations to upland grassland on terraces and ridges. The gradation of communities included robust emergent, sedge-rush, seasonal herbaceous, wet grassland, and upland grassland habitat types. A rich diversity of animal species historically used the Benton Lake ecosystem; waterbird abundance and productivity was tied to seasonal and long-term patterns of water levels.

The Benton Lake ecosystem was relatively unchanged from historical condition until the late 1880s, when initial settlement of the area occurred. Early attempts to ditch, drain, and farm the Benton Lake bed were unsuccessful and little conversion of native grassland to agricultural crops in the surrounding area did not occur until the 1920s following development of the Sun River Irrigation Project. Much native grassland was converted to dry-land crop/fallow rotation from

1930 to 1950 and this farming practice gradually increased the number and severity of saline seeps in the region, and ultimately the discharge of selenium into Benton Lake.

Benton Lake NWR was established in 1929, but little development or management occurred until the early 1960s, when the area was staffed and a major water pumping and conveyance system was constructed to bring irrigation return flow from Muddy Creek 15 miles to Benton Lake. In addition to the pump station and conveyance system, the historic Benton Lake bed was divided into six pools by dikes, levees, and water-control structures to facilitate more predictable and prolonged flooding regimes in summer for breeding waterfowl. Water management on Benton Lake NWR from the early 1960s through the late 1980s typically sought to regularly pump water from Muddy Creek to Benton Lake to extensively flood most wetland pools for prolonged periods; relative amounts pumped from Muddy Creek compared to natural runoff from Lake Creek varied substantially among years related to annual precipitation and runoff.

More permanent water regimes in Benton Lake gradually changed vegetation communities to more water tolerant types, increased selenium accumulation, promoted expansion of invasive plant species, and increased severity and occurrence of avian botulism. Water management at Benton Lake since the early 1990s has reduced pumping during summer and attempted to create more seasonal water regimes, except in Pools 1 and 2, which continue to be managed for permanent flooding and water storage. A model of selenium cycling within Benton Lake pools indicates continued accumulation in Pools 1 and 2 and near saline seeps in Pool 4c unless water regimes are restored to more seasonal patterns in these areas and seeps are reduced. Vegetation communities at Benton Lake also contain increasing amounts of the aggressive introduced creeping foxtail.

Based on the HGM data obtained and analyzed in this report, future management of Benton Lake NWR should seek to:

1. Maintain the physical integrity of the hydrologically closed Benton Lake Basin and emulate more natural seasonally- and annually-dynamic water regimes within Benton Lake proper.

2. Control and reduce accumulation of salts and contaminants, especially selenium.

3. Restore and maintain the diversity, composition, distribution, and regeneration of historic wetland and upland vegetation communities in relationship to topographic and geomorphic landscape position.

4. Provide functional complexes of resource availability and abundance including seasonal food, cover, reproductive, and refuge resources for key animal species.

Specific recommendations to meet ecosystem restoration goals identified above are provided and include:

- Retain the closed nature of Benton Lake proper and protect watersheds and drainage routes of its tributaries.

- Restore natural topography and reconnect water flow corridors and patterns where possible. This recommendation suggests careful evaluation of the need for existing levees, roads, water-control structures and the pool configuration with removal of those not desired for future management.

- Manage Benton Lake water levels (with or without the current or altered pool configuration) for more natural seasonal and annual water regimes.

- Restore natural hydroperiods to Benton Lake proper and balance seasonal and long-term inputs from Muddy Creek pumping vs. natural runoff in the Lake Creek watershed.

- Encourage and participate in conservation programs in regional watersheds to reduce the extent and severity of saline seeps.

- Evaluate vegetation manipulation techniques for possibilities of reducing accumulation of selenium.

- Restore more natural distribution and composition of native plant communities.

- Control expansion of invasive plant species, especially creeping foxtail.

- Provide a rotational complex of wetland habitats and seasonal resources.

- Protect native terrace and upland grasslands.

- Maintain functional seasonal refuges.

Future management of Benton Lake NWR that incorporates the recommendations of this report can be done in an adaptive management framework where: 1) predictions about community restoration and water quality/quantity are made relative to specific management actions and then; 2) follow-up systematic monitoring and evaluation are implemented to measure ecosystem responses and to suggest future changes or strategies based on the monitoring data. Critical issues that need this monitoring include:

1. Restoring seasonally- and annually-dynamic water regimes.

2. Salt and selenium accumulation levels.

3. Long-term changes in vegetation communities related to changed water management.

4. Endemic and invasive species.

HISTORICAL PHOTOS

FROM BENTON LAKE NATIONAL WILDLIFE REFUGE ARCHIVES

East side of Benton Lake, 1938

Coulee June 9, 1938 NW side of Benton Lake

1938

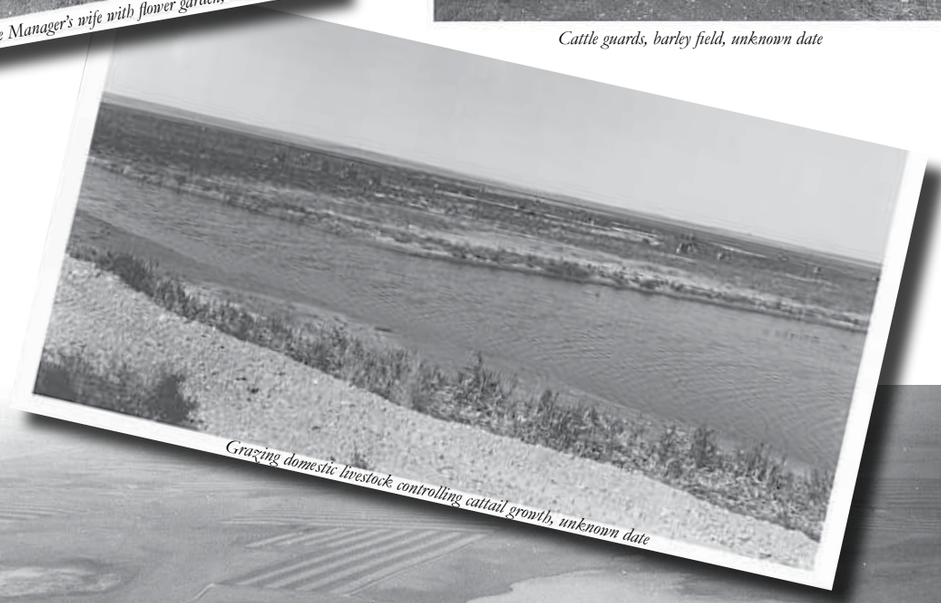
Notes about these pics:
"On April 14, the coulee in the northwest portion of the Benton Lake Refuge had water in it for a distance of about five miles and a width of about 20 ft. On June 9, this coulee was practically dry, with the exception of small potholes in its deeper portions (*top right here*). On June 30, just after unusually heavy rains the lake bed itself had some water."

HISTORICAL PHOTOS

FROM BENTON LAKE NATIONAL WILDLIFE REFUGE ARCHIVES

Refuge Manager's wife with flower garden, 1954

Cattle guards, barley field, unknown date



Grazing domestic livestock controlling cattail growth, unknown date

Benton Lake Unit II on left, Unit I on right, unknown date