



MONITORING AND EVALUATION

Many monitoring and evaluation programs and studies have been conducted at Benton Lake NWR in the past two decades and data from these efforts have been important to document changes to the ecosystem and to help design future restoration programs including those identified in this report. Regular monitoring and studies directed toward specific information needs should be continued and expanded at Benton Lake NWR to help determine success or failure of management/restoration actions, provide information on uncertainties about the ecosystem, and ensure institutional memory of management programs.

Ultimately, the success in restoring and sustaining communities and ecological functions at Benton Lake NWR will depend on how well changes in water management can emulate natural water regimes that supported specific habitat types and how changes in water management and regional land use can control accumulation of salts and selenium in the system. Recommendations in this report address these critical issues and propose restoration of fundamental ecological processes that drive ecosystem function. Suggestions are made about the intensity of management that will be needed to achieve these goals. Nonetheless, some uncertainty exists about the short- and long-term ecosystem effects of these changes in water, vegetation, and contaminant management. 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 (e.g., annual accumulation rates of selenium in Pool 1 sediments) relative to specific management actions (e.g., changing Pool 1 water regimes to more seasonally-flooded patterns with extended drying in long-term patterns) and then 2) follow-up systematic monitoring and evaluation are implemented to measure

ecosystem responses to various management actions and to suggest future changes or strategies based on the monitoring data. Critical issues that need this monitoring are described below.

RESTORING SEASONALLY- AND ANNUALLY-DYNAMIC WATER REGIMES

This report recommends many changes to water management in Benton Lake pools. Most changes involve restoring at least some natural water flow patterns and seasonally- and annually-dynamic flooding and drying regimes. The following data and monitoring programs are needed:

- Continue to document annual water budgets for all management pools including source (pumped vs. natural runoff), delivery mechanisms and routes, and extent and duration of flooding.
- Monitor and model surface water movement across elevations, among pools, through natural flow channels, and measures of time required to flood and drain various pools with current and proposed infrastructure developments and water management schedules.
- Determine the adequacy of all water-control structures.

SALT AND SELENIUM ACCUMULATION LEVELS

Since the mid 1980s, many studies have been conducted to document changes in water quality and quantity by source; accumulation of selenium and other trace elements in sediments and biota; and biogeochemical cycling mechanisms in Benton Lake. Certain studies also attempted to model and forecast future changes of selenium, in particular, given various scenarios of water inputs, water man-

agement, and climate. Collectively, these studies have been invaluable in establishing a baseline of information to document changes and guide recommendations for future management, including many of the recommendations in this report. Basic monitoring of these factors should continue and include:

- Periodic evaluation of water quality in Muddy Creek, Lake Creek, saline seep discharge, and Benton Lake wetland pools.
- Periodic evaluation of selenium levels in sediments, plants, and animals (including eggs and juveniles) within Benton Lake pools.
- Update water and selenium models for Benton Lake as more information becomes available and as new water management regimes are incorporated.
- Evaluate the effectiveness of using select disturbance techniques, including fire and tillage, in increasing selenium volatilization.

LONG TERM CHANGES IN VEGETATION COMMUNITIES RELATED TO WATER MANAGEMENT

One ultimate goal at Benton Lake NWR is to restore native plant communities in composition and distribution similar to historic conditions where possible. Certain developments, such as ditches, levees, and water-control structures within the Benton Lake bed will obviously constrain restoration of native vegetation communities in exactly the same distribution and extent as in pre-development periods. Nonetheless, general changes in community/habitat type distribution should occur if the recommended changes in water management, topographic restoration, and annual disturbances are followed.

Specific monitoring needs are:

- Periodic monitoring of distribution and composition of major plant communities in all wetland pools, terraces, and uplands using aerial photography, satellite imagery, and ground reconnaissance.
- Evaluation of key individual plant species survival, growth and reproduction including cattail, alkali bulrush, foxtail barley, and sedges.

ENDEMIC AND INVASIVE SPECIES

Complete inventories are needed for all plant and animal species and populations at Benton Lake. These inventories will help establish baseline conditions of population/species occurrence and production and allow managers to determine changes in distribution, survival, and management actions over time. Surveys of some species and periods, e.g., waterfowl numbers during fall migration, have been relatively consistent over time, however, little is known about population dynamics of other species including most amphibians and reptiles, mammals, and non-waterbirds. In all cases, monitoring abundance and distribution of both plants and animals should be coupled with information of annual water regimes and management schedules, water quality, disturbance, public use, and long-term habitat/community changes. New geographical information technologies now enable the integration of digital information into GIS frameworks that can be the basis for documenting and tracking changes in species and communities.

Specific monitoring is needed to:

- Determine changes in distribution and abundance of aggressive invasive plants, especially creeping foxtail, related to changes in water management and control techniques.
- Determine relative abundance and distribution of key amphibian, reptile, and mammal species.
- Continue long-term surveys of waterbirds during breeding and migration periods and relate local and regional distribution to changes in water management, habitat types and distribution, disturbance and refuge, and public access.



