HYDROGEOMORPHIC EVALUATION
OF
ECOSYSTEM RESTORATION
AND MANAGEMENT OPTIONS
FOR
MONTE VISTA NATIONAL WILDLIFE REFUGE

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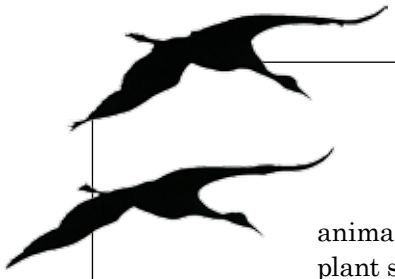
EXECUTIVE SUMMARY

This report provides a hydrogeomorphic (HGM) evaluation of ecosystem restoration options to assist future management of the Monte Vista National Wildlife Refuge (NWR) located in the San Luis Valley (SLV) of south-central Colorado. Monte Vista NWR contains 14,800 acres and was established in 1952. The refuge is located at the base of the San Juan Mountain foothills immediately south of where the Rio Grande enters the SLV. Most of the refuge lies on the large Rio Grande alluvial fan and three creek drainages (Spring, Rock, and Cat) bisect the area. Historically, the alluvial fan area was dominated by an extensive salt desert shrub community and wetlands were located along the creek corridors. The foothills of the San Juan Mountains on the far west side of the refuge historically contained undershrub grasslands.

The SLV is a highly modified region. Major ecological changes in the SLV began in the mid-1800s when agricultural production expanded and extensive irrigation systems were constructed to divert Rio Grande river water, pump groundwater from shallow unconfined and deeper confined artesian sources, and move water through an elaborate system of ditches and canals to upland areas. Over time, most native vegetation communities in the SLV were converted to agricultural production and current water use in the valley is tightly regulated and becoming more limited. Early landscape changes to the Monte Vista NWR lands were further modified after refuge establishment, primarily to increase flooded areas of wetlands and meadows. While this development was beneficial to certain species in some seasons, including breeding dabbling ducks, the long-term consequences of water diversion and seasonal inundation of areas formerly in shrub habitat have included increased soil salinity, shifts in native vegetation species distribution, altered resource availability to native



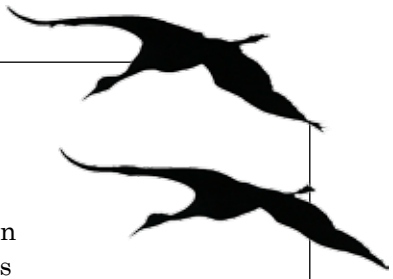
animal species, and invasion and establishment of non-native plant species, especially tall whitetop (*Lepidium latifolium*).

In 2003, a Comprehensive Conservation Plan (CCP) was prepared for Monte Vista NWR and the nearby Alamosa NWR to identify habitat and public use goals. Since that time, management has sought to implement CCP goals, but also has recognized the need for more holistic system-based approaches to future restoration and management strategies. In 2011, a new CCP planning process for SLV NWRs, including Monte Vista NWR, was initiated and this planning is being facilitated by Hydrogeomorphic Methodology (HGM). The HGM process obtains and collates historical and current information about: 1) geology and geomorphology, 2) soils, 3) topography and elevation, 4) hydrology, 5) aerial photographs and maps, 6) land cover and plant/animal communities, and 7) anthropogenic features of ecosystems.

This report provides HGM evaluation of Monte Vista NWR with the following objectives:

1. Identify the Presettlement ecosystem condition and ecological processes in the Monte Vista NWR region.
2. Evaluate differences between Presettlement and current conditions in the Monte Vista NWR ecosystem with specific reference to alterations in hydrology, vegetation community structure and distribution, and resource availability to key fish and wildlife species.
3. Identify restoration and management approaches and ecological attributes needed to successfully restore specific habitats and conditions within the Monte Vista NWR region.

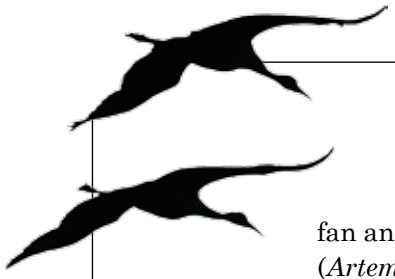
The dominant geological feature of Monte Vista NWR is the large alluvial fan formed where the Rio Grande enters the SLV. This fan is Quaternary-age and three creeks that originate from the San Juan Mountains flow across the fan. About 30 distinct soil types are present on Monte Vista NWR and three general soil associations define geomorphology and topography. The alluvial fan is dominated by Hooper-Arena-San Luis Association soils formed in mixed alluvium. Torrifluvent-Torsido-Alamosa Association soils occur in



historic floodplains of the three creeks on the refuge. San Juan Mountain foothills contain Luhon-Garita-Travelers Association soils; these are well drained coarse texture materials formed in mixed erosional alluvium and weathered basalt residuum. The topography of the refuge largely reflects the transition from foothill to alluvial fan surfaces and the bisection of narrow creek corridors. Few natural "wetland" depressions exist on the refuge and historical maps show these areas primarily along Rock Creek in the north-central part of the refuge.

The climate of the SLV is arid, with cold winters and moderate summers. Monte Vista NWR is in the pronounced rain shadow of the San Juan Mountains and receives an average of about seven inches of precipitation per year; about 60% of this precipitation is rain in July and August. Long-term precipitation data from Del Norte, west of Monte Vista NWR, indicates annually dynamic patterns with frequent switches between dry (< 6 inches) to wet (> 12 inches) years. Historically, Monte Vista NWR received annual inputs of surface water primarily from the limited onsite precipitation during summer and surface water drainage from Rock, Spring, and Cat creeks. Rock Creek historically was fed primarily by snowmelt and subsurface drainage helped maintain some creek baseflow. Spring Creek, as its name implies, historically was fed by a relatively large groundwater discharge "spring head" located in the southwest corner of Monte Vista NWR. Cat Creek originated in the San Juan Mountain foothills and apparently had intermittent flow that terminated on the alluvial fan of the refuge. The refuge area did not receive surface water flooding from the Rio Grande.

Vegetation in the SLV historically was highly influenced by the relatively low, but intense, amounts of summer rainfall and most annual plants germinate and grow, and most perennial plants flower, during late summer. The surface soils outside of creek areas on Monte Vista NWR usually are dry until early summer and even if soils are not dry, the cold spring temperatures prevent plant germination until June. The undershrub grasslands historically present on the San Juan Mountain foothills are dominated by grama-type grasses with some intermixed shrubs. This grassland community transitions to salt desert shrub on the Rio Grande alluvial

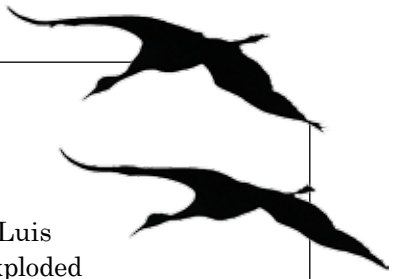


fan and throughout the floor of the SLV. Scattered sagebrush (*Artemsia tridentata*) historically was present in transition areas between grassland and salt desert shrub and shrublands were dominated by greasewood (*Sarcobatus vermiculatus*), rubber rabbitbrush (*Ericameria nauseous*), shadscale, commonly called fourwing saltbush (*Atriplex canescens*), alkali sacaton (*Sporobolus airoides*), and saltgrass (*Distichlis spicata*). Soils in salt desert shrub areas typically are poorly drained and groundwater tables historically were close to the ground surface. Even slight differences in elevation of a few inches can alter drainage and cause ephemeral ponding, which creates higher salinity and heterogeneity in plant distribution. When alkali is high, "chico slick spots" occurs as barren salt flats.

The relatively narrow creek corridors on Monte Vista NWR include active and relict creek channels and associated narrow floodplains. Historically, wetland depressions typically had seasonal flooding regimes and supported diverse sedges, rushes, and herbaceous wetland species. A few deeper areas may have supported persistent emergent species such as cattail (*Typha spp.*) and softstem bulrush (*Sciprus validus*). Vastine soils are the most common soil type associated with historic distribution of wetlands on Monte Vista NWR. The edges of creek channels included a marginal wet meadow zone that contained diverse sedges and rushes. These meadows extended away from stream bank zones in some areas. Riparian trees were limited, if present at all, along creeks.

An HGM matrix of the relationships between major plant communities and a combination of geomorphic surface, soil, topography and hydrology attributes was developed to prepare a map of potential distribution of historical communities on Monte Vista NWR. The major factors influencing vegetation distribution were: 1) geomorphic surface and topographic position, 2) soil salinity, and 3) onsite hydrology that was affected by seasonally and annually variable inputs of water and whether the site was subirrigated by high groundwater tables.

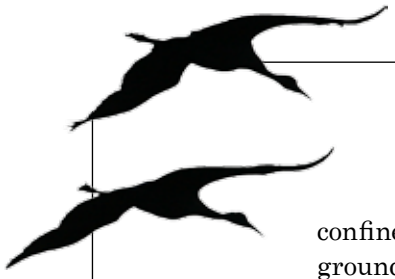
Many studies and reports have documented the extensive land use changes in the SLV, mostly associated with the development of elaborate irrigation capacity to support regional agricultural production. The first ditch to move water



from local rivers to the interior of the SLV was the San Luis Peoples Ditch constructed in 1852. The "Ditch Boom" exploded in the 1880s and major canals that affect Monte Vista NWR including the Empire and Monte Vista Canals were built at that time. Agricultural production in the SLV was further enhanced by drilling thousands of wells into both the shallow unconfined and the deeper confined aquifers starting in the late-1800s. By 1980, about 2,300 pumped wells existed in the unconfined aquifer and over 7,000 wells tapped deeper artesian groundwater sources. At Monte Vista NWR, many areas of former salt desert shrub lands on higher elevation alluvial fans near creek channels were converted to annually irrigated wet meadows for livestock grazing and cropland production using irrigation infrastructure built in the late-1800s and early-1900s. Much of this early water-control infrastructure remains present on the refuge.

Immediately prior to refuge establishment in 1952, the Monte Vista NWR area was predominantly pasture/hay and cropland. The original development plan for the refuge proposed considerable expansion of existing ditches, dikes, drains, water-control structures and roads to increase the diversion of water from the Monte Vista and Empire Canals to enhance existing, and create new, irrigated meadows and wetland ponds. The subsequent development of extensive water diversion and storage infrastructure subdivided the refuge into more than 80 sub-units. Certain units on Monte Vista NWR have been extensively developed and compartmentalized by relatively large angle-dikes (e.g., Units 6, 10, 15, 16, 19), closely-spaced contour levees (Units 7 and 9), and conveyance ditches (Units 15, 16, 6, 8, 10). Many of these water-diversion/control developments have effectively blocked, diverted, and significantly modified former natural surface water flow pathways and patterns and have attempted to create meadow and wetland habitats in areas that formerly were salt desert shrub habitat. Modification of natural surface flow pathways occurs throughout the Spring and Rock Creek drainage corridors in Units 1-11, 14, and 15 and within the smaller formerly intermittent flow corridor of Cat Creek in Units 16, 17, and 22.

In the early-1950s, all of the wells on Monte Vista NWR were free-flowing from artesian pressure in the deeper

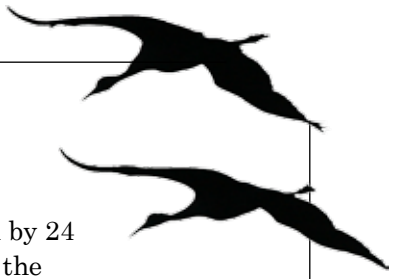


confined aquifer and Spring Creek was still discharging groundwater. However, by the 1970s, the Spring Creek groundwater "spring head" stopped flowing and the number of free-flowing artesian wells on the refuge declined greatly. Currently, during summer months almost all artesian wells on Monte Vista NWR cease flowing when maximum groundwater pumping occurs on and off the refuge for irrigation purposes. Currently, Monte Vista NWR has 254 wells that historically provided at least some water to the refuge. Water from these wells is adjudicated for irrigation, wildlife, domestic and stock water purposes.

Water availability and management at Monte Vista NWR is heavily controlled by SLV-wide water diversion infrastructure and associated Rio Grande Compact and water rights law. Monte Vista NWR receives an annual average of about 8,500 acre-feet of irrigation water from the Rio Grande primarily through the Empire and Monte Vista canals and from water draining neighboring private lands into several drainage ditches (e.g., Parma and Bowen drains). The water delivery and diversion to the more than 80 wetland management sub-units on Monte Vista NWR is achieved using the complex infrastructure that includes more than 30 major and 100 minor dikes, over 400 water-control structures ranging from road culverts to larger creek dams and diversion points, and 61 miles of ditches.

Early in the development of Monte Vista NWR, over 100 small (1/4- to one-acre) "ponds" were created by constructing ring-dikes around artesian wells that were present when the property was purchased by the USFWS. These ponds were intended to capture and hold artesian well water and provide small wetlands for waterfowl and other local wildlife species. Many of these ponds were not capable of holding water for more than short periods, because of low artesian flow and porous soils. The soil salinity of some pond sites also was high. Currently, many of these ponds are dysfunctional. As some small artesian wells quit discharging water, other deeper and bigger wells were drilled. More than 100 islands were built in wetland units for nesting waterbirds and ducks.

Annual narratives for Monte Vista NWR chronicle the many water and habitat management activities on the refuge



through 1994. Management on the refuge is designated by 24 major management or "administrative" units and since the early-1960s management has focused on providing habitat for breeding ducks, which included early annual flooding, planting and maintaining dense nesting cover, and some predator control. This management emphasis was fostered by the attraction of high numbers and densities of breeding dabbling ducks to flooded wetlands on the refuge. Long-term studies of nesting ducks on the refuge indicated generally good nesting success and recruitment of young from the refuge into the 1990s.

Water management on Monte Vista NWR has been generally consistent over the past 30+ years based on refuge annual narratives. The extensive development of wetland management infrastructure before and after refuge establishment, the relatively consistent annual water regime management (flooding) among management units, and clearing of shrubland for croplands greatly altered the vegetation community/habitat composition on Monte Vista NWR since its establishment. Major modifications/degradations included a major reduction in the extent and composition of salt desert shrub habitat and a shift in remnant shrubland community composition toward the invasive weed, tall whitetop, and wetland vegetation, especially Baltic rush (*Juncus balticus*). Currently about 24% of the refuge is in salt desert shrub habitat, which when compared to the potential historic vegetation represents a decrease of about 67% of this community type over time.

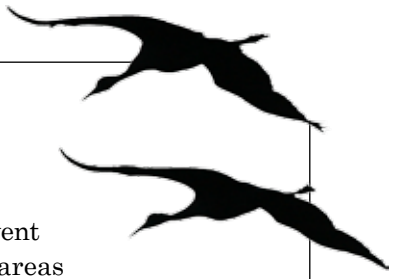
The extensive spread of tall whitetop on Monte Vista NWR is closely associated with the disturbance of soils and changes in hydrology caused by artificial irrigation and diversion of water to former shrublands. Although initially spread through the ditch system, native shrub vegetation communities were converted to wetter states through prolonged seasonally flooded hydrologic regimes, which allowed tall whitetop to out-compete natives. About 80%+ of the tall whitetop present on Monte Vista NWR is associated with levees and ditches or has spread over time from these points to interior areas. Refuge management has attempted to limit the spread of invasive plant species, especially tall whitetop, using

repeated mowing, herbicide application, and targeted grazing using sheep in some areas.

This HGM report provides information to help identify general options for restoration of native ecosystems on Monte Vista NWR if that is a future strategic conservation goal. Assuming this goal, the paramount issue influencing future restoration and management success is the need to change how management addresses the timing, distribution and movement of water on the refuge. General recommendations to address critical water issues include:

1. Restore natural surface water flow pathways and associated hydrological regimes where possible to restore and manage wetlands and wet meadows along Spring, Rock, and Cat Creeks.
2. Restore natural topography and promote natural hydrologic regimes to restore at least some areas of historically occurring salt desert shrub and undershrub grassland habitat including its natural heterogeneity of sub-habitat components.
3. Restore natural disturbance regimes such as herbivory, fire, and drought to promote the health and quality of all habitat types and reduce noxious weeds.

Specific recommendations to implement each of the above general goals are provided in the report. For recommendation #1, future water management at Monte Vista NWR should consider changes in water-control and water diversion infrastructure and refuge management strategies to more closely emulate natural flow patterns, distribution, and seasonal/long-term dynamics of surface and subsurface water to reinstate appropriate historical distribution of communities, especially wetland and wet meadow habitats, improve native plant species diversity and productivity, reduce alkali concentrations, and increase efficiency of total water use. Itemized recommendations are provided to restore the Cat Creek drainage, remove ring-dikes, restore flow in the natural Rock and Spring Creek drainages, modify and remove certain water-control infrastructure, restrict prolonged flooding in soils historically dominated by shrubs, manage water regimes in former wet meadow sites, vary annual flooding regimes



among years, remove many wetland sub-units, and prevent conversion of former wet meadow and salt desert shrub areas to seasonal or semipermanent wetlands.

For recommendation # 2, restoration of salt desert shrub and undershrub grassland should be carefully targeted to former occupancy sites. Itemized recommendations are provided to target salt desert shrub to former distribution especially where some shrubland still exists, remove water-control infrastructure and restore natural topography and overland sheetflow of water in historic shrub areas, remove ring-dikes and decommission small flow artesian wells, restore natural hydrological regimes in shrublands by changing irrigation and flooding to spring periods, protect foothill areas from additional physical alteration, remove roads that alter natural water flow and that cause impoundment of water, and remove water-control structures in former shrublands that are no longer used.

For recommendation #3, natural disturbance regimes should be reintroduced and managed where possible. Itemized recommendations are provided to investigate the historical occurrence of disturbance events, attempt late winter burns if fire can be used, consider methods to remove residual vegetation in wetland and wet meadow habitats, mow or hay if natural herbivory is not an option, encourage overbank flood events on creeks, promote periodic drought in shrublands and current tall emergent wetland habitats, and control invasive species using a combination of treatment methods.

Future management of Monte Vista NWR will benefit from continued key monitoring studies and directed studies as needed. Future management also can be conducted in an adaptive management framework. Specific information needs for the refuge are related to ground and surface water quality and quantity, efforts to restore natural water flow patterns and water regimes, and long-term changes in vegetation and animal communities.