OPTIONS FOR ECOSYSTEM RESTORATION AND MANAGEMENT

SUMMARY OF HGM INFORMATION

Information obtained during this study was sufficient to conduct an HGM evaluation of historic and contemporary ecological attributes of the Cokeville Meadows NWR ecosystem. Key summary data include:

1. Cokeville Meadows NWR currently is a small, relatively disjunct ownership, tract in the Bear River Valley of southwestern Wyoming.

2. This floodplain area at Cokeville Meadows was created by a laterally meandering Bear River system in a relatively narrow floodplain surrounded by terraces and alluvial fans that were formed mainly by erosion of adjacent mountains.

3. The geological/river hydrological setting of the refuge area created multiple abandoned channels and wide wet meadows within the floodplain.

4. Snowmelt and spring rains caused the Bear River to rise each spring/early summer and to flood many floodplain areas in most years.

5. Long-term climatic and river gauge data indicate alternating wet vs. dry years in the Cokeville Meadows region at about 12-15 year intervals. During wet years the spring/summer discharge in the Bear River was greater and caused more extensive and prolonged overbank flooding into floodplain habitats. Conversely, in dry years, little or no overbank flooding occurred along the Bear River and only short duration flooding of floodplain depressions occurred when higher river stages caused some backwater flooding into drainages.

6. The topography of Cokeville Meadows is heterogeneous and largely reflects the alluvial formation of the Bear River Valley.

7. Four major vegetation communities historically were present at Cokeville Meadows. These were a narrow band of riparian/riverfront forest in newly deposited coarse texture soils along the Bear River; semipermanently flooded emergent-type wetlands in deeper abandoned channels/oxbows of the Bear River; expansive wet meadows of sedge/rush/wet grassland species throughout much of the floodplain; and sagebrush-grassland communities on higher elevation older-age terraces and alluvial fans.

8. Habitats in the Bear River Valley, including the Cokeville Meadows area, provided abundant and diverse seasonal resources that were important to sustain populations of many animal species in the Intermountain West ecoregion. Most common species exploited seasonally available resources from spring through fall. Migratory birds were especially abundant in the region and over 30 waterbird species bred in the region, especially during wet years.

9. Native people occupied the Cokeville Meadows regions at various times over the past 10-12,000 years, but use was probably restricted to spring-fall periods and they had little impact on vegetation communities except for occasionally setting fires.

10. Permanent European occupation of the area did not occur until the mid- to late 1800s and sparse human populations; short growing seasons, and small infrastructure limited ecosystem changes to the area except for early diversions of water for human and livestock use and eventually more extensive grazing. Only about 16,000 people lived in Lincoln County, WY by the late 1980s.

11. Extensive water diversion and irrigation systems were constructed in the Bear River Valley near Cokeville Meadows NWR in the mid to late 1900s. Two larger dams within the Cokeville Meadows NWR acquisition boundary, the B-Q and Pixley Dams, were built across the Bear River and allowed local ranchers to divert water into distribution ditches and onto wet meadow and wetland depressions in the floodplain at Cokeville Meadows.

12. Many groundwater wells have been installed in the Bear River Valley near Cokeville Meadows and water from these wells supports hay production and some small grain crops. Pumping from these wells reduces groundwater discharge into the Bear River during July and August.

13. Floodplain topography and drainage systems, including floodplain depressions and abandoned channels, have been altered by levees, ditches, culvert and bridge crossings, water-control structures, and some channelization.

14. Currently, floodplain habitats at Cokeville Meadows are flooded more regularly and for longer periods than historically occurred, because of annual water diversions to irrigate hay/pasturelands.

15. Vegetation communities at Cokeville Meadows have shifted to wetter-type species including more extensive stands of persistent robust emergent species in deeper depressions, more sedges and rushes in meadows, and expansion of the introduced Garrison creeping foxtail across many floodplain areas.

16. Major invasive plant species now common on Cokeville Meadows include Canada thistle, whitetop, musk thistle, and Russian knapweed.

17. In February 1989, the State of Wyoming approved an act enabling the USFWS to potentially acquire about 27,000 acres south of the town of Cokeville, WY for the establishment of Cokeville Meadows NWR.

18. Currently, the refuge contains 9,259 acres in fee title (6,466 acres), conservation easements (1,672 acres), FmHA lands (758 acres), and a State of Wyoming land lease (363 acres).

19. Management efforts to date at Cokeville Meadows NWR mainly have been directed at impounding and diverting water to wetlands to increase waterfowl production and provide more predictable migration habitat; improving upland nesting habitat for ducks, providing foraging and nesting areas for sandhill cranes; enhancing roosting sites for bald eagles; protecting lek sites for sage grouse; improving winter range for ungulates; and providing riparian/wetland habitat for waterbirds, neotropical migrant birds, and some fish and mammals.

20. Wetland developments on the refuge have included constructing levees, water-control structures, and ditches. Typically, these developments have sought to divert higher water flows from the Bear River in spring and early summer into the impounded sites and then to hold the water through summer and/or fall.

21. Existing irrigation hay and pasture lands on the refuge have largely been maintained; about 50% of hayable meadows are hayed by adjacent landowners under permit.

GENERAL RECOMMENDATIONS FOR ECOSYSTEM RESTORATION AND MANAGEMENT

This study is an attempt to evaluate restoration and management options that will protect, restore, and sustain natural ecosystem processes, functions, and values at Cokeville Meadows NWR. Cokeville Meadows NWR provides key resources to meet annual cycle requirements of many plant and animal species in the Rocky Mountain region of the western U.S., and the signature wet meadows of Cokeville

Meadows NWR are an especially critical component of this important habitat type, and its species assemblages, in the Rocky Mountain ecoregion. Cokeville Meadows is an important area that can provide opportunities for wildlife-dependent uses. These public uses are important values of the refuge, but they must be provided and managed within the context of more holistic regional landscape- and system-based management. This study does not address where, or if, the many sometimes competing uses of the refuge can be accommodated, but rather this report provides information to support The National Wildlife Refuge System Improvement Act of 1997, which seeks to ensure that the biological integrity, diversity, and environmental health of the (eco)system (in which a refuge sets) are maintained (USFWS 1999, Meretsky et al. 2006). Administrative policy that guides NWR goals includes mandates for: 1) comprehensive documentation of ecosystem attributes associated with biodiversity conservation, 2) assessment of each refuge's importance across landscape scales, and 3) recognition that restoration of historical processes is critical to achieve goals (Mertetsky et al. 2006). Most of the CCP's completed for NWR's to date have highlighted ecological restoration as a primary goal, and choose historic conditions (those prior to substantial human related changes to the landscape) as the benchmark condition (Meretsky et al. 2006). General USFWS policy, under the Improvement Act of 1997, directs managers to assess not only historic conditions, but also "opportunities and limitations to maintaining and restoring" such conditions. Furthermore, USFWS guidance documents for NWR management "favor management that restores or mimics natural ecosystem processes or functions to achieve refuge purpose(s) (USFWS 2001).

Given the above USFWS policies and mandates for management of NWR's, the basis for developing recommendations for Cokeville Meadows NWR is the HGM-approach used in this study. The HGM approach objectively seeks to understand: 1) how this ecosystem was created, 2) the fundamental physical and biological processes that historically "drove" and "sustained" the structure and functions of the system and its communities, and 3) what changes have occurred that have caused degradations and that might be reversed and restored to historic and functional conditions within a "new desired" environment. This HGM approach also evaluates the NWR within the context of appropriate regional and continental landscapes, and helps identify its "role" in meeting larger conservation goals and needs at different geographical scales. In many cases, restoration of functional ecosystems on NWR lands can help an individual refuge serve as a "core" of critical, sometimes limiting, resources than can complement and encourage restoration and management on adjacent and regional private and public lands.

Although many areas within the Bear River Valley on and near Cokeville Meadows NWR have been altered, much of the acquisition boundary area has retained historic vegetation community types and distribution. The primary ecological process that controlled this Bear River ecosystem was rising water levels in the Bear River in spring and early summer that seasonally inundated floodplain habitats in alternating wet vs. dry long-term patterns. The basic pattern of this spring-flood driven ecosystem remains present, but dams and diversion of water have created a more prolonged flooding pattern with less annually dynamic pulses of flood height and duration throughout the floodplain system than existed historically. Floodplain topography and hydrology in the Cokeville Meadows NWR acquisition boundary is most altered where extensive irrigation infrastructure has been constructed (e.g. dams, ditches, levees, water-control structures). Concurrently, vegetation in the NWR boundary is most changed from historic conditions where extensive irrigation, haying, and grazing have occurred over the last century. Further, the plant communities on the east side of the refuge are affected by U.S. Highway 30 and the railroad that travel north-south through the refuge. The specific effects of continual annual irrigation and long-term effects of constant grazing/haying are unknown, but collectively these factors seem to have shifted wet meadows to more introduced grasses and probably to more persistent emergent, sedge, and rush communities in lower elevations and depressions.

Major ecosystem changes and issues that affect future management and restoration of habitats on Cokeville Meadows NWR include:

- Maintaining and complying with adjudicated water rights and irrigation flow/drainage constraints with neighboring land holdings that control water flow delivery pathways and amounts of surface water that cross, and flood onto, NWR lands.

- Disjunctive land ownership with intervening private land holdings.

- Presence and some expansion of several invasive and/or introduced plant species, especially the current extensive coverage by creeping foxtail.

- Altered water flow regimes, and perhaps degraded water quality, in the Bear River and flood waters that flow on and through the floodplain.

- Altered vegetation communities throughout the refuge and conversion of native wet meadow plant communities to irrigated hay land.

- Public expectation for continued agricultural uses (haying, pasture, small grain production) on refuge lands, an expanded refuge acquisition, and greater public access.

Based on the HGM context of information obtained and analyzed in this study, we believe that future management of Cokeville Meadows NWR should seek to:

1. Maintain the physical and hydrological character of the Bear River and its floodplain in the Cokeville Meadows NWR acquisition boundary area.

2. Restore the natural topography, water regimes, and physical integrity of surface water flow patterns in and across the Bear River floodplain and adjacent terraces and alluvial fans.

3. Restore and maintain the diversity, composition, distribution, and regenerating mechanisms of native vegetation communities in relationship to topographic and geomorphic landscape position.

The following general recommendations are suggested to meet these ecosystem restoration and management goals for Cokeville Meadows NWR.

1. *Maintain the physical and hydrological character of the Bear River and its floodplain in the Cokeville Meadows NWR acquisition boundary area.*

Fortunately, most of the major physical features of the Bear River Valley, including the Cokeville Meadows NWR acquisition boundary area, have not been highly altered by large dams or channelization of the Bear River and its major tributaries; major bridges, rail beds and roads that cross the floodplain valley; land leveling; urban or residential developments; excavations on terraces and alluvial fans adjacent to the floodplain; or large mining operations. The most important alterations to physical attributes of the Cokeville Meadows ecosystem have been construction of the B-Q and Pixley dams on the Bear River, irrigation ditches and canals, and roads/rail beds on the edges of the floodplain. Most of these developments do not appear to have compromised the integrity or functioning of the ecosystem in irreversible ways. Nonetheless, it is important to protect the Cokeville Meadows NWR area from future landscape and hydrological development proposals that might significantly alter the physical and hydrological characteristics of this ecosystem. Collectively, completing the establishment of Cokeville Meadows NWR within its acquisition boundary and maintaining the integrity of the Bear River Valley is critically important within the context of larger Intermountain West and Great Basin conservation initiatives (e.g., USFWS 1992, Nachlinger et al. 2001).

2. *Restore the natural topography, water regimes, and physical integrity of surface water flow patterns in and across the Bear River floodplain and adjacent terraces and alluvial fans.*

The diversity and productivity of the Bear River Valley, including the Cokeville Meadows NWR acquisition boundary area, was created and sustained by a diverse geomorphic/topographic surface (that reflected historic migrations and scouring/deposition by the Bear River) that was seasonally "hydrated" by a strong seasonal pulse of water into the ecosystem each spring from flooding of the Bear River and its tributaries and surface and groundwater drainage/recharge from surrounding mountain/terrace slopes. The topographic and geomorphology/soil characteristics of the region created complex, and highly interconnected, mosaics of elevations and water flow pathways with site-specific hydrology that supported local vegetation communities and diverse resources that were used by many animal assemblages on Cokeville Meadows NWR. Unfortunately, considerable changes have occurred in topography and flow of water across the Bear River Valley because of water diversion from the Bear and Smith's Fork rivers, seasonally impounding water upstream of the B-Q and Pixley dams, over 100 miles of irrigation ditches and canals in and on the edge of the floodplain, low-

level dams and berms along the Bear River and in floodplain depressions, numerous water-control structures, and some pumping of groundwater from over 100 wells in the region. Most of the water developments in the region have been intended to provide more sustained annual irrigation water to floodplain meadows to enhance hay production and pastures. Diversion of water for irrigation of hay and pasturelands in spring simulates natural flooding from the Bear River into the Cokeville Meadows floodplain but has reduced inter-annual variation of low vs. high flooding, prolonged annual flooding of meadows, and changed in-stream flows especially in late summer. Seasonal impoundment upstream of the B-Q and Pixley dams has caused higher prolonged water levels in summer and appears to have promoted steep-angle channel bank erosion in some places. The cumulative impacts of these hydrological changes on ecosystem structure, functions, and values are not known, however, plant communities have shifted to more water tolerant species and the many ecologically beneficial effects of periodic extreme drought or flooding have been reduced.

Some topographic/hydrologic developments on Cokeville Meadows NWR have been constructed by the USFWS to partly impound water in floodplain depressions to provide more consistent water areas with longer hydroperiods for breeding waterbirds, especially ducks. While this impoundment does provide more consistent wetland habitat during spring and summer, it reduces the natural dynamic variation in water regimes that ultimately is necessary to sustain long-term diversity and production of floodplain wetlands. These wetlands require periodic annual drying that alternates with more extensive flooding in wet years to recycle nutrients, provide germination surfaces to regenerate plant communities, and provide access to specific foods by certain animal groups in both wet and dry periods of the long-term cycle (e.g., van der Valk 1989). Further, all topographic alterations to the floodplain alter how and where river floodwater flows across lands and moves nutrients and resources. For example, historically high water in the Bear River occasionally overflowed banks and spread across floodplains in a "sheetflow" manner by first inundating depressions and then gradually moving onto higher elevations and then draining in a similar manner. Now, because of ditches, dams, etc., water usually is purposefully routed to specific areas where it may or may not overflow onto low elevations in a sheetflow manner. Likewise, drainage of floodwater from the floodplain usually is channeled through ditches and not back through natural lower elevation locations.

Generally, restoration of the physical and biotic diversity and productivity of the Cokeville Meadows ecosystem will require at least some restoration of natural topography, especially reconnecting natural water flow pathways in the floodplain. Further, the annually dynamic nature of historic spring flooding patterns should be restored, or emulated, where possible. This restoration of natural flooding patterns will mean that occasional dry, and conversely occasional very wet, conditions in floodplain depressions and meadows will occur. Reinstating this annually dynamic hydroperiod also will mean that waterbird production will be annually dynamic across years; with higher use and production in wet years and lower abundance and production in dry years. While waterbird production may be more irregular among years, restoring the natural hydrodynamics of the system ultimately will sustain the long-term diversity and production of the ecosystem, and thus its long-term carrying capacity for many animal species. Disjunct ownership of lands by the NWR and historical precedents and legal constraints of water use and water rights will make management for emulation of natural flooding dynamics difficult in many areas of the refuge acquisition boundary. However, emulation of more natural water regimes seems possible in some managed areas and may be possible to some larger geographic extent if NWR lands are expanded to the approved boundary, thus allowing more opportunity for restoration of natural topography, overbank flooding, and water movement/duration patterns.

3. *Restore and maintain the diversity, composition, distribution, and regenerating mechanisms of native vegetation communities in relationship to topographic and geomorphic landscape position.*

Four major vegetation communities historically were present in the Cokeville Meadows ecosystem and they were distributed along geomorphic, soil, topographic, and flood frequency gradients. HGM-based mapping of potential historic distribution of communities was somewhat constrained in this study by the lack of refined soil and topographic information. Nonetheless, the distribution of geomorphic surfaces and flood frequencies in various floodplain elevations described vegetation community distribution rela-

tively well. Riparian/riverfront forest was present on natural levees with coarse material soils immediately adjacent to the Bear River and its major tributaries, while emergent-type wetland vegetation occurred in floodplain depressions, especially old river meander channels. Sagebrush-grassland communities occurred on alluvial fans and terraces along the edge of the floodplain. The largest community type at Cokeville Meadows was the namesake meadow habitat. If more refined soil and topographic information had been available, it might have been possible to map specific plant distribution in the meadows relative to slight variations in soil salinity and elevation. For example, more alkali species such as saltgrass and alkali sacaton historically occurred on more saline areas while more extensive rush and sedge species were present in slightly lower elevations in the meadow areas that flooded more regularly and for slightly longer duration. Future information on soils and elevations should help identify the distribution of specific historic plant assemblages in meadow areas.

Each vegetation community in the Bear River Valley provided important, usually seasonal, resources to a diverse animal community that used the area. And, each community was the result of distinctive seasonal flooding regimes caused by inter- and intra-annual dynamics of water flows and flooding of the Bear River and its major tributaries. The winter climate in the region is extreme and most animals using the area were seasonal visitors. More water/flooding, and thus available aquatic/wetland resources, occurred in spring and early summer than in other periods. For waterbirds, shallowly flooded habitats in most springs provided extremely important spring migration habitat and in wet years the extended summer water area provided important periodic breeding habitat. In contrast, less habitat and resources were available from late summer through the following spring except in wet years when higher, more prolonged floods, inundated floodplain wetlands for longer periods and carryover water into fall/winter was higher.

Based on the HGM model of potential Pre-settlement vegetation communities, the current distribution of major vegetation community types at Cokeville Meadows is not drastically altered from historic condition, but significant shifts have occurred in species composition of the communities. The primary changes from historic condition are:

1. Conversion of some habitats to agricultural crops or introduced hay lands.
2. Shifts in species composition in wetland and meadow communities.
3. Loss of much woody species in riparian corridors.
4. Expansion of emergent wetland species along ditches, canals, and drainages where surface water is present for longer periods.

Typically, ecosystem restoration strategies seek to restore elements of the diversity, composition, and natural distribution patterns of habitats in a region where they may have been altered (e.g., Heitmeyer 2007). At Cokeville Meadows, this restoration goal seems important to sustain plant and animal communities and to provide other related ecosystem functions and values such as nutrient and energy flow, carbon sequestration, water filtration and recharge, flood water storage, human uses, etc. As such, management actions at Cokeville Meadows NWR should attempt to protect, maintain, and restore (if need be) functional areas of all native habitat types that were present in the early 1900s prior to major changes in irrigation and land use. The appropriate distribution for each community is identified by the HGM matrix produced for this region in terms of geomorphic surface, soil and elevation to the extent that data allow, and hydrologic regime. In meadow habitats, extensive grazing/haying and diversion of irrigation water to floodplains appears to have gradually shifted plant species composition and distribution to wetter and more introduced species. The shift in meadow vegetation may not be highly detrimental if the new species provide similar resources to the historic communities, however, retaining the native community diversity and composition is a desirable goal to assure the historic attributes of the ecosystem, including those not fully understood at present, are retained.

Each community at Cokeville Meadows had important driving ecological processes, usually including some periodic disturbance event such as flood, drought, fire, herbivory, etc. A key to sustaining or restoring historic plant associations will be making sure the driving processes and disturbances are present. Consequently, future management should identify where basic processes are still present, and where they need to be restored. As such, some "deconstruction" of past infrastructural developments including physical works such as ditches, levees, water-control structures, etc. may be required. Clearly, certain changes may not

be possible for the reasons mentioned in #2 above, however, other USFWS-controlled changes can be conducted. Likely, some conflicts in changing existing landscape features may occur among user groups, but management of Cokeville Meadows NWR ultimately should be based on restoring sustainable communities to meet resource/ecosystem goals.

SPECIFIC RECOMMENDATIONS FOR RESTORATION AND MANAGEMENT OPTIONS

Maintain the Physical and Hydrological Character of the Bear River System

The Bear River Valley ecosystem was created and sustained by geological and hydrological processes of the Bear River and its tributaries that largely still exist in their general physical/hydraulic form. It also is helpful that human presence in, and disturbance of, floodplain/terrace plant and animal communities at Cokeville Meadows NWR historically has been low. Changes to ecosystem features on the refuge have occurred and many issues cannot be controlled by the USFWS. Nonetheless, the USFWS has the opportunity to manage Cokeville Meadows NWR in an exemplary way that contributes to the overall sustainability and restoration of the Bear River Valley. The USFWS also can help promote stewardship and protection of other private and public lands in the Bear River Valley, especially those adjacent to Cokeville Meadows, which can help protect the integrity of this ecosystem. The following conservation actions seem important in this regard:

1. *Protect and restore, where possible, the physical and hydrological integrity of the Bear River and major tributary channels and their water flows, especially the large spring pulse of water in these rivers and streams that originates from snowmelt and spring precipitation.*

   - Do not construct additional dams, levees, or channel-bank stabilization structures on the Bear River or its tributaries.

   - Evaluate the need, and legal standing, for existing dams and water diversions structures on the Bear River and major tributaries.

   - Remove and do not replace hard points or bank stabilization structures along the channel banks of the Bear River on Cokeville Meadows NWR unless they protect non-USFWS property or structures.

   - Remove, or place wide spillways in mainstem levees along the Bear River and larger tributaries. Where old or existing levees have been breached or destroyed, do not rebuild them.

   - Reconnect floodplain habitats with the Bear River to allow natural overbank and backwater flooding into and out of the floodplain.

   - Maintain unimpeded physical and water-flow connection between tributaries and the main Bear River channel.

   - Participate in Bear River watershed activities that help protect water quantity and quality in the Bear River.

   - Complete acquisition and establishment of Cokeville Meadows NWR within its authorized boundary.

2. *Protect the natural heterogeneous topography of the floodplain including the unique geologic/soil characteristics of abandoned channels and river meander scars, floodplain drainages, alluvial fans, and older geologic-age higher elevation terraces.*

   - Protect alluvial fans and terraces along the Bear River floodplain on Cokeville Meadows NWR from development, mining, and topographic alteration and develop private land programs to maintain natural topographic and geological features on similar private lands.

   - Do not alter topography further in floodplain wetlands, natural drainages, and other floodplain/meadow lands.

   - Reduce agricultural activities that may cause erosion, increased sediment loading, and alteration of topographic elevation/features.

3. *Maintain a low human presence in, and disturbance of, floodplain/terrace plant and animal communities.*

- Restrict residential/commercial developments on Cokeville Meadows NWR and work with county and state entities to maintain low human impacts on adjacent lands.

- Control public access to compatible uses and seasons.

- Evaluate ecosystem disturbances caused by widespread continued haying and grazing on Cokeville Meadows NWR lands.

4. *Protect alluvial aquifers and the delicate soil-mineral balances throughout the floodplain and its adjoining alluvial fans and terraces.*

- Further evaluate groundwater-surface water recharge and discharge distribution and capacities, with additional monitoring of effects of irrigation and wells on alluvial aquifer water quantity and quality.

- Maintain undisturbed vegetation on critical groundwater recharge and discharge sites including seeps and artesian well locations.

Restore Floodplain Topography, Water Regimes, and Water Flow Patterns

Restoration of historic ecological communities and processes at Cokeville Meadows NWR will require at least some restoration of natural topography, water flow patterns, and flooding/drainage regimes. Many past irrigation infrastructural developments and some NWR wetland impoundment projects have altered these important ecosystem attributes and all existing alterations should be carefully evaluated to determine their purpose, efficiency, and interactions with regional water rights and water use needs and history. The Bear River ecosystem is semi-arid and water regimes historically were dominated by increased precipitation and snowmelt in spring that caused higher river flows and flooding followed quickly by drying through summer and fall to low levels in winter and early spring. Superimposed on this strong seasonal water regime were long-term patterns of occasional high flow and flood events and alternating low flow, more droughty conditions on ca. 15-year recurrence intervals. Since the development of extensive water diversions and irrigations systems in the Bear River Valley near Cokeville Meadows, water regimes in floodplain areas, especially meadows and depression wetlands have been more annually consistent, prolonged, and generally wetter than during historical periods. Likewise, management of wetlands (through levees, ditches, and water-control structures) on Cokeville Meadows NWR lands also have tended to provide longer duration and more regular flooding of these areas and has greatly reduced annual flooding-drying dynamics. A return to more historic seasonal and long-term patterns of flooding in this ecosystem will be difficult across wide areas because of the disjunctive ownership of lands, past irrigation history and water rights, and the extensive irrigation infrastructure. Nonetheless, some changes seem possible for specific areas on Cokeville Meadows and include:

1. *Restore natural topography and reconnect natural water flow patterns and pathways where possible.*

- Remove and/or breach spoil material berms and levees along the Bear River and major natural drainages.

- Improve water flow into and through historic floodplain wetland depressions including abandoned channels by removing obstructions, levees, and dams in and across these drainages and depressions.

- Restore at least some natural topography in wetland impoundments, crop and hay fields that may be restored to native vegetation, and terraces and remove islands or other deposition sites in wetlands.

- Evaluate all levees, roads, ditches, and water-control structures to determine if they are necessary, or are detrimental, to water management or restoration of natural water flows and regimes. Remove unnecessary levees and roads and/or construct spillway breaches in drainages.

- Do not construct additional wetland impoundments, roads, levees, or other water-control structures that alter water flow into and across the floodplain.

- Remove roads, berms, and ditches that disrupt natural surface water sheetflow or ground-

water discharge and seepage across and from alluvial fans and terraces.

2. *Manage wetland impoundments (that are retained) and natural floodplain depressions for more natural seasonal and long-term water regimes.*

- Manage water regimes in all wetlands for a more natural seasonally and annually dynamic water regime that emulates natural increases in distribution and depth of water in spring followed by drying in summer and fall.

- Emulate long-term patterns of drier wetland regimes in floodplain wetlands in most years including periodic complete drying of shallower depressions in some years and occasionally flooding all basins for more prolonged periods throughout summer and fall in some years.

Restore Natural Vegetation Communities

The current types and distribution of major vegetation communities are similar to historic conditions, but some changes have occurred in species composition of communities. The primary changes are increases in introduced grasses in meadows and sagebrush habitats; loss of willow and cottonwood in riparian corridors; and the presence of more water tolerant sedge, rush, and persistent robust emergent species in floodplain depressions and low elevation meadow areas. The native mixture of vegetation communities present in the Bear River Valley, including the Cokeville Meadows NWR acquisition boundary area, provided critical resources to many animal species and populations in the Intermountain West. Maintaining and restoring, where necessary, the distribution and types of historic habitats is important to the long term capability of the Bear River ecosystem, and entire Intermountain West, to support endemic communities and system functions and values. Fortunately, at Cokeville Meadows NWR, less restoration of native communities is needed compared to other highly degraded and altered areas (e.g., Heitmeyer et al. 2010). Major ecosystem changes appear to be the loss of the woody component of riparian corridors and the potential aggressive expansion of certain introduced cultivars, e.g., creeping foxtail, and invasive species. A detailed vegetation inventory of all lands in the Cokeville Meadows acquisition boundary is needed as is careful monitoring to identify changes in species and potential key resources for animal species.

Restoration of native communities seems possible and is desirable for some areas on Cokeville Meadows NWR, including sites that have been converted from native habitats or are in more highly altered locations. Specific actions to assist this restoration include:

1. *Restore distribution of plant communities to appropriate sites based on HGM-predicted geomorphology, soil, topography, and hydrology features identified in Figure 17.*

- Sustain Riparian Forest corridors along the Bear River and larger tributaries including the Smith's Fork River on newly deposited/scoured coarse material surfaces. Attempts should be made to encourage and/or reintroduce willow and cottonwood in these sites, including protection of these river corridors from extensive grazing.

- Sustain diverse wetland plant assemblages in floodplain depressions and reduce robust emergent coverage by restoring more natural water regimes.

- Maintain the large meadow community in the Bear River floodplain and encourage conversion of areas that have been converted to introduced grasses or cropland to revert to more native species mixes.

- Sustain sagebrush-grassland communities on alluvial fans and terraces.

2. *Improve conditions to increase the distribution and historic composition of native Meadow habitats.*

- Restore certain meadow areas currently in alfalfa or grain production to native meadow species.

- Restore seasonal and annual dynamics of historic water regimes in meadow communities where possible.

- Evaluate the extent of permittee haying and grazing in meadow areas on the refuge and

possibly restore some areas to native species composition and more natural disturbance mechanisms by removing haying/grazing in some or all years and include fire and irregular herbivory/grazing.

3. *Reduce the area of more permanently flooded wetlands and robust emergent vegetation.*

- Reduce or modify impoundment structures in floodplain depressions.

- Remove levees, ditches, and water-control-structures from all higher elevations within floodplains, alluvial fans, and terraces where possible.

- Change water management in retained impoundments to more natural seasonal and long-term water regimes.

4. *Actively control invasive and noxious plant species.*

- Actively control invasive and noxious plant species using appropriate chemical, mechanical, and biological methods.

Karen Kyle

Karen Kyle