Assessment of the Red Rock River Subbasin and Wetlands of the Centennial Valley

Prepared for:

Bureau of Land Management,
Montana / Dakotas State Offices

By:

Linda K. Vance, Karen Newlon, Jessica Clarke and David M. Stagliano

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Executive Summary

This report summarizes results from a multi-scale ecological assessment of fourteen watersheds in the Red Rock River subbasin in southwestern Montana, and an in-depth assessment of wetlands on BLM-managed lands in the Red Rock Creek and Lima Reservoir watersheds of the Centennial Valley. The goal of the project was to provide landscape-level assessments of watershed health and integrity, as well as site-specific evaluations of wetland and aquatic condition, using a probabilistic survey approach. This was accomplished using both broad-scale GIS analysis and field sampling.

The value of watershed-level assessments lies in identifying areas where impacts are currently occurring or may occur, rather than merely documenting effects that have already occurred. By combining both site-level and watershed-level assessments, it is possible to select areas where management can make a substantial difference in future wetland and aquatic health.

Our broad-scale GIS assessment examined underlying biological diversity, measured current conditions, and evaluated potential threats. Several key findings emerged from the GIS data analysis:

• The assessment area lies in a sparsely-populated part of Montana, where most of the land is in public ownership. Across the Red Rock River subbasin area, the BLM Dillon Field Office owns or manages approximately 411,977 acres (206,497 hectares). The BLM State Office owns an additional 21,328 acres (8,631 hectares) in the Centennial Mountains Wilderness Study Area. Altogether, the BLM has responsibility for 433,305 acres (175,352 hectares) in the Red Rock River subbasin, almost 29% of the area. The Forest Service is the next largest public land owner, managing 391,924 acres (158,606 hectares). In the two watersheds containing the Centennial Valley (Lima Reservoir and Red Rock Lakes), the BLM owns or manages approximately 106,213 acres (42,983 hectares). The U.S. Fish and Wildlife Service manages almost 100,000 acres (40,469 hectares) in these two watersheds, and both the Nature Conservancy and Montana Land Reliance have substantial easements on private lands in the Centennial.

• Across the subbasin as a whole, 45% of the land cover is grassland, 31% is shrubland, 17% is forest, and 4% is agriculture. Wetlands make up less than 2% of the land cover. In the Centennial Valley, 35% of the land cover is grassland, 37% is shrubland, 16% is forest, 8% is wetland and 2.5% is open water. Throughout the subbasin, both public and private grasslands and shrublands are used primarily for cattle grazing.

• In terms of hydrology, topography, and vegetation communities, the Red Rock Lakes 5th code hydrologic unit has the most complexity of the watersheds we evaluated, while the Muddy Creek 5th code hydrologic unit has the least.

• Watershed condition, as measured by a broad landscape integrity index and a separate stream corridor integrity index, was relatively high. The Red Rock Lake 5th code hydrologic unit had the highest score on our Composite Watershed Integrity Index, while Lower Horse Prairie Creek had the lowest score. These indices are based on the amount and density of landscape level disturbances (roads, stream diversions, mines, etc.), and do not necessarily reflect site-specific impacts. However, landscape disturbance is often correlated with site-specific disturbance. For example, in the Lower Horse Prairie Creek watershed, floodplains have been altered by agriculture and associated water extraction.

• The primary human-caused threat to wetland and watershed integrity in the subbasin as a whole is riparian grazing. The highest potential threat is in the Lima Reservoir watershed, where most streams and waterbodies are on land used primarily for grazing. However, this potential threat can be offset by proper grazing management practices.

Our fine-scale assessments focused on wetlands and streams in the Red Rock Lakes and Lima Reservoir watersheds in the Centennial Valley. We conducted Proper Functioning Condition (PFC) assessments at 103 lentic and lotic sites, and found:

- 74 in Proper Functioning Condition;
- 19 Functional at Risk with a downward trend;
- 3 Functional at Risk with an undetermined trend;
- 7 Nonfunctional

All lotic sites sampled (8) were in Proper Functioning Condition.

Of 83 sampling sites on or immediately adjacent to BLM-managed lands, we found:

- 56 in Proper Functioning Condition with a stable trend;
- 17 Functional at Risk with a downward trend;
- 3 Functional at Risk with an undetermined trend;
- 7 Nonfunctional.

We also carried out aquatic assessments at 37 sites using macroinvertebrate-based metrics. Because the streams in the Centennial Valley exhibited characteristics of both foothill-valley streams and mountain streams, we used two multimetric indices to interpret our findings. With the Montana DEQ's Foothill-Valley index, 15 of the 16 lotic sites sampled were ranked non-impaired (good to excellent biological integrity) and 1 was slightly impaired. Using the DEQ Mountain index, 6 of 15 were non-impaired, 5 slightly impaired and 4 moderately to severely impaired. In both cases, the macroinvertebrate index scores showed little correlation with riparian and instream habitat assessments.

The best opportunities for wetland protection in the Centennial Valley involve grazing management. Upland condition in the Centennial Valley indicates that good grazing practices are the norm. We suggest two specific strategies for wetlands: identification of clusters of high-quality or restorable fens and/or carrs where exclusion could be an option, and identification of areas with high concentrations of seasonally flooded wetlands, where seasonality of grazing could be adjusted to prevent damage to wet soils.

ACKNOWLEDGEMENTS

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Table of Contents

List of Figures

List of Figures (Con't)

List of Tables

Introduction

Scope of the Report

This assessment covers fourteen 5th code hydrologic units (HUCs) or watersheds[1] (Figure 1) encompassing roughly 1.5 million acres (600,000 hectares) in Beaverhead and Madison counties in southwestern Montana The watersheds are all part of the Red Rock River subbasin (4th code HUC) that drains into the Beaverhead River, a tributary of the Jefferson River, and ultimately, the Missouri.

The goal of this project was to provide site-specific evaluations of riparian areas, wetlands, and aquatic resources under the jurisdiction of the Bureau of Land Management (BLM) in the Centennial Valley, and a broad GIS-based assessment of the Red Rock River subbasin. Field sampling of wetland and aquatic sites provided detailed information on the composition and distribution of plant and invertebrate communities in sites under BLM management. We conducted a broad GIS analysis to evaluate watershed condition across the contributing watersheds, using indices of watershed integrity developed in earlier watershed assessments (Vance and Stagliano 2007, 2008).

The Ecological Setting: Level III and IV Ecoregions

The assessment area lies within the Middle Rockies Level III ecoregion (Omernik 1987). Five Level IV ecoregions dominate: the Barren Mountains; the Centennial Basin; the Dry-Gneissic-Schistose-Volcanic Hills; the Dry Intermontane Sagebrush Valleys; and the Forested Beaverhead Mountains (Figure 2). Small portions of the Western Beaverhead Mountains, the Eastern Gravelly Mountains, and the Alpine Zone occur near the perimeter of the subbasin.

The **Barren Mountains** ecoregion consists of dry, partially forested slopes with a sparsely grassy understory and barren outcrops, overlaying carbonate-rich sedimentary rock. Douglas-fir (*Pseudotsuga menziesii*) is the dominant tree species at lower elevations, while subalpine fir (*Abies lasiocarpa*) is more common above 8,000 feet and on north-facing slopes. The shrub layer is generally not well developed. Pinegrass (*Calamagrostis rubescens*) is the characteristic grass species. Winters are typically cold and long.

The cold, low-relief **Centennial Basin** is distinctively subirrigated with extensive grasslands, wet and mesic meadows, lakes, shrub carrs, and herbaceous wetlands. Wetlands within the Basin vary from tree-dominated Engelmann spruce (*Picea engelmannii*) and quaking aspen (*Populus tremuloides*) habitats to willow-dominated swamps and carrs to emergent herbaceous types such as sedge-dominated marshes and fens. Additionally, subirrigated areas with sodic soils support black greasewood (*Sarcobatus vermiculatus*), Nuttall's alkaligrass (*Puccinellia nuttalliana*), and inland saltgrass (*Distichlis spicata*)-dominated communities. Some of the most extensive wetlands are those dominated by hardstem bulrush (*Schoenoplectus acutus*), baltic rush (*Juncus balticus*), Northwest Territories sedge (*Carex utriculata*) and northern reedgrass (*Calamagrostis stricta*). On the northern edge of the basin, the Centennial Sandhills form a unique regional environment supporting a number of sensitive plant species and rare natural communities. In addition to the stable vegetation comprised of basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*), three-tip sagebrush (*Artemisia tripartita*) and needle-and-thread (*Hesperostipa comata*) or Idaho fescue (*Festuca idahoensis*), the Centennial Sandhills include vegetation that depends on active sand dunes and blowouts, such as green rabbitbrush (*Chrysothamnus viscidiflorus*) and thickspike wheatgrass / silverleaf phacelia (*Elymus lanceolatus* / *Phacelia hastata*) communities.

The shrubby, semi-arid **Dry Gneissic-Schistose-Volcanic Hills** ecoregion occurs above 4,800 feet, where average annual precipitation is higher than in the dry sagebrush valleys and the basin. Here

[1] HUC nomenclature correspond to common usage as follows: 4th code HUCs are subbasins; 5th code HUCs are watersheds, and 6th code HUCs are subwatersheds

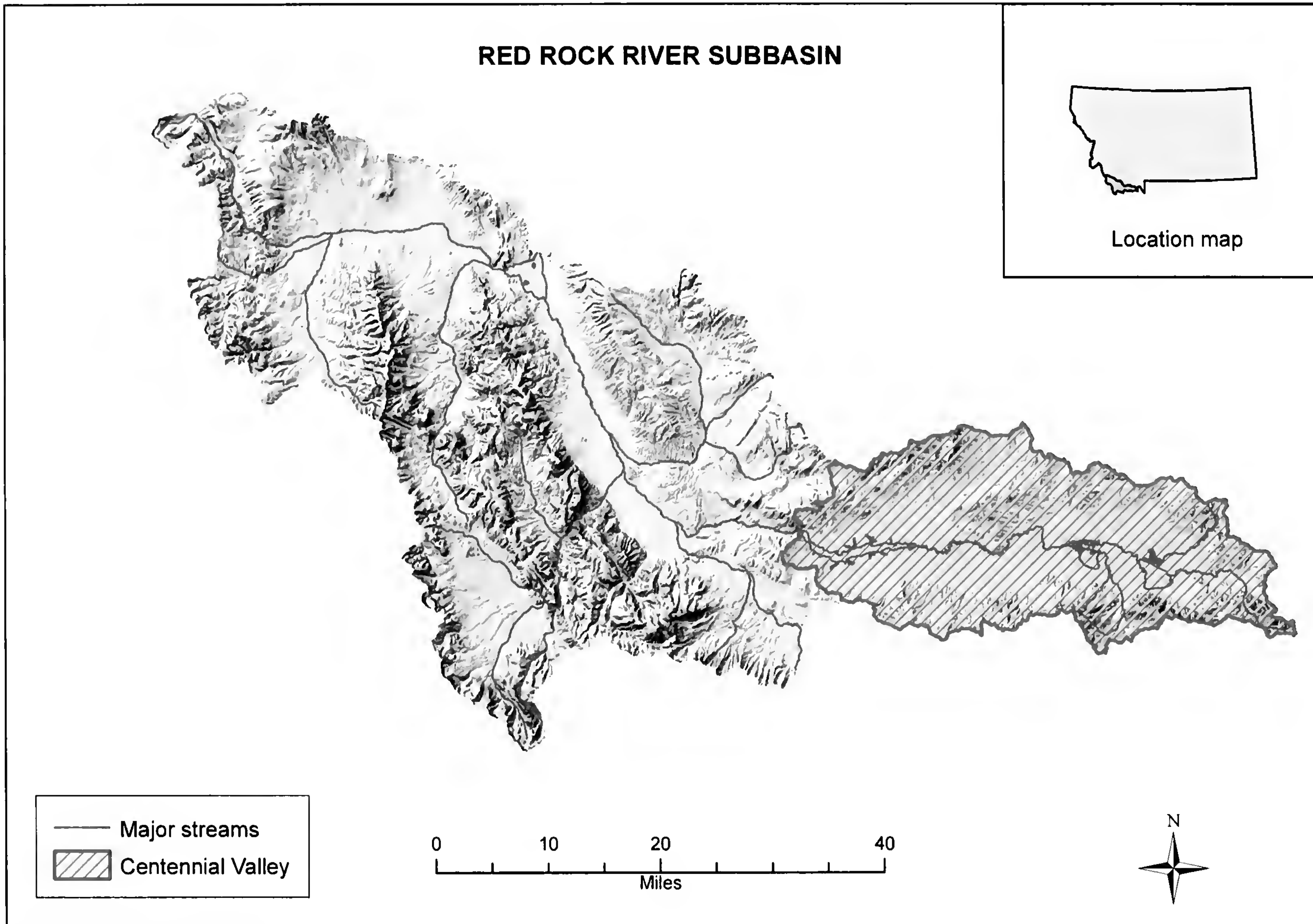


Figure 1. Red Rock River subbasin.

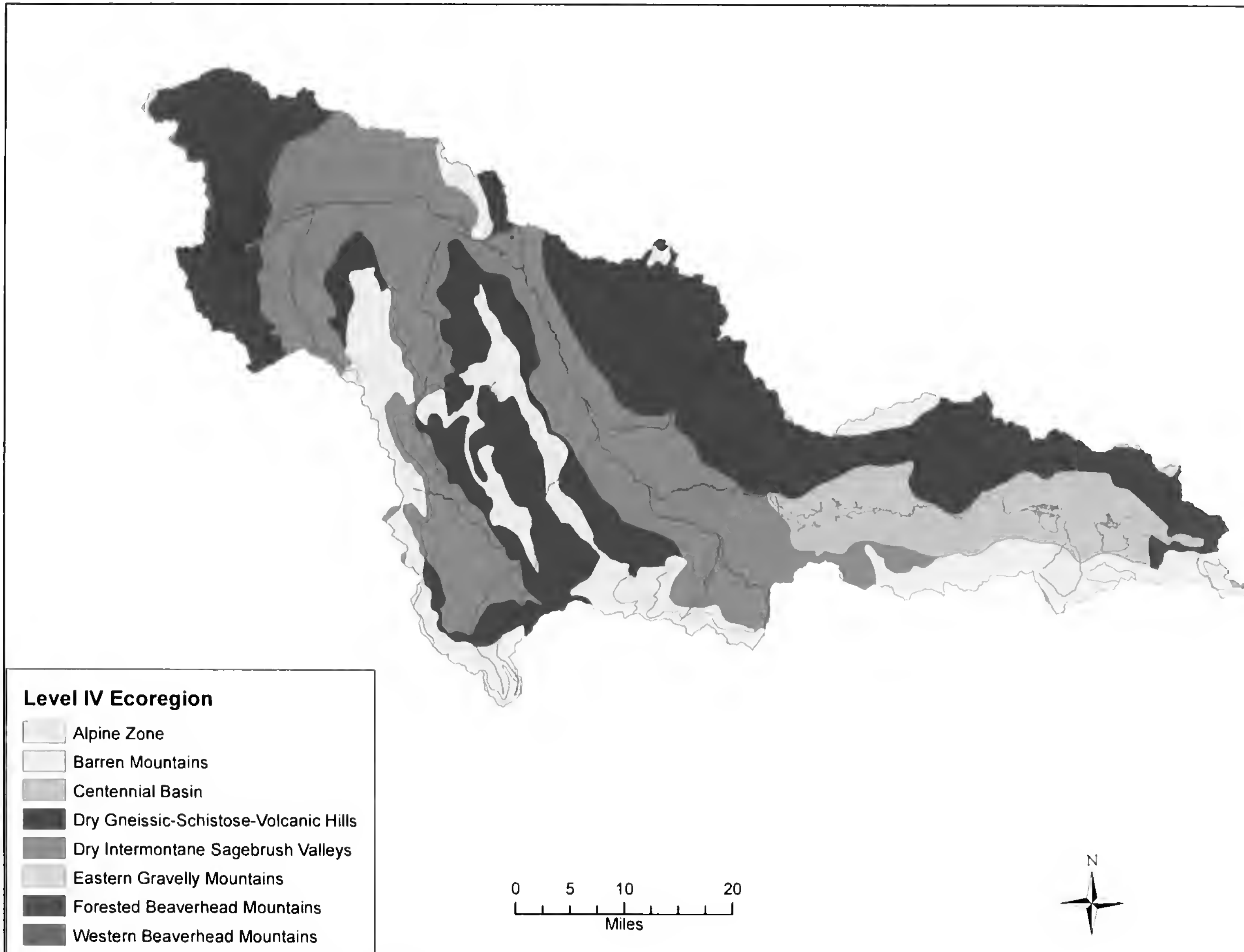


Figure 2. Level IV ecoregions of the Red Rock River subbasin.

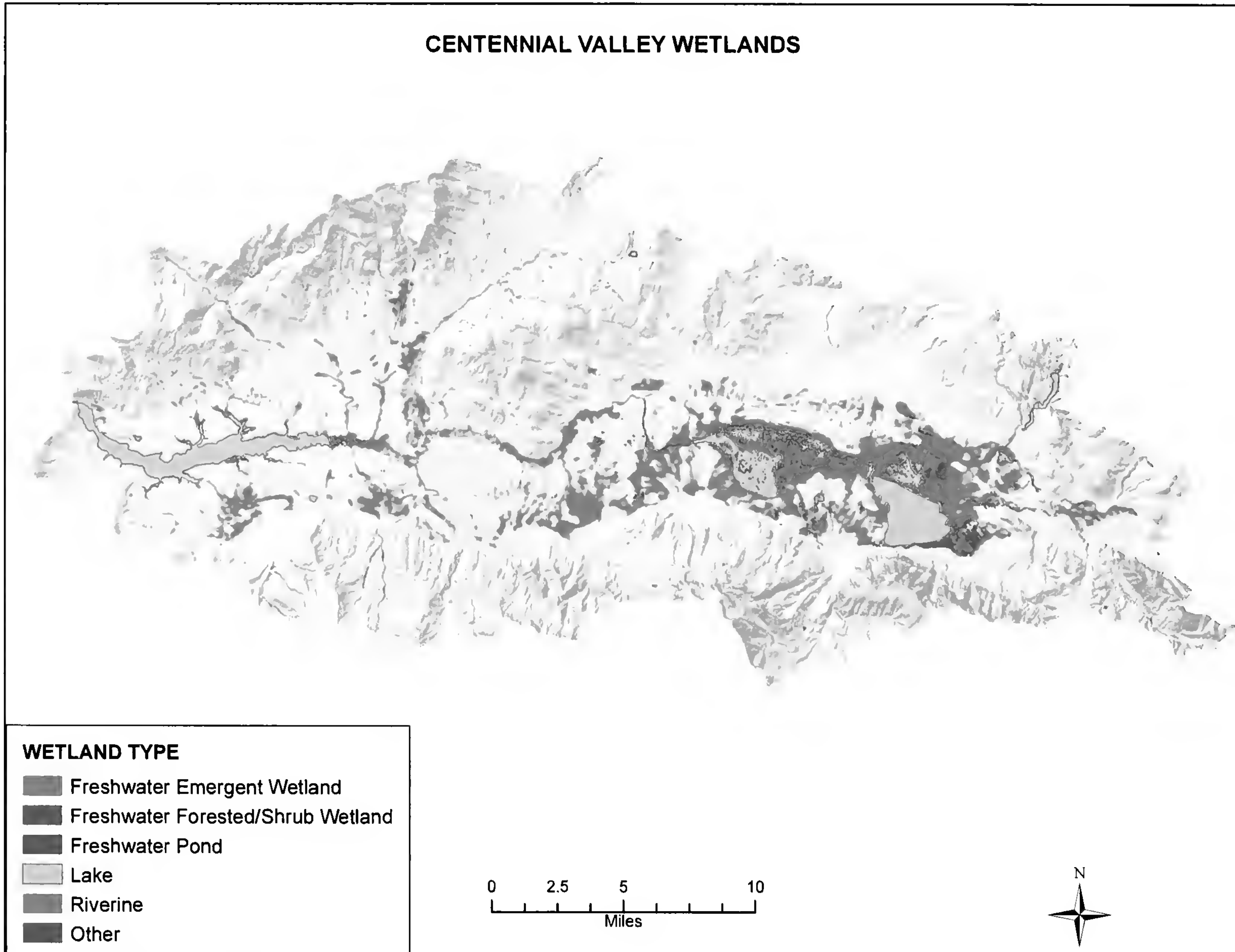


Figure 3. Centennial Valley wetlands.

too, vegetation is primarily sagebrush steppe. Shrub cover can be high for a steppe system due to greater moisture found at mountain elevations; the canopy cover is usually between 20 to 80 percent. The herbaceous layer is usually well represented, but bare ground may be common in particularly arid or disturbed occurrences.

The **Dry Intermontane Sagebrush Valley** ecoregion occurs on stream terraces, fans, and floodplains mostly composed of alluvium and valley fill deposits. The vegetation is primarily sagebrush steppe, dominated by mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) and Idaho fescue and related taxa such as basin big sagebrush and three tip sagebrush. Antelope bitterbrush (*Purshia tridentata*) may codominate or even dominate some stands. Most stands have an abundant perennial herbaceous layer (over 25% cover, in many cases over 50% cover). The growing season is typically short (70 to 110 days), although it is longer than in the low-lying Centennial Basin.

The glaciated **Forested Beaverhead Mountains** are characterized by gentle lower slopes, pothole lakes, and marshy areas. Average annual precipitation ranges from 20 to just over 40 inches. Underlying geology is composed of Precambrian argillite, quartzite, carbonates, and shales. At the lower treeline immediately above valley grasslands or sagebrush steppe and shrublands, vegetation includes extensive Douglas-fir forests, occasionally mixed with limber pine (*Pinus flexilis*) on calcareous substrates, and lodgepole pine (*Pinus contorta*) at higher elevations. In the upper montane and subalpine zones, Engelmann spruce appears. Subalpine areas are dominated by Engelmann spruce and subalpine fir.

Hydrology

The Red Rock River subbasin includes fourteen 5th code HUCs (Figure 4), with streams and rivers that drain into the Beaverhead River. The longest of these is Red Rock River, formed by Odell and Hellroaring Creeks, which originate on the north flank of the Centennial Mountains. Horse Prairie Creek, Sheep Creek, and Medicine Lodge Creek drain the western mountains. The National Hydrography Dataset (NHD) shows 1,573 miles of perennial streams and rivers in the assessment area, and 4,315 miles of intermittent streams and rivers. The Lima Reservoir and Red Rock Lakes 5th code HUCs have the most perennial stream miles; the Bloody Dick Creek and Red Rock Lakes HUCs have the highest density of perennial streams and creeks per square mile of watershed.

There are 1,579 lakes, pond, and reservoirs in the assessment area. Of these, 1,133 are in the Red Rock Lakes and Lima Reservoir watersheds. Many are shallow, and most lower-elevation water bodies have been created or enhanced by human structures. For example, Upper and Lower Red Rock Lakes are remnants of more extensive ancestral lakes that formed in the pluvial climates of the Pleistocene and early Holocene epochs. Current depth is approximately 8 feet. Although there is a water control structure on Lower Red Rock Lake, it has been open for several years, allowing water to flow through. Downstream from the lakes, the Red Rock River flows into the 4,422 acre Lima Reservoir, one of the major irrigation reservoirs in Montana.

Several streams and reservoirs in the assessment area are on Montana's 2006 list of waters that are impaired within the meaning of section 303(d) of the Clean Water Act. The beneficial uses that are most frequently impaired are aquatic life and coldwater fisheries. Table 1 lists the water bodies on the 2006 303(d) list and the pollutant(s) underlying the impairment.

Wetland mapping is only complete for portions of the Lima Reservoir and Red Rock Lakes watersheds, the part of the study area where wetlands are most abundant. The National Wetlands Inventory shows some 5,675 wetlands in the Centennial Valley and surrounding hills. Of these, 3,467 are herbaceous emergent wetlands (32,567 acres), 1,487 are aquatic bed wetlands associated with lakes and ponds (12,185 acres), 565 are forested or scrub-shrub wetlands (2,356 acres). The remaining 156 wetlands are riverine wetlands along the banks of perennial rivers, or seasonally flooded, sparsely vegetated basins. Riparian shrub communities that are not wet enough to be mapped

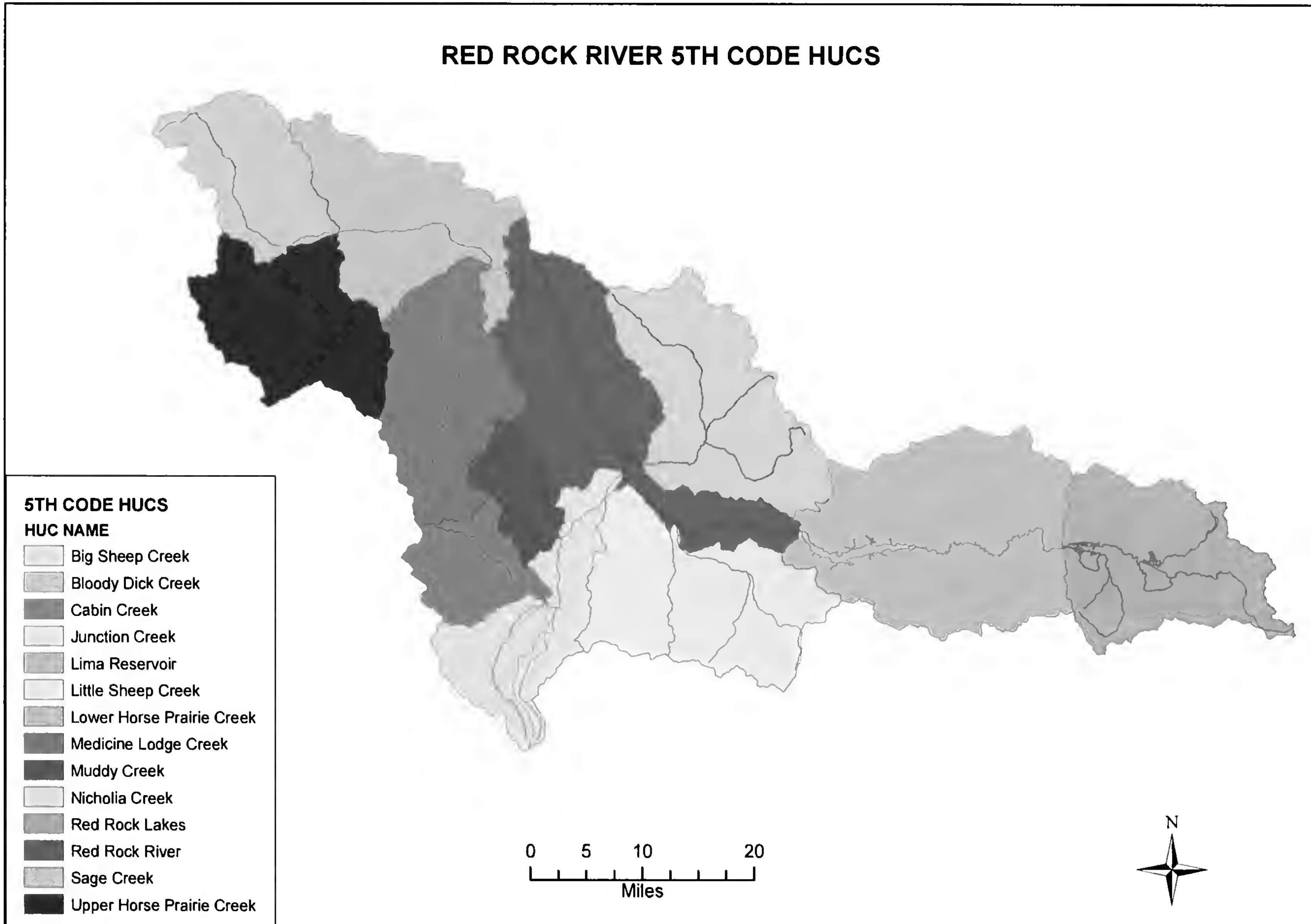


Figure 4. 5th code HUCs in the assessment area.

Table 1. 303(d) impaired waters.

Water body	Impairment
RED ROCK RIVER, Lima Dam to Clark Canyon Reservoir	Lead, sedimentation/siltation, temperature, zinc
RED ROCK RIVER, Lower Red Rock Lake to Lima Dam	Phosphorus (Total), sedimentation/siltation, temperature, TKN
MEDICINE LODGE CREEK, headwaters to mouth (Horse Prairie Creek)	Phosphorus (Total), sedimentation/siltation, temperature
MUDDY CREEK, headwaters to mouth (Sheep Creek-Red Rock River)	Turbidity
HORSE PRAIRIE CREEK, headwaters to mouth (Clark Canyon Res)	Arsenic, cadmium, copper, lead, mercury, zinc
BLOODY DICK CREEK, headwaters to mouth (Horse Prairie Creek)	Phosphorus (Total), TKN
SHEEP CREEK, Muddy Creek to mouth (Red Rock River)	Excess Algal Growth, nonnative fish or zooplankton, sedimentation/siltation
PRICE CREEK, headwaters to the mouth (Red Rock River)	Sedimentation/siltation
FISH CREEK, headwaters to mouth (Metzel Creek)	Chlorophyll-a, sedimentation/siltation
CORRAL CREEK, headwaters to mouth (Red Rock Creek)	Phosphorus (Total), sedimentation/siltation
EAST FORK CLOVER CREEK, headwaters to mouth (Clover Creek)	Phosphorus (Total), sedimentation/siltation
LONG CREEK, headwaters to mouth (Red Rock River)	Sedimentation/siltation
O'DELL CREEK, headwaters to mouth (Lower Red Rock Lake)	Turbidity
PEET CREEK, headwaters to mouth (Red Rock River)	Phosphorus (Total), sedimentation/siltation, TKN
TOM CREEK, headwaters to the mouth (Upper Red Rock Lake)	Sedimentation/siltation
RED ROCK CREEK, headwaters to the mouth (Upper Red Rock Lake)	Turbidity
JONES CREEK, headwaters to Winslow Creek	Excess algal growth, phosphorus (total), sedimentation/siltation
BEAN CREEK, headwaters to the Mouth (Red Rock River)	Sedimentation/siltation
LOWER RED ROCK LAKE	Sedimentation/siltation
UPPER RED ROCK LAKE	Sedimentation/siltation

as wetlands are extensive along the upper reaches of Red Rock River and its tributaries.

Natural Communities

Ecological Systems

Management of biological diversity rests on our ability to understand how the individual components of that diversity –species, natural communities, ecosystems, and landscapes—are distributed across the landscape, and how they intersect each other. In particular, successful conservation or restoration of individual species depends on the integrity of the biological communities in which they live. Consequently, land managers need to be able to link species to mid-scale ecological units that can be easily identified, evaluated, and managed. In response to this need, Natural Heritage Programs across the country have put forward the concept of ecological systems (Comer et al. 2003), which represent "recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes." Ecological systems offer a classification unit that is easily mappable and identifiable in the field and can be crosswalked to other classification systems in use by land management agencies. These ecological communities are the mapping units of the new regional Gap Analysis Program maps (ReGAP), produced under the auspices of the United States Geological Survey.

The ReGAP maps are based on classification of 30-m satellite images, using a massive field data set, and incorporating the input of ecologists and land managers with intimate knowledge of specific landscapes. In Montana, where ReGAP maps have just become available, the Montana Natural Heritage Program has committed itself to further correction and refinement of the classification. Therefore, we consider the current ReGAP layer to be a working draft. However, while the distribution and extent of less common systems need to be verified, the broad characterization of landscapes is reasonably accurate, and we were comfortable relying on it to interpret the ecological systems in the assessment area. Table 2 has a complete list of ecological systems greater than 1,000 acres in size found in the study area; the most prevalent ones are described below.

The most extensive ecological system in the area is Intermountain Basins Montane Sagebrush Steppe, which thrives on cool and semi-arid slopes and ridgetops away from the valley floors (Figure 5). In general, this system is most common in areas of mild topography, fine soils, and more mesic sites where there is subsurface moisture, above-average precipitation, or snow accumulation. It is composed primarily of mountain big sagebrush, silver sagebrush (*Artemisia cana* ssp. *viscidula*), and related taxa such as basin big sagebrush and threetip sagebrush. Antelope bitterbrush may codominate or even dominate some stands. Little sagebrush (*Artemisia arbuscula* ssp. *arbuscula*) dominated shrublands commonly occur within this system on rocky or windblown sites. In more mesic mountain big sagebrush communities, canopy cover is generally 20-30%, with grasses—typically dominated by basin wildrye (*Leymus cinereus*) and Idaho fescue—making up 60-70% of the canopy. Forb diversity tends to be low to moderate. On south-facing slopes, mountain big sagebrush cover ranges from 10-40%, with grass canopy in the 40-70% range. Grass communities are generally dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*), needle-and-thread and Sandberg bluegrass (*Poa secunda*).

The next most common ecological system is Middle Rocky Mountain Montane Douglas-fir Forest and Woodland. This Douglas-fir dominated system thrives in a dry to sub-mesic continental climate, typically occurring at the lower treeline immediately above valley grasslands, or sagebrush steppe and shrublands. It includes extensive Douglas-fir forests, occasionally with limber pine on calcareous substrates, and lodgepole pine at higher elevations. Engelmann spruce occurs in some stands within the upper montane zone. Understory shrubs include mallow ninebark (*Physocarpus malvaceus*), common juniper (*Juniperus communis*), white spirea (*Spiraea betulifolia*), snowberry species (*Symphoricarpos* spp.), buffaloberry (*Shepherdia canadensis*), and creeping barberry (*Mahonia repens*). Bilberry (*Vaccinium caespitosum*) and huckleberry

Table 2. Major ecological systems in the assessment area.

ECOLOGICAL SYSTEM	ACRES
	(approx)
Inter-Mountain Basins Montane Sagebrush Steppe	870159
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	88314
Rocky Mountain Lodgepole Pine Forest	59323
Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland	58668
Rocky Mountain Alpine-Montane Wet Meadow	55059
Rocky Mountain Subalpine-Montane Mesic Meadow	50279
Pasture/Hay	38259
Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	34448
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	32551
Northern Rocky Mountain Lower Montane, Foothill, and Valley Grassland	28500
Rocky Mountain Subalpine-Montane Riparian Shrubland	23941
Inter-Mountain Basins Big Sagebrush Steppe	20916
Rocky Mountain Alpine Turf	19527
Open Water	13757
Rocky Mountain Aspen Forest and Woodland	11396
North American Arid West Emergent Marsh	11363
Northern Rocky Mountain Subalpine-Upper Montane Grassland	9748
Cultivated Crops	9207
Developed, Open Space	8397
Rocky Mountain Alpine Fell-Field	6782
Rocky Mountain Subalpine-Montane Riparian Woodland	5334
Inter-Mountain Basins Active and Stabilized Dune	3121
Developed, Low Intensity	2937
Rocky Mountain Alpine Bedrock and Scree	2853
Harvested forest-grass regeneration	2688
Introduced Upland Vegetation - Annual and Biennial Forbland	2144
Wyoming Basins Low Sagebrush Shrubland	2106
Developed, Medium Intensity	1239
Rocky Mountain Alpine Dwarf-Shrubland	1057

(*Vaccinium membranaceum*) are found on colder, mesic sites. Common grasses include pinegrass, Ross' sedge (*Carex rossii*), and Geyer's sedge (*Carex geyerii*). Bluebunch wheatgrass is common on some sites adjacent to upper elevation montane grasslands. Common forbs include yarrow (*Achillea millefolium*), broadleaf arnica (*Arnica latifolia*), pussytoes (*Antennaria* spp.), strawberry (*Fragaria virginiana*), western rattlesnake plaintain (*Goodyera oblongifolia*), twinflower (*Linnaea borealis*), and beargrass (*Xerophyllum tenax*). Penstemon (*Penstemon* spp.) and upland paintbrush species (*Castilleja* spp.) are found on drier, open sites. Other upland forest ecological systems common to the assessment area include Rocky Mountain Lodgepole Pine Forests and Rocky Mountain Mesic and Dry-Mesic Spruce-Fir Forest and Woodland.

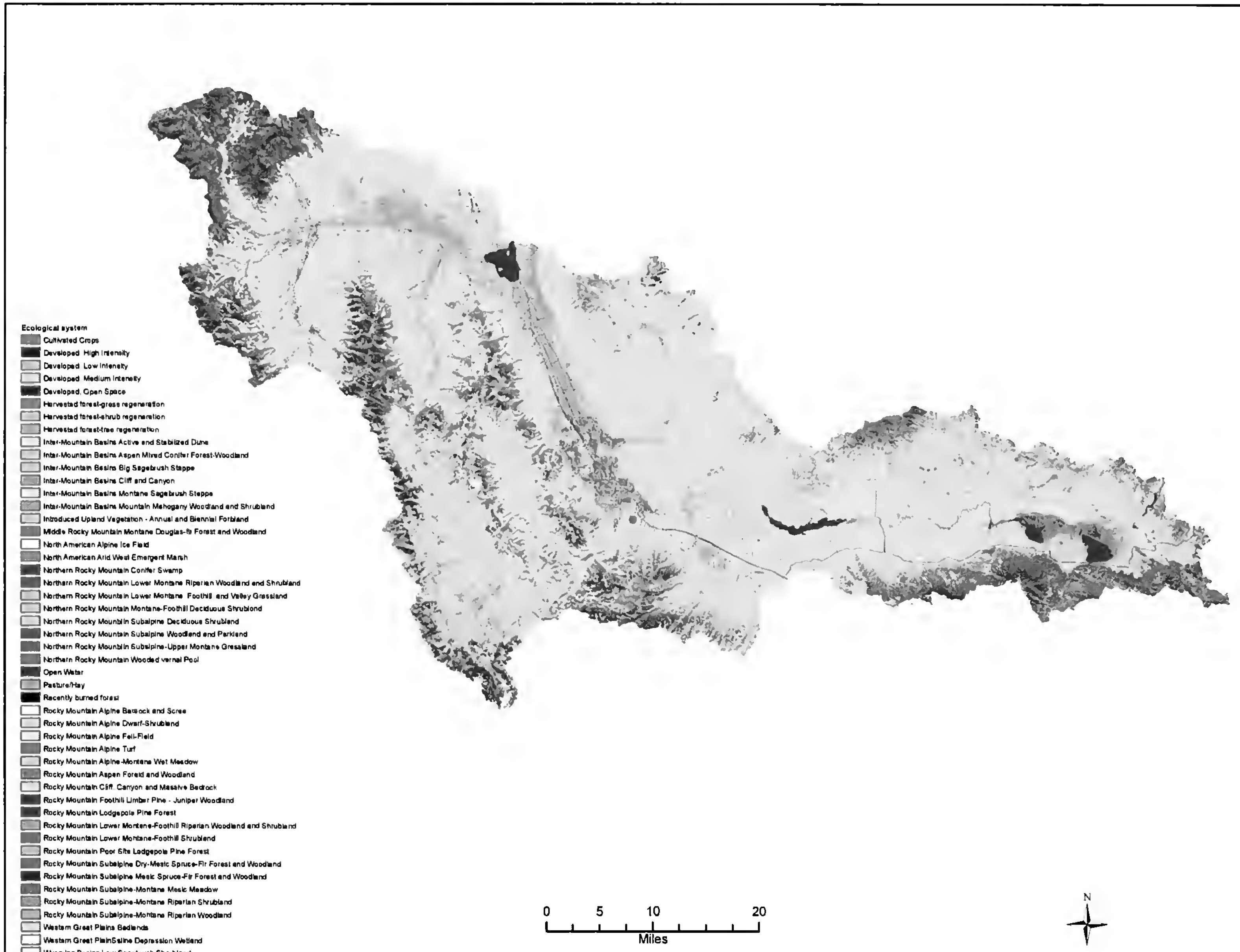


Figure 5. Ecological systems in the assessment area.

The Rocky Mountain Aspen Forests and Woodlands system occurs in patches throughout the assessment area, usually as small to large patches within wetlands, sagebrush steppe, and Douglas-fir forests. Jean et al. (2002) found the most extensive quaking aspen stands on lower slopes of the northern flank of the Centennial range, particularly on old mass wasting features (earthflows and landslides). In most of the Intermountain west, the distribution of aspen is limited mostly by the soil moisture it needs to meet its heavy evapotranspiration needs (Mueggler 1988); these lower slope locations tend to have more subsurface moisture, allowing the aspen to prosper. Within the assessment area, aspen stands are generally rich in forbs. Tall forbs include Engelmann's aster (*Eucephalus engelmannii*), western larkspur (*Delphinium occidentale*), showy stickseed (*Hackelia floribunda*), cowparsnip (*Heracleum maximum*), western sweet-cicely (*Osmorhiza occidentalis*), Fendler's meadowrue (*Thalictrum fendleri*), or western meadowrue (*Thalictrum occidentale*), tall ragwort (*Senecio serra*), and western valerian (*Valeriana occidentalis*) in the Centennial region. The more common forbs, easily overlooked amongst the luxuriant graminoids, include silvery lupine (*Lupinus argenteus*), common yarrow (*Achillea millefolium*), sticky geranium (*Geranium viscosissimum*), sweet-cicely (*Osmorhiza berterois*), and woodland strawberry (*Fragaria vesca*).

Grasslands are also extensive through the assessment area, with the most common upland ecological systems being Rocky Mountain Subalpine-Montane Mesic Meadow, and Northern Rocky Mountain Lower Montane, Foothill, and Valley Grassland.

- Rocky Mountain Subalpine-Montane Mesic Meadows occupy a slightly drier environment and fall into two broad categories: grass-dominated or forb-dominated. Grass-dominated meadows are typically characterized by tufted hairgrass, showy oniongrass (*Melica spectabilis*), mountain brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), fowl bluegrass (*Poa palustris*), and sedges. Forb-dominated meadows are restricted to sites from lower montane to subalpine elevations where finely textured soils, snow deposition, or windswept dry conditions limit tree establishment. Many occurrences are small patch in spatial character and are often found in mosaics with woodlands, more dense shrublands, or just below alpine communities. Important forbs include common camas (*Camassia quamash*), aspen daisy (*Erigeron speciosus*), aster (*Eucephalus* and *Symphyotrichum* species), fireweed (*Chamerion angustifolium*), small flowered penstemon (*Penstemon procerus*), harebells (*Campanula rotundifolia*), Canadian goldenrod (*Solidago canadensis*), mountain deathcamas (*Zigadenus elegans*), and western meadowrue (*Thalictrum occidentale*).
- Northern Rocky Mountain Lower Montane, Foothill, and Valley Grasslands occur across the study area. They are found at elevations from 1,000 to 5,000 feet, ranging from small meadows to large open parks surrounded by conifers in the lower montane zone, to extensive foothill and valley grasslands below the lower treeline. Many of these valleys may have been primarily sage-steppe with patches of grassland in the past, but because of land-use history post-settlement (herbicide, grazing, fire suppression, pasturing, etc.), they have been converted to grassland-dominated areas. Soils are relatively deep, fine-textured, often with coarse fragments, and non-saline, and may have a microphytic crust. This system is typified by cool-season perennial bunch grasses and forbs (>25% cover), with a sparse (<10% cover) shrub cover. Rough fescue (*Festuca campestris*) and Idaho fescue are usually dominants, and bluebunch wheatgrass occurs as a co-dominant. In the assessment area, these grasslands range from the needle-and-thread / blue grama (*Bouteloua gracilis*) communities found in valley floors and alluvial fans to bluebunch wheatgrass / Sandberg bluegrass communities on warm aspect, moderate to steep slopes to Idaho fescue / bluebunch wheatgrass grasslands on moderate to steep, predominantly southerly-facing slopes at 6,000-7,500 feet.

Wetlands and riparian areas occur throughout the assessment area, with especially high concentrations in the Centennial Valley. There, the most abundant wetland types are Rocky Mountain Alpine-Montane Wet Meadows, Rocky Mountain Subalpine-Montane Fens, and Western North American Freshwater Marshes.

•Rocky Mountain Alpine-Montane Wet Meadows are moderate-to-high-elevation systems found throughout the Rocky Mountains and Intermountain regions, dominated by herbaceous species found on wetter sites with very low-velocity surface and subsurface flows. Occurrences range in elevation from montane to alpine (1,000-3,600 m). This system typically occurs in cold, moist basins, seeps, and alluvial terraces of headwater streams or as a narrow strip adjacent to alpine lakes (Hansen et al. 1995). They are typically found on flat areas or gentle slopes, but they may also occur on sub-irrigated sites with slopes up to 10%. In alpine regions, sites typically are small depressions located below late-melting snow patches or on snowbeds. The growing season may only last for one to two months. Soils of this system may be mineral or organic. In either case, soils show typical hydric soil characteristics, including high organic content and/or low chroma and redoximorphic features. This system often occurs as a mosaic of several plant associations, often dominated by graminoids such as tufted hairgrass and a diversity of sedges. Forbs such as groundsels (*Senecio* spp.) often form high cover in these meadows. Wet meadows are tightly associated with snowmelt and high water tables and are usually not subjected to high disturbance events such as flooding. Salinity and alkalinity are generally low due to the frequent flushing of moisture through the meadow. Depending on the slope, topography, hydrology, soils, and substrate, intermittent, ephemeral, or permanent pools may be present. Standing water may be present during some or all of the growing season, with water tables typically remaining at or near the soil surface. However, fluctuations of the water table throughout the growing season are not uncommon. On drier sites supporting the less mesic types, the late-season water table may be one meter or more below the surface. Soils typically possess a high proportion of organic matter, but this may vary considerably depending on the frequency and magnitude of alluvial deposition. Organic composition of the soil may include a thin layer near the soil surface. Soils may exhibit gleying and/or mottling throughout the profile.

•Rocky Mountain Subalpine-Montane Fens occur infrequently throughout the Rocky Mountains from Colorado north into Canada. They are confined to specific environments defined by groundwater discharge, soil chemistry, and peat accumulation. This system includes poor fens, rich fens, and extremely rich fens. Fens form at low points in the landscape or near slopes where groundwater intercepts the soil surface. Groundwater inflows maintain a fairly constant water level year-round, with water at or near the surface most of the time. Constant high water levels lead to accumulation of organic material. In addition to peat accumulation and perennially saturated soils, the extremely rich and iron fens have distinct soil and water chemistry, with high levels of one or more minerals such as calcium, magnesium, or iron. Fens are among the most floristically diverse of all wetland types, supporting a large number of rare and uncommon bryophytes and vascular plant species, as well as providing habitat for uncommon mammals, mollusks, and insects. Fens also help maintain stream water quality through denitrification and phosphorus absorption. Fens usually occur as a mosaic of several plant associations dominated by sedges (*Carex* spp.), spikerushes (*Eleocharis* spp.), and rushes (*Juncus* spp.). Bryophyte diversity is generally high and includes sphagnum (*Sphagnum* spp.). In rich and extremely rich fens, forb diversity is equally high. In southern Montana, subalpine and alpine fens potentially occur at higher elevations (Heidel and Rodemaker 2008). These communities typically occur in seeps and wet sub-irrigated meadows in narrow to broad valley bottoms. Soils within this system are organic histosols with 40 cm or more of organic material if overlying a mineral soil. Organic histosols may be any depth, however, if overlying bedrock, cobbles or gravels. Histosols range in texture from clayey-skeletal to loamy-skeletal and fine-loams.

•Western North American Freshwater Marshes occur throughout western North America, typically found in depressions surrounded by an upland matrix of forest, shrub steppe, steppe or mixed prairie vegetation. Within Montana, this system is most common from 671 to 2,256 m (2,200 to 7,400 feet). Natural marshes occur in and adjacent to ponds and prairie potholes, as fringes around lakes or oxbows, and along slow-flowing streams and rivers as riparian marshes. Wetland marshes are classified as either seasonal, semipermanent, or permanent based on the dominant vegetation found in the deepest portion of the wetland. The type of vegetation that occurs in these marsh systems is representative of their hydroperiod, where some basins dry to bare soil after seasonal flooding while others will have a variety of wetland types in a zoned pattern dependent on seasonal water table depths and salt concentrations. A central shallow marsh zone dominated by graminoids and sedges characterizes seasonal wetlands. Semipermanent and permanent wetlands are continually inundated with water up to 2 m deep and have a deeper central marsh zone typically dominated by cattails (*Typha* species) and bulrushes (*Schoenoplectus* species). In semipermanent systems, the drawdown zone is typically dominated by Northwest Territories sedge and Nebraska sedge (*Carex nebrascensis*). Water sedge (*Carex aquatilis*) and/or awned sedge (*Carex atherodes*) are frequently co-dominant. Inflated sedge (*Carex vesicaria*) is sometimes intermixed with Northwest Territories sedge or occurs as a co-dominant, especially in riparian marshes associated with beaver activity. Water chemistry may include some alkaline or semi-alkaline situations, but the alkalinity is highly variable even within the same complex of wetlands. Marshes have distinctive soils that are typically mineral, but they can also accumulate organic material. Soils have characteristics that result from long periods of anaerobic conditions in the soils (e.g., gleyed soils, high organic content, redoximorphic features).

Special Status Plants

The assessment area supports at least 74 vascular plant Species of Concern. These are listed along with vertebrate and invertebrate species in Appendix A.

Wildlife and Fish

The extensive sagebrush steppe habitat found throughout the assessment area supports several sagebrush obligates, including pygmy rabbit (*Brachylagus idahoensis*), Sage Thrasher (*Oreoscoptes montanus*), Brewer's Sparrow (*Spizella breweri*), and Greater Sage-Grouse (*Centrocercus urophasianus*). Greater Sage-Grouse are found throughout the assessment area, with multiple leks. The abundant small mammal population in sagebrush steppe and grasslands also support concentrated populations of raptors, notably Ferruginous Hawk (*Buteo regalis*), Prairie Falcon (*Falco mexicanus*), Swainson's Hawk (*Buteo swainsoni*), and Golden Eagle (*Aquila chrysaetos*). Similarly, broadly distributed forests support forest-dependent species like as Hairy Woodpecker (*Picoides villosus*), Dusky Grouse (*Dendragapus obscurus*), Ruffed Grouse (*Bonasa umbellus*), Northern Goshawk (*Accipiter gentilis*), Red-naped Sapsucker (*Sphyrapicus nuchalis*), and snowshoe hare (*Lepus americanus*). The Centennial Sandhills, a unique habitat in the Centennial Valley region, support an exceptionally diverse array of invertebrates and vertebrates. A 1999 survey found 18 mammal species, 29 bird species, 3 amphibian and reptile species, 4 tiger beetle species, and 14 butterfly and skipper species (Hendricks and Roedel 2001). Similarly, the extensive wetlands in the Centennial Valley support breeding populations of numerous bird and amphibian Species of Concern, including Trumpeter Swan (*Cygnus buccinator*), Black-crowned Night-Heron (*Nycticorax nycticorax*), White-faced Ibis (*Plegadis chihi*), Franklin's Gull (*Larus pipixcan*), Forster's Tern (*Sterna forsterii*), and boreal toad (*Bufo boreas*). In addition to the Species of Concern, these wetlands also support breeding populations of western chorus frog (*Pseudacris triseriata*), Columbia spotted frog (*Rana luteiventris*), and tiger salamander (*Ambystoma tigrinum*). Beaver are present in low numbers along the Red Rock River, Clark Canyon Creek, and Sheep Creek (BLM 2007). Terrestrial gartersnakes (*Thamnophis elegans*), common gartersnakes (*Thamnophis sirtalis*), and western rattlesnakes (*Crotalus viridis*) are common. Gopher snakes (*Pituophis catenifer*) and rubber boas (*Charina bottae*) have not been documented but are likely to occur.

Several streams support coldwater fisheries, primarily cutthroat trout (*Oncorhynchus clarkii lewisi*) and brook trout (*Salvelinus fontinalis*). Red Rock Lakes and the upper stretches of Red Rock River contain Arctic grayling (*Thymallus arcticus*), burbot (*Lota lota*), white sucker (*Catostomus commersoni*), longnose sucker (*Catostomus catostomus*), and mottled sculpin (*Cottus bairdi*).

The assessment area also has extensive populations of habitat generalists. Both migratory and resident elk (*Cervus elephus*) are common throughout the region. Pronghorn (*Antelocapra americana*) inhabit the sagebrush habitats and agricultural fields throughout the area. Mule deer (*Odocoileus hemionus*) are resident year round. Moose (*Alces alces*) are plentiful in willow bottoms, especially in and around the willow flats in the eastern Centennial Valley. Black bear (*Ursus americanus*) use both forested and riparian areas. Mountain lions (*Felis concolor*), while not common, are seen occasionally. Bighorn sheep (*Ovis canadensis*) were introduced in the Tendoy Mountains in the late 1980's and early 1990's, and have moved both southward and northward into suitable habitat. Gray wolves (*Canis lupus*) and grizzly bears (*Ursus horribilis*) have both been sighted in the assessment area (BLM 2007), and suitable habitat exists for both wolverine (*Gulo gulo*) and lynx (*Lynx canadensis*).

Methods

Broad-scale Remote Sensing Analysis

For this analysis, we use a modified version of a broad-scale landscape assessment approach that was developed in prior watershed studies (Vance and Stagliano 2007, Vance and Stagliano 2008) to provide a landscape perspective on the natural diversity, current conditions, and potential threats to wetland and riparian habitats. We began by separating the assessment area into component landscape units so that effective comparisons could be made between units. Based on topography, land cover, and field observations, we decided to analyze the landscape by individual 5th code hydrologic units. We calculated a number of metrics to allow overall comparisons and provide managers with a basis for planning.

We conducted a GIS analysis using geographic and statistical data to summarize potential and actual watershed condition, and to compare watershed conditions and threats among the landscape units. The analysis was divided into three parts. The first part assessed "background" or natural conditions in the watershed by evaluating ecological diversity and hydrologic and topographic complexity. The second part addressed current conditions and disturbances, including land use, ownership patterns, and alterations and impacts to riparian areas. The third part focused on the primary threat to watershed integrity in the assessment area: riparian grazing.

In each part, indices were created or used to facilitate comparison between watersheds. This index-based approach follows a method initially developed by the Northeast Region of the National Wetland Inventory Program (Tiner et al. 2000), modified and expanded by the Montana Natural Heritage Program (Vance 2005, Vance et al. 2006) to address some of the unique conditions in western ecosystems (e.g., grazing impacts, energy development, etc.). This methodology is explained in greater detail in subsequent sections.

National Wetland Inventory photointerpretations dating from the 1980's have only been digitized or turned into hard-copy maps for the USGS quadrangles in the Centennial Valley. The Montana Natural Heritage Program is currently producing wetland and riparian maps for Southwestern Montana, but mapping of this subbasin is incomplete, so no subbasin-wide calculation can be made.

The geographic data used in the assessment and in calculating the sub-indices were derived as follows:

1. Natural Complexity Index

a) Hydrologic Complexity Index

- Using the high-resolution National Hydrography Dataset, identify springs, intermittent and perennial streams, and intermittent and perennial lakes, and sum the number and length/area, as appropriate, for each category.

b) Topographic Complexity Index

- Create a topography polygon layer by reclassifying 10-meter USGS Digital Elevation Maps into 25 elevation classes, and sum acreage in each elevation class.

c) Ecological Diversity Index

- From ReGAP maps, calculate the diversity of ecological systems in each 5th code HUC.

2. Composite Wetland Condition Index

a) Landscape Integrity Index

- Using an inverse weighted distance model that integrates land cover, road density, hydrological modification, and extractive resources such as mining, calculate an integrity score for each pixel in the subbasin, and average the score for each 5th code HUC.

b) Stream Corridor Integrity Index

- Buffer stream segments in the 1:100,000 USGS National Hydrography Dataset streams layer;

• Overlay the buffered stream segments on the 2001 National Land Cover Dataset;
• Sum the acreage of land cover categories within the buffered areas.

3. Riparian Grazing Threat Index
• Create a layer of private grazing lands from cadastral records (parcels listed as having grazing as their major land use);
• Create a layer of public grazing lands from cadastral records (parcels listed as having BLM, Forest Service, USFWS, Montana Fish, Wildlife and Parks or the Montana Department of Natural Resources as the owner);
• Overlay the public and private grazing lands layer on the buffered stream layer.

Field Data Collection and Assessment

During the summer of 2008, MTNHP ecologists carried out Proper Functioning Condition (PFC) assessments at 103 sites in the Centennial Valley (Figure 6), using the methods described in Pritchard et al. (1999). At 94 of those sites, MTNHP ecologists also conducted ecological integrity assessments, using protocols developed by the MTNHP (See Appendix B). During all phases of data collection, wetlands were classified with the National Wetland Inventory (NWI) system (Cowardin et al. 1979). We also assigned wetlands to broad ecological systems, using the classifications and descriptions developed by NatureServe and the MTNHP. For both wetland and upland plants, our principle floristic references were Dorn (1984) and the Flora of the Great Plains (1977, 1986). All plant nomenclature follows Kartesz (1999).

Riparian habitat assessments, water quality parameter measurements, and macroinvertebrate surveys were performed at thirteen sites. Biological community integrity was calculated at all sites using the Montana Macroinvertebrate Multimetric Index (MT MMI).

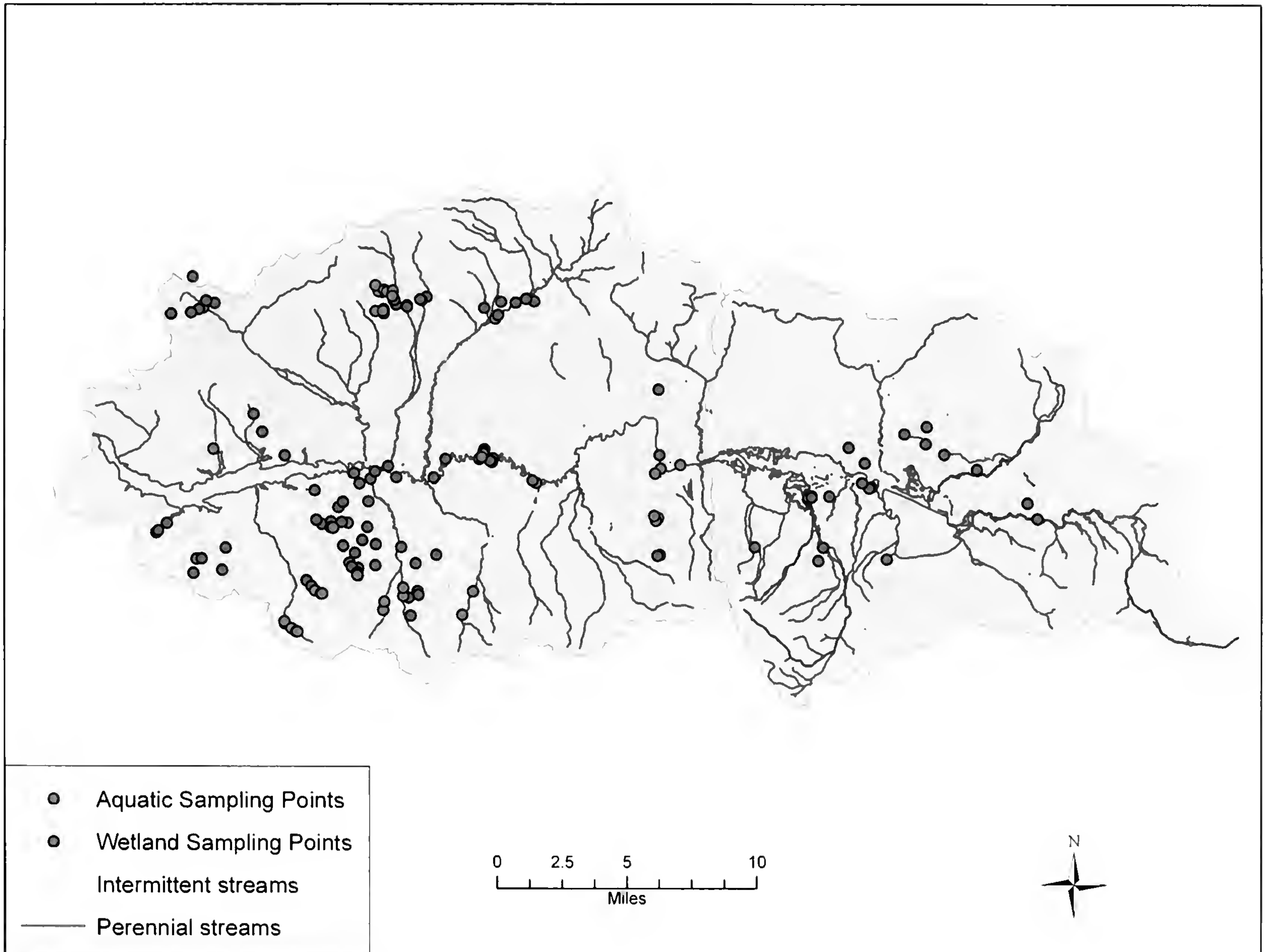


Figure 6. Centennial Valley sampling locations.

Results and Discussion

Overview

Current Conditions

The assessment area lies in a sparsely-populated part of Montana, where most of the land is in public ownership. Across the Red Rock River subbasin area, the BLM Dillon Field Office owns or manages approximately 411,977 acres (206,497 hectares). The BLM State Office owns an additional 21,328 acres (8,631 hectares) in the Centennial Mountains Wilderness Study Area. Altogether, the BLM has responsibility for 433,305 acres (175,352 hectares) in the Red Rock River subbasin, almost 29% of the area. The Forest Service is the next largest public land owner, managing 391,924 acres (158,606 hectares). In the two watersheds of the Centennial Valley (Lima Reservoir and Red Rock Lakes), the BLM owns or manages approximately 106,213 acres (42,983 hectares). The U.S. Fish and Wildlife Service manages almost 100,000 acres (40,469 hectares) in these two watersheds[2], and both the Nature Conservancy and Montana Land Reliance have substantial easements on private lands.

Across the subbasin as a whole, 45% of the land cover is grassland, 31% is shrubland, 17% is forest, and 4% is agriculture. Wetlands make up less than 2% of the landcover. In the Centennial Valley, 35% of the land cover is grassland, 37% is shrubland, 16% is forest, 8% is wetland, and 2.5% is open water. Throughout the subbasin, both public and private grasslands and shrublands are used primarily for cattle grazing. Most of the agricultural use is along the valley bottoms adjacent to Red Rock River and Horse Prairie Creek.

The assessment area encompasses 1,481,484 acres (599,535 hectares), of which 44,225 acres (17,897 hectares) are lakes, ponds, or manmade reservoirs. There are 1,573 miles (2,531 kilometers) of perennial streams and rivers, and 4,315 miles (6,944 kilometers) of intermittent streams. Some of these intermittent streams are headwater streams that flow only during snowmelt; others, especially in more arid portions of the subbasin, are in fact ephemeral, flowing only in response to heavy rain events.

Factors and Magnitude of Change

Since Euro-American settlement, three human activities have impacted watershed health and integrity in this part of Montana: extraction, diversion, and impoundment of water; conversion of riparian floodplains to agriculture; and livestock grazing. Associated impacts such as road-building, and secondary impacts, such as low-intensity residential development, have also altered natural conditions.

Extraction, diversion, and impoundment of water

Flows in Red Rock River are moderated by major upstream and downstream impoundments, and influxes from many tributary streams are reduced by diversion and impoundment. Nonetheless, flows prior to irrigation season are sufficient to maintain a more-or-less natural hydrologic regime, with floods and peak flows occurring at regular intervals. The hydrographs for Red Rock River above Red Rock Lake and below Lima Dam have similar peak discharge intervals, although base flows from the dam are lower during summer months than they would be in the absence of the reservoir (Figures 9a and 9b).

Across the assessment area, small dams, diversions, and impoundments on headwater and mainstem streams tend to minimize temporal variability in stream flows. By eliminating flood peaks, these dams, diversions, and impoundments lead to narrowing and firming of channel beds over time, and to the loss of bare substrate on streambanks that is necessary for successful regeneration of woody vegetation. Some of the streams in the assessment area have also downcut significantly over time, and in many areas, only remnant (and decadent) cottonwoods remain. While our onsite investigations were restricted to streams in and around the Centennial Valley, we noted that the

[2] The USFWS lands include the 45,000 acre Red Rocks National Wildlife Refuge in the Centennial Valley.

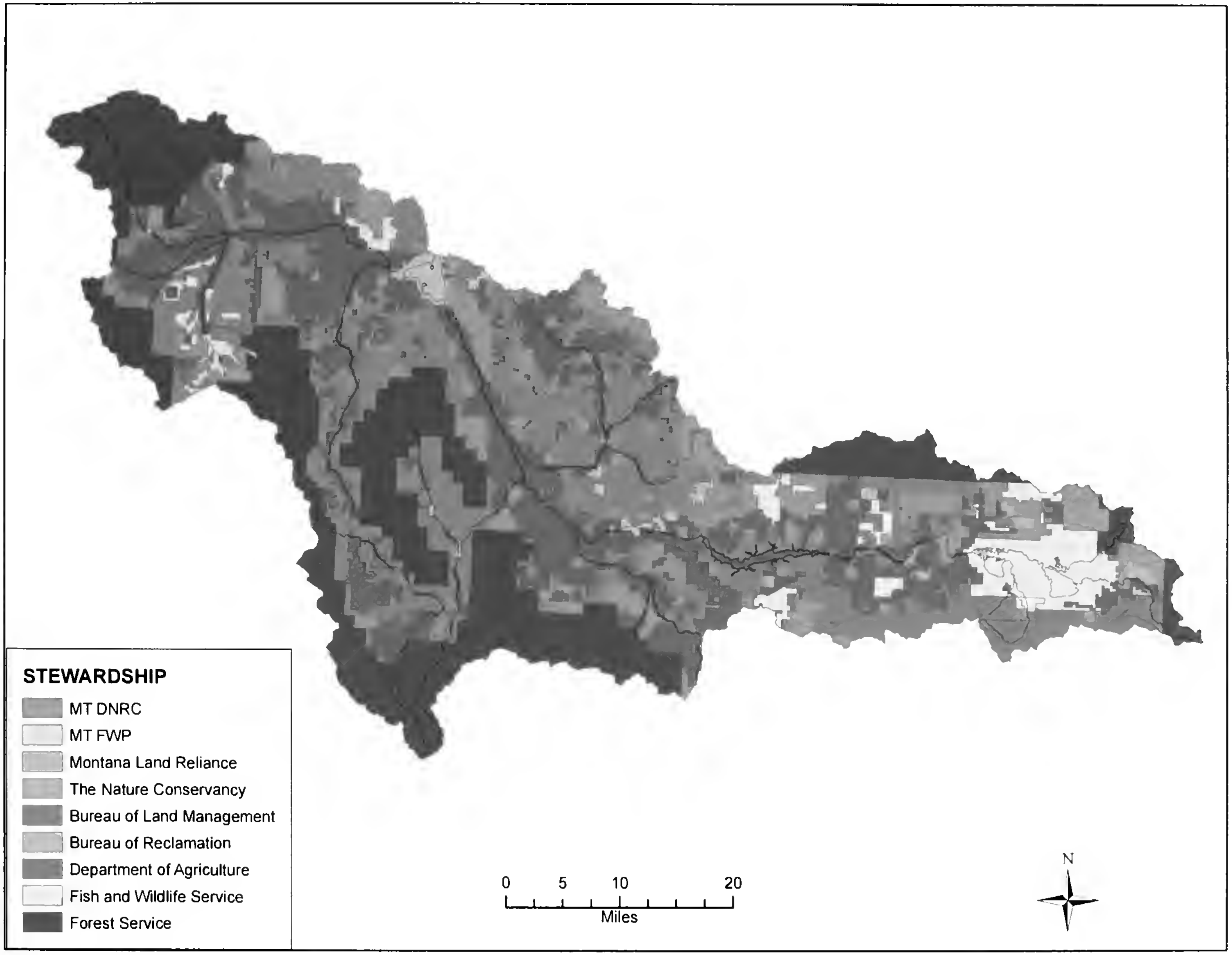


Figure 7. Land stewardship, Red Rock Subbasin.

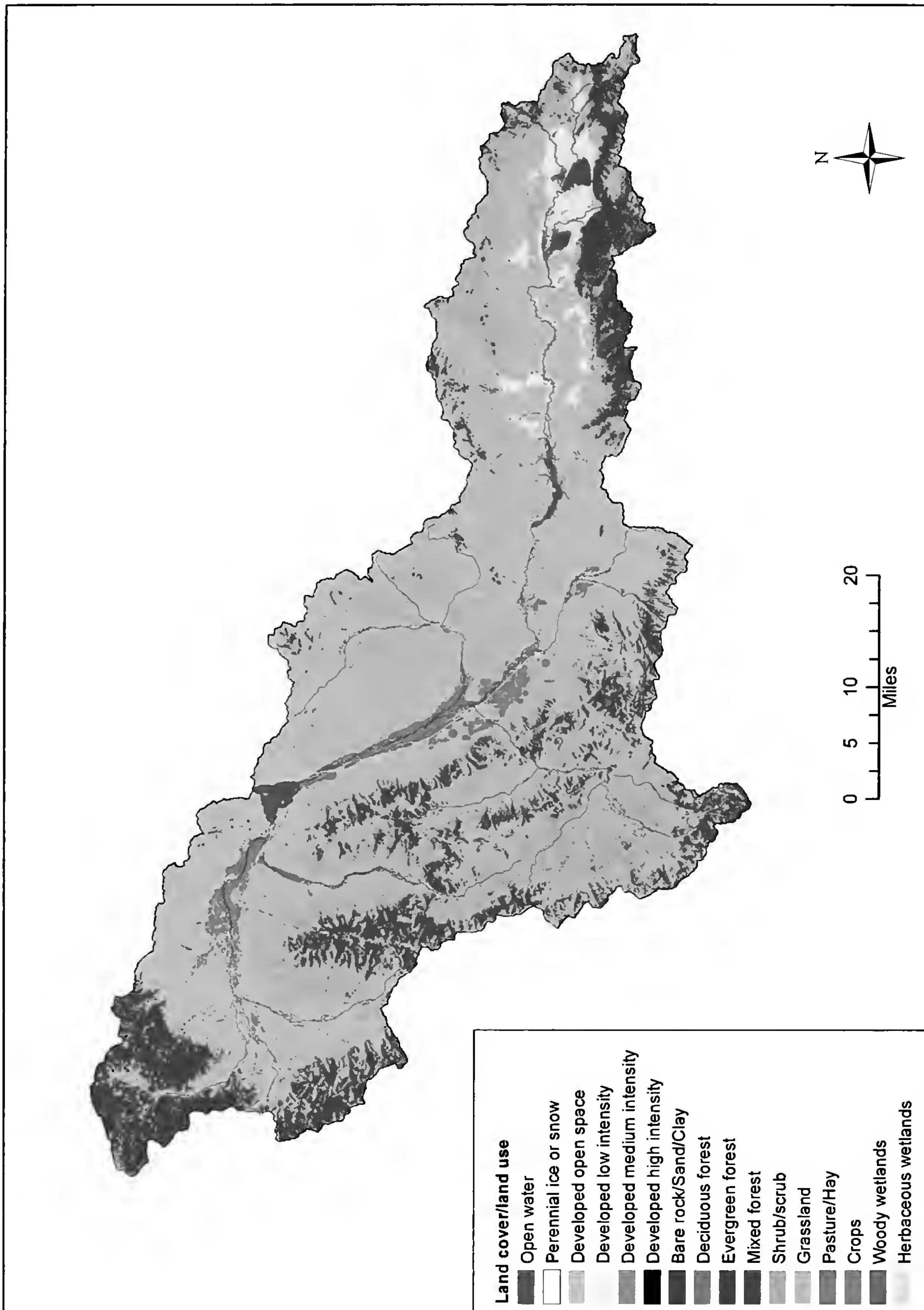
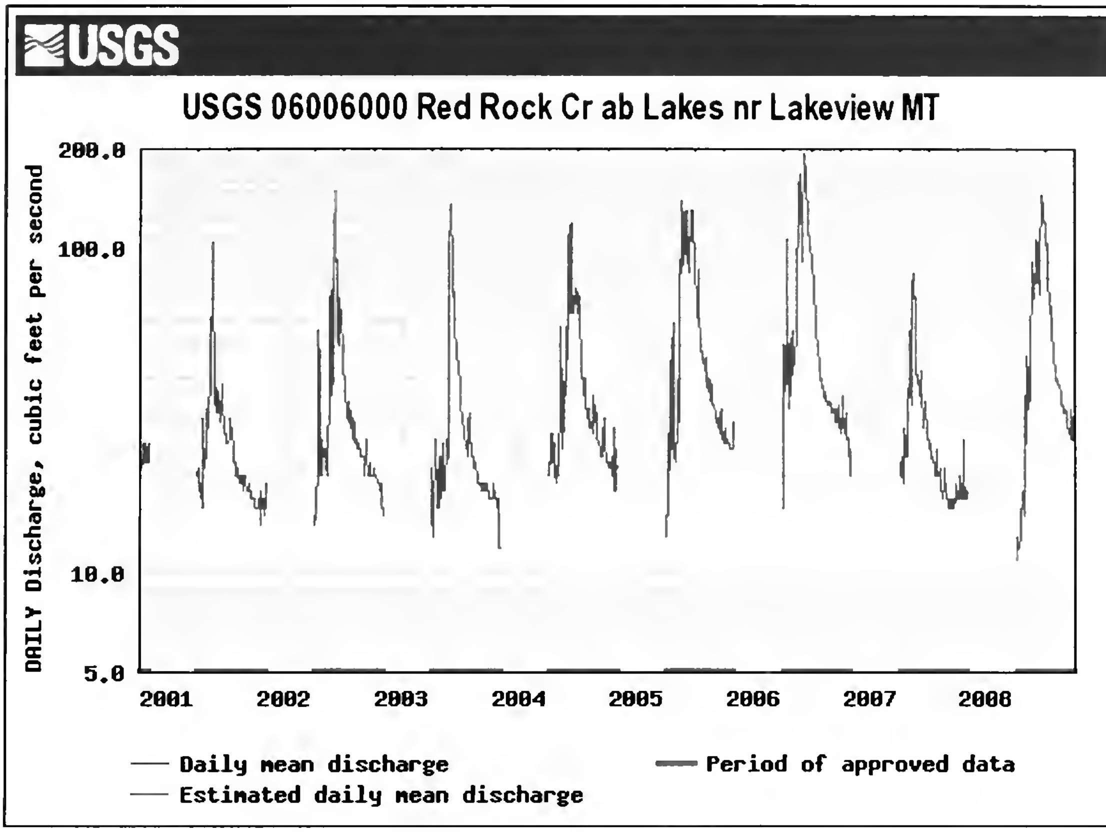


Figure 8. Land cover and land use.



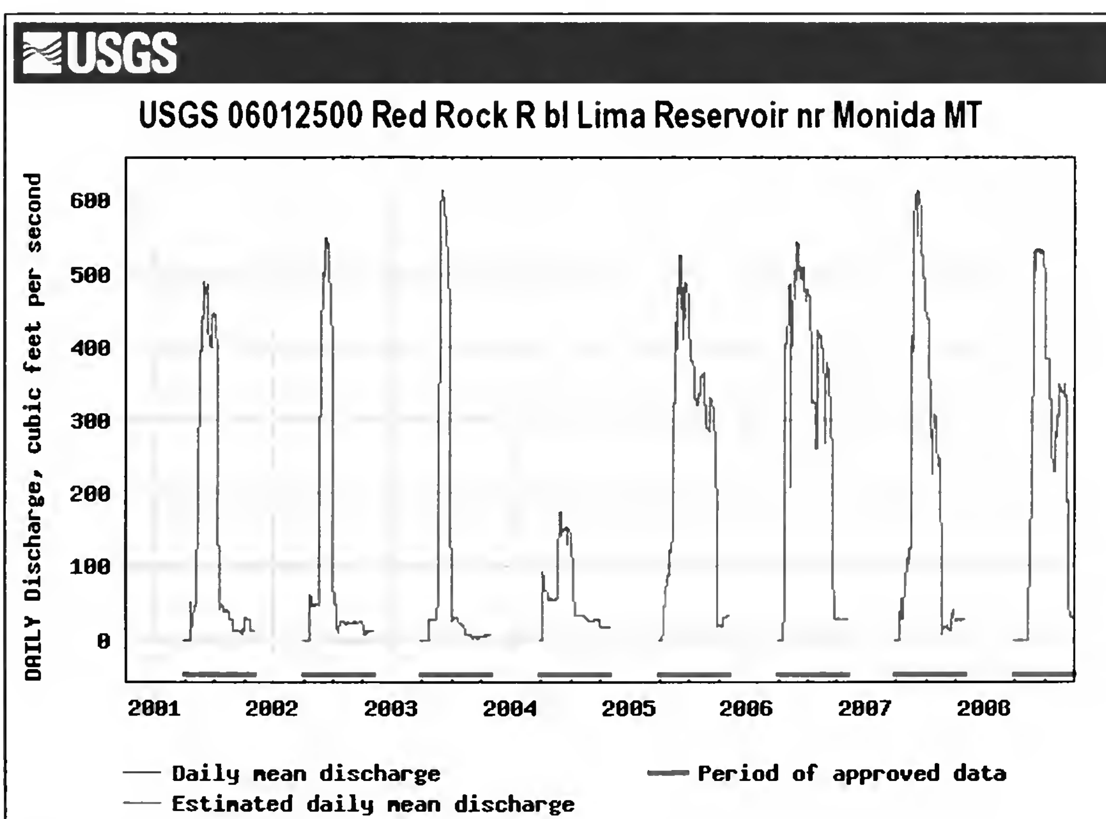


Figure 9a and 9b. Hydrographs for Red Rock River gauging stations, 2000-2008.

BLM watershed assessment of the downstream portions of the subbasin found many riparian areas to be functioning at risk (BLM 2007).

Conversion of riparian floodplains to agriculture

Floodplain conversion can affect watershed health and integrity in a number of ways. First, it is generally accompanied by water withdrawal for agricultural use; second, it eliminates or impedes regrowth of native vegetation while facilitating invasion by weedy species; and third, erosion from tillage and farm roads contributes to increased sedimentation of streams and rivers (Power et al. 1995). In the assessment area, agricultural conversion of floodplains along the Red Rock River and Horse Prairie Creek is extensive. In the subbasin as a whole, 416,446 acres are private agricultural uses, with 370,222 acres reported as having grazing as their primary use, 30,787 acres reported as irrigated agriculture, and 7,454 as wild hay. Over 20,000 acres of irrigated agriculture and 4,600 acres of wild hay land lie within a mile of Red Rock River, Horse Prairie Creek, Red Rock Lakes, Lima Reservoir, or Canyon Creek Reservoir.

Both publicly and privately owned grasslands in the subbasin are used for grazing. While this is not strictly a conversion, both grazing and crop production put heavy demands on water supplied by wells and surface water diversions. Agricultural conversion also puts aquatic resources at risk through increased erosion and sedimentation, while overgrazing can lead to invasion of grasslands by non-native plant species. During our field surveys, we observed widespread Canada thistle (*Cirsium arvense*) and Kentucky bluegrass (*Poa pratensis*) in grazed grassland areas.

Livestock grazing

As noted earlier, livestock grazing is the dominant agricultural use in the assessment area. Cattle are the most common grazing animals, although sheep are still present in small numbers. Although many ecosystems east of the Continental Divide evolved under grazing pressures from hoofed ungulates, the seasonality and intensity of bison and elk grazing differ from current systems. If not managed optimally or effectively, cattle and sheep grazing can cause soil compaction, nutrient enrichment, vegetation trampling and removal, habitat disturbance, and, depending on the season and intensity of use, reproductive failure for native plants and animals. Grazing in riparian areas can cause stream and river bank destabilization, loss of riparian shade, and increased sediment and nutrient loads in the aquatic ecosystem (George et al. 2002). Stock watering tanks can contribute to dewatering of streams and aquifers, and may concentrate livestock movement and congregation in sensitive areas. During hot summers, cattle and sheep prefer to loaf in shady areas, trampling understory vegetation.

In our field surveys, we saw several instances where cattle had free access to riparian and wetlands areas, and some cases where pugging and hummocking had severely impacted both the soil and the vegetation (Figures 10a and 10b). Springs and seeps were also frequently impacted. While we saw individual instances of fencing and exclusion, most of the aquatic resources were unprotected.

Figure 10a. Pugging in a Centennial Valley wetland.

Figure 10b. Hummocking in a Centennial Valley wetland.

Broad-Scale Assessment Indices

In previous watershed assessments (Crowe and Kudray 2003, Vance 2005, Vance et al. 2006), the Montana Natural Heritage Program developed a method for broad-scale assessment of wetlands based on a procedure originally developed by the Northeast Region of the U.S. Fish and Wildlife Service's National Wetland Inventory Program (Tiner et al. 2000). We have continued to refine this method by adding new metrics, dropping redundant or insensitive metrics, and refining scoring for land use categories. We believe that these ongoing refinements provide a better baseline for assessment, and more accurately evaluate the stressors found in western watersheds.

This assessment procedure has three components. First, we generated a Composite Natural Complexity Index, based on underlying vegetation, hydrologic, and elevation factors, to capture the extent and variation of natural conditions within the overall assessment area and the individual watersheds. Each of the sub-indices is scaled from 0.0 to 1.0, with higher scores reflecting greater complexity.[3]

Next, we used a landscape integrity index and a stream corridor integrity index to produce an overall Composite Watershed Condition Index (CWCI). This index gives a sense of how much pre-settlement habitat remains in the assessment area watersheds, emphasizing riparian systems and adjacent upland habitat, i.e. buffers. The landscape integrity index integrates several disturbance factors including roads, agricultural development, hydrologic alterations, and mines. The stream corridor integrity index synthesizes the extent of human land uses within a riparian corridor. These indices are added together to create the Composite Watershed Condition Index (CWCI) for each 5th code HUC.

In the final step, we calculated a Riparian Grazing Threat Index. Grazing has both current and long term impacts, so we have designated it as an ongoing threat. However, it is easily mitigated by the adoption of grazing management practices. By indicating where potential threats occur, appropriate management plans can be identified and implemented. Here, higher scores signal a higher level of threat.

One criticism of indices of biological integrity is that individual characteristics of the system being assessed are blurred by the act of collapsing multiple metrics into a single number (Moyle and Marchetti 1999). To offset this effect, we have chosen to keep the three overall indices separate. This way, characteristics of each watershed can be compared without significantly diminishing the magnitude of specific disturbances or threats.

Composite Natural Complexity Index

The Composite Natural Complexity Index measures the richness and extent of vegetation, hydrologic features, and topography. It has three subindices, the Natural Community Complexity Index, the Hydrologic Complexity Index, and the Topographic Complexity Index, explained below.

Natural Community Complexity Index (INC)

The Natural Community Complexity Index is a simple measure of the number of ecological systems in individual watersheds relative to the total number of ecological systems across the study

[3] In earlier assessments, we were also able to evaluate wetland diversity as part of this index; in this assessment area, wetland mapping was not complete by the time of this report, so this part of the assessment could not be performed. However, our field surveys indicated that there is considerable wetland diversity in these watersheds, and large numbers of natural wetlands.

area. Ecological systems are defined as groups of plant community types that tend to co-occur within areas that have similar ecological processes, substrates, and/or environmental gradients (Comer et al. 2003). Spatially, ecological systems occur at the scale of less than an acre to tens of thousands of acres; temporally, they persist for 50 to 150 years. This temporal scale allows typical successional dynamics to be integrated into the concept of each ecological system. Because individual ecological systems themselves may contain multiple community types, system richness is a good indicator of complexity[4]. There are 40 different natural ecological systems in the assessment area as a whole. Natural community complexity was calculated by dividing the number of ecological systems in each 5th code HUC by the number of systems in the assessment area. The results were relativized by dividing all scores by the highest score.

Table 3. Natural Community Complexity Index

Red Rock Lakes	1.00
Lima Reservoir	0.95
Lower Horse Prairie Creek	0.95
Nicholia Creek	0.92
Upper Horse Prairie Creek	0.89
Bloody Dick Creek	0.87
Medicine Creek	0.87
Junction Creek	0.84
Little Sheep Creek	0.84
Red Rock River	0.79
Big Sheep Creek	0.76
Sage Creek	0.66
Cabin Creek	0.61
Muddy Creek	0.58

The Red Rock Lakes, Lima Reservoir, and Lower Horse Prairie Creek watersheds had the highest Natural Community Complexity scores, indicating that they have the greatest ecological diversity. These three watersheds all cross several ecological subsections and have a considerable range of elevations. The Muddy Creek watershed scored lowest. It is primarily a lower-elevation watershed characterized by shrub and steppe ecological systems with limited forest cover.

Hydrologic Complexity Index (IHC)

The Hydrologic Complexity Index describes the number and density of hydrologic features in a watershed (springs, seeps, perennial lakes and streams, and intermittent lakes and streams). By characterizing the number and extent of these features, this subindex allows managers to prioritize watersheds for management efforts or further assessment. Although many of the lakes and ponds are manmade, we have included them in the analysis because they provide significant habitat when managed for those values.

We calculated this index by summing 1) the number of springs and seeps 2) the number of lakes, ponds, and reservoirs per 100 square miles of watershed; 3) the number of wetlands per 100 square miles of watershed 4) the density of perennial streams (in miles of stream per square miles of watershed); 5) and the density of intermittent streams (in miles of stream per square miles of watershed). Each of the 14 watersheds received a rank of 1-14 in each category (springs, lake density, wetland density, perennial stream density, and intermittent stream density). Low scores in a category meant that the watershed had the lowest density of the feature in question. Scores were summed across the categories, and averaged for each watershed. This was then relativized by taking the highest score, and dividing all other scores by that score.

Based on this analysis, the Red Rock Lakes watershed has the most Hydrologic Complexity while the Little Sheep Creek watershed has the least. The Red Rock Lakes watershed is a headwaters area with numerous lakes, ponds, springs, seeps, wetlands, and perennial streams. Little Sheep Creek, which is also considerably smaller is size, is located in the Dry Gneissic-Schistose Volcanic Hills and Barren Mountains

[4] It is possible that ecological systems richness is a function of patchiness resulting from human land uses. However, in the assessment area, our field observations led us to conclude that this was not the case, but rather that ecological system richness did in fact reflect more natural conditions.

ecological subsections, both characteristically arid, with few perennial streams, wetlands, and springs. Table 4 shows the individual scores on this metric.

Table 4. Hydrologic Complexity Index.

Red Rock Lakes	1
Lima Reservoir	0.89
Bloody Dick Creek	0.89
Nicholia Creek	0.84
Junction Creek	0.82
Big Sheep Creek	0.78
Medicine Lodge Creek	0.73
Lower Horse Prairie Creek	0.71
Sage Creek	0.60
Cabin Creek	0.56
Upper Horse Prairie Creek	0.47
Red Rock River	0.47
Muddy Creek	0.44
Little Sheep Creek	0.35

Topographic Complexity Index (ITC)
Topography influences plant community composition and habitat availability for animal populations. Increased topographic diversity within a watershed increases the availability of niches and microhabitats, which in turn provides habitat for rare species with unique habitat requirements while also ensuring suitable habitat for a broad suite of species.

Elevations in the assessment area range from 1,688 to 3,397 meters (5,538 to 11,145 feet) above sea level. Scores on this sub-index were calculated by using a GIS to create 25 equal elevation bands across the assessment area. We summed the number of elevation bands in each watershed, took the log of that sum, and relativized the scores by dividing each log score by the highest log score. Table 5 shows the scores on this metric. The Little Sheep Creek watershed has the highest Topographic Complexity score, while the Muddy Creek watershed has the lowest.

Composite Natural Complexity Index (CNCI)
We combined the three sub-indices into a Composite Natural Complexity Index. This index has a maximum possible score of 3.00, which would mean the watershed had a score of 1.00 on each of the three complexity metrics. Table 6 shows the scores on this composite index. As the scores indicate, the Red Rock Lakes 5th code HUC has the highest natural complexity among the assessment area watersheds, while the Muddy Creek 5th code HUC, which had the lowest scores on the Natural Community Complexity and Hydrologic Complexity sub-indices, has the lowest complexity.

Table 5. Topographic Complexity Index.

Little Sheep Creek	1.00
Junction Creek	0.99
Big Sheep Creek	0.99
Medicine Lodge Creek	0.97
Nicholia Creek	0.96
Lower Prairie Horse	0.96
Cabin Creek	0.94
Upper Prairie Horse Creek	0.94
Red Rocks River	0.94
Sage Creek	0.91
Red Rock Lakes	0.90
Lima Reservoir	0.90
Bloody Dick Creek	0.90
Muddy Creek	0.84

Table 6. Composite Natural Complexity Index.

Red Rock Lakes	2.85
Lima Reservoir	2.69
Nicholia Creek	2.67
Bloody Dick Creek	2.62
Junction Creek	2.60
Lower Prairie Horse	2.56
Medicine Lodge Creek	2.52
Big Sheep Creek	2.49
Upper Prairie Horse Creek	2.26
Red Rocks River	2.16
Little Sheep Creek	2.15
Sage Creek	2.14
Cabin Creek	2.08
Muddy Creek	1.83

Composite Watershed Condition Index

The Composite Watershed Condition Index is made up of three sub-indices. The first is a Landscape Integrity Index, derived from a model developed by Vance (2009). This is an inverse weighted distance model premised on the idea that ecosystem processes and functions achieve their fullest expression in areas where human activities have the least impact. It was specifically developed as a broad-scale method for assessing wetland health. It presumes that wetland condition will be highest when wetlands are isolated from roads, commercial or industrial development, urban areas, resource extraction sites, or hydrologic modifications. The second, the Stream Corridor Integrity Index, measures the amount of natural land cover within a set buffer on either side of all perennial and intermittent streams. The third index is the Riparian Loss Index. This estimates the amount of riparian vegetation that has been lost since European settlement. To calculate the Composite Watershed Condition Index, scores on the two integrity indices are summed, and the loss index score is subtracted.

Landscape Integrity Index (ILI)

The model uses four categories of human impacts. The first, land cover and land use, identifies urban areas, croplands, and timber harvest areas as stressors. The second, roads, is broken into three classes: four-wheel drive roads, local roads, and state/federal highways. The third category is hydrologic modification. This consists of dammed stream and river segments, water rights points of use, and Clean Water Act section 404 permits. The fourth category is resource extraction and consists of energy wells (gas, oil, coalbed methane) and current or abandoned mines.

The four categories of impacts are weighted and summed into a single raster layer, with a pixel size of 30 meters by 30 meters, or 900 square meters. To calculate mean values for a given assessment area (in this case, 5th code HUCs) we used the zonal statistics tool in ArcGIS 9.3. Mean scores were converted to a 0 to 1 scale with the formula 1-Log10 (raw landscape integrity score). The resulting scores were relativized to obtain the final results, shown in Table 7.

Table 7. Landscape Integrity Index.

Muddy Creek	1.00
Sage Creek	1.00
Nicholia Creek	0.99
Cabin Creek	0.99
Red Rock Lakes	0.98
Medicine Lodge Creek	0.98
Lima Reservoir	0.98
Big Sheep Creek	0.95
Bloody Dick Creek	0.94
Junction Creek	0.93
Upper Horse Prairie Creek	0.91
Little Sheep Creek	0.90
Lower Horse Prairie Creek	0.87
Red Rock River	0.87

In general, the watersheds in the study area have not been heavily disturbed by human activities; human impacts are relatively concentrated, and at the watershed scale, are offset by large roadless areas with no permanent development. The Muddy Creek and Sage Creek watersheds have the highest scores on the Landscape Integrity Index, while the Red Rock River and Lower Horse Prairie Creek watersheds, where most agricultural land use is concentrated, have the lowest scores.

Stream Corridor Integrity Index (ISCI)

The Stream Corridor Integrity Index measures the amount of natural land cover within a set buffer on either side of all perennial and intermittent streams. It was calculated by creating a 60-meter buffer on each side of the stream segments in the 1:100,000 National Hydrography Dataset and assessing land cover and land use from the NLCD. Although higher resolution stream data are available and were used in other calculations (e.g., the Hydrologic Complexity Index), these data include many ephemeral streams and drainages where transport of sediment, runoff, and pollution may be minimal. By using lower-resolution data, we hoped to capture perennial and intermittent streams while avoiding ephemeral drainages.

This index offers a way to determine whether areas adjacent to streams are contributing more than natural amounts of sediment, runoff, and pollution. Croplands and fallow fields will produce higher sedimentation rates than naturally vegetated areas (Wilkin and Hebel 1982), and activities that create impermeable cover (particularly roads and commercial, industrial, or residential development) will lead to elevated runoff levels, as well as overland transport of chemical pollutants.

The Stream Corridor Integrity Index, as developed by Tiner et al. (2000), is generally a simple ratio of naturally vegetated stream corridor to total stream corridor area, with no allowance made for either grazing impacts or types of non-vegetation cover. Accordingly, we weighted the various land uses in terms of their assumed impacts on riparian systems. We assumed, for example, that grazing pressure would be better characterized as "moderate" than as "light" in riparian grasslands, as cattle are prone to congregate near sites offering shade and water, but that riparian grasslands would be more lush and therefore somewhat more resilient to grazing than more water-stressed uplands. Following Hauer et al. (2002), we therefore gave grasslands in the stream corridor (which we assumed were all grazed) a weight of 0.6. Again following the weights assigned by Hauer et al. (2002) for riparian corridors, we changed the weight assigned to Hay or Pasture from a 0.6 to a 0.5 to reflect the higher risk of erosion, sedimentation, and nutrient enrichment from agricultural activities near a stream. The weights we used for individual activities in the calculation of the Stream Corridor Index were:

Use	**Weight**
Other	0.5
Open Water	1.0
Low intensity residential	0.0
Commercial, industrial, transportation	0.0
Bare rock, sand or clay	1.0
Deciduous forest	1.0
Evergreen forest	1.0
Mixed forest	1.0
Shrubland	1.0
Grassland or herbaceous	0.6
Pasture or hay	0.5
Cultivated crops/fallowed land	0.2
Developed, open space	0.4
Herbaceous wetlands	1.0
Woody wetlands	1.0

We then calculated this index as:

ISCI = ALCWt/ATC,

where ALCWt = the sum of the weighted scores for land cover in acres and ATC = total stream corridor area, in acres.

We report 60 meters as the buffer width on each side of the streams (100 meters total) because many of the tributary corridors are in relatively confined valleys, but we found little difference between scores calculated with 60, 120, and 180 meter buffers.[5] As can be seen from Table 8, the Red Rock Lakes watershed retains the highest amount of stream corridor integrity, while the Lower Horse Prairie Creek watershed appears to have the greatest amount of disturbance along the corridor.

Table 8. Stream Corridor Integrity Index.

Red Rock Lakes	0.96
Lima Reservoir	0.84
Muddy Creek	0.81
Bloody Dick Creek	0.80
Cabin Creek	0.80
Medicine Lodge Creek	0.79
Sage Creek	0.77
Nicholia Creek	0.76
Upper Horse Prairie Creek	0.76
Big Sheep Creek	0.76
Little Sheep Creek	0.71
Red Rock River	0.70
Junction Creek	0.69
Lower Horse Prairie Creek	0.69

Riparian Loss Index (IRL)

Land use activities within the stream and river corridor are one measure of the departure from natural conditions; another is direct loss of riparian

[5] We used 60m rather than 50 because the NLCD is based on 30m grids.

vegetation. This is especially true along the major streams and rivers in the region of the assessment area, where cottonwoods, mixed forests, or willow shrublands should be dominant land cover features. To approximate riparian loss, we used the 2001 National Land Cover Dataset to create a vegetation layer that includes forests and woody wetlands. Willow-dominated shrublands are generally classified as woody wetlands in the NLCD, while cottonwoods are usually assigned to the deciduous forest class. Because there are some evergreen forests along higher elevation streams, we included all forest types (deciduous, evergreen and mixed) in this calculation. We buffered all streams from the 1:100,000 National Hydrography Dataset by 60 meters on each side, and calculated the acres of riparian vegetation.

To be on the conservative side, and recognizing the inaccuracies inherent in land cover data at this resolution, we calculated that under natural conditions, the riparian corridor area would include at least 30% forest and woody wetland vegetation. Any departure from that was held to be a loss. The index was calculated as:

$$IRL = 1 - (ARV)/(0.50 * ATR),$$

where ARV = the acreage of riparian vegetation within the buffered corridor, and ATR = the total riparian corridor area, in acres.

Table 9 shows the Riparian Loss scores for each watershed; high scores indicate a greater level of disturbance, while low scores equal a lower level. Negative scores mean that the current riparian corridor is more than 30% forested. There was a large spread between scores, ranging from a high of 0.45 for the Junction Creek and Lower Horse Prairie Creek watersheds to a low of -0.18 for the Red Rock Lakes watershed. Although many of the watersheds with less than 30% woody cover in the riparian corridor are in semi-arid areas, in the absence of stream incision and diversion of stream flows, we would expect more willows and other riparian shrubs. Therefore, we suggest that there has been significant loss of woody riparian vegetation since pre-settlement times in several of the assessment area watersheds. However, we also note that ten of the fourteen watersheds still have close to, or more than, an average of 30% woody cover along their streams and rivers.

Table 9. Riparian Loss Index.

Red Rock Lakes	-0.18
Muddy Creek	-0.04
Bloody Dick Creek	-0.03
Medicine Lodge Creek	-0.03
Cabin Creek	0.02
Lima Reservoir	0.10
Upper Horse Prairie Creek	0.13
Big Sheep Creek	0.13
Sage Creek	0.14
Nicholia Creek	0.17
Little Sheep Creek	0.26
Red Rock River	0.37
Lower Horse Prairie Creek	0.45
Junction Creek	0.45

Composite Watershed Condition Index (CWCI)

The Composite Watershed Condition Index is calculated by subtracting the Riparian Loss Index from the Landscape Integrity Index and the Stream Corridor Integrity Index.

$$CWCI = (ILI + ISCI) - (IRL)$$

The highest possible score would be 2.00, assuming scores of 1.00 (best) on each of the integrity indices and 0.00 (best) on the Riparian Loss Index. Because we had negative scores on the Riparian Loss Index, we had one CWCI score over 2.00, so all scores were converted to a range of 0.00 to 2.00 by dividing them by 0.5 of the high score. A score of 2.00 represents the sort of conditions associated with remote, undeveloped areas with little history of mining, agriculture, or other human land use other than grazing . For inhabited areas, scores will be much lower and could be a negative number when integrity indices are low and riparian loss is high. We would expect to see scores between 1.00 and 1.50 in inhabited rural watersheds.

The Composite Watershed Condition scores are shown in Table 10 and in Figure 11. All the watersheds received positive scores, ranging from highs of 2.00 for the Red Rock Lakes watershed to a low of 1.05. Half of the watersheds in the assessment area scored higher than 1.50, and two were very close (1.49). In general, this indicates that there are relatively few landscape-level disturbances affecting watershed health and integrity, and that they tend to be concentrated in a handful of watersheds. The highest-scoring Red Rock Lakes watershed has a high percentage of U.S. Fish and Wildlife Service, Nature Conservancy, and BLM- and Forest Service-managed land, and is sparsely populated. By contrast, the lowest scoring watersheds (Lower Horse Prairie Creek, Junction Creek, Red Rock River) have more population, and concentrations of agriculture on riparian floodplains.

Table 10. Composite Watershed Condition Index.

Red Rock Lakes	2.00
Muddy Creek	1.74
Medicine Lodge Creek	1.70
Bloody Dick Creek	1.67
Cabin Creek	1.66
Lima Reservoir	1.62
Sage Creek	1.54
Big Sheep Creek	1.49
Nicholia Creek	1.49
Upper Horse Prairie Creek	1.46
Little Sheep Creek	1.27
Red Rock River	1.14
Junction Creek	1.11
Lower Horse Prairie Creek	1.05

Riparian Grazing Threat Index

In past watershed assessments, we have calculated a Composite Watershed Condition Index based on multiple threats: residential and recreational development, oil and gas extraction, conversion of prairie grasslands to agriculture, riparian grazing, etc. Energy transmission lines and facilities may be routed through this area in the future, and the area south of Dillon may see some population growth, but neither of these possibilities is certain enough for us to assess the scope of the threat at this time. Similarly, although agriculture and water diversions have certainly affected the natural environment in the past, we do not foresee major new agricultural initiatives or water projects. However, grazing around wetlands and riparian areas is a current threat that we expect will continue. Therefore, we have calculated a Riparian Grazing Threat (IRGT) for the assessment area watersheds.

Cattle grazing can cause soil compaction, nutrient enrichment, vegetation trampling and removal, habitat disturbance, and, depending on the season and intensity of use, reproductive failure for both plants and animals. In riparian areas, grazing can cause stream bank destabilization, loss of riparian shade, and increased sediment and nutrient loads (George et al. 2002). To assess this threat, we used the same 60 meter buffers that we used in the calculation of the riparian loss index, but here we measured the percentage of those buffers which were either under public land ownership (assumed to be available for grazing) or were private but listed in cadastral records as having grazing as a primary use. These buffers are narrow to capture the most intense riparian grazing effects (bank collapse, loss of vegetation filtering function, etc.) and to allow a cross-comparison to the Riparian Loss Index.

The Riparian Grazing Threat Index was then calculated as:

$$IGT = ARG/ART,$$

where ARG is the area of public and private grazing land in the stream buffers and ART is the total buffer area, in acres. These scores were then relativized by dividing all scores by the highest score.

Table 11 has a breakdown of Riparian Grazing Threat scores for each of the 5th code watersheds. Two caveats are in order here. First, the scores represent a potential threat, and not necessarily an existing threat. For instance, riparian areas in the Lima Reservoir watershed, which have the highest scores on this metric, are not necessarily in worse

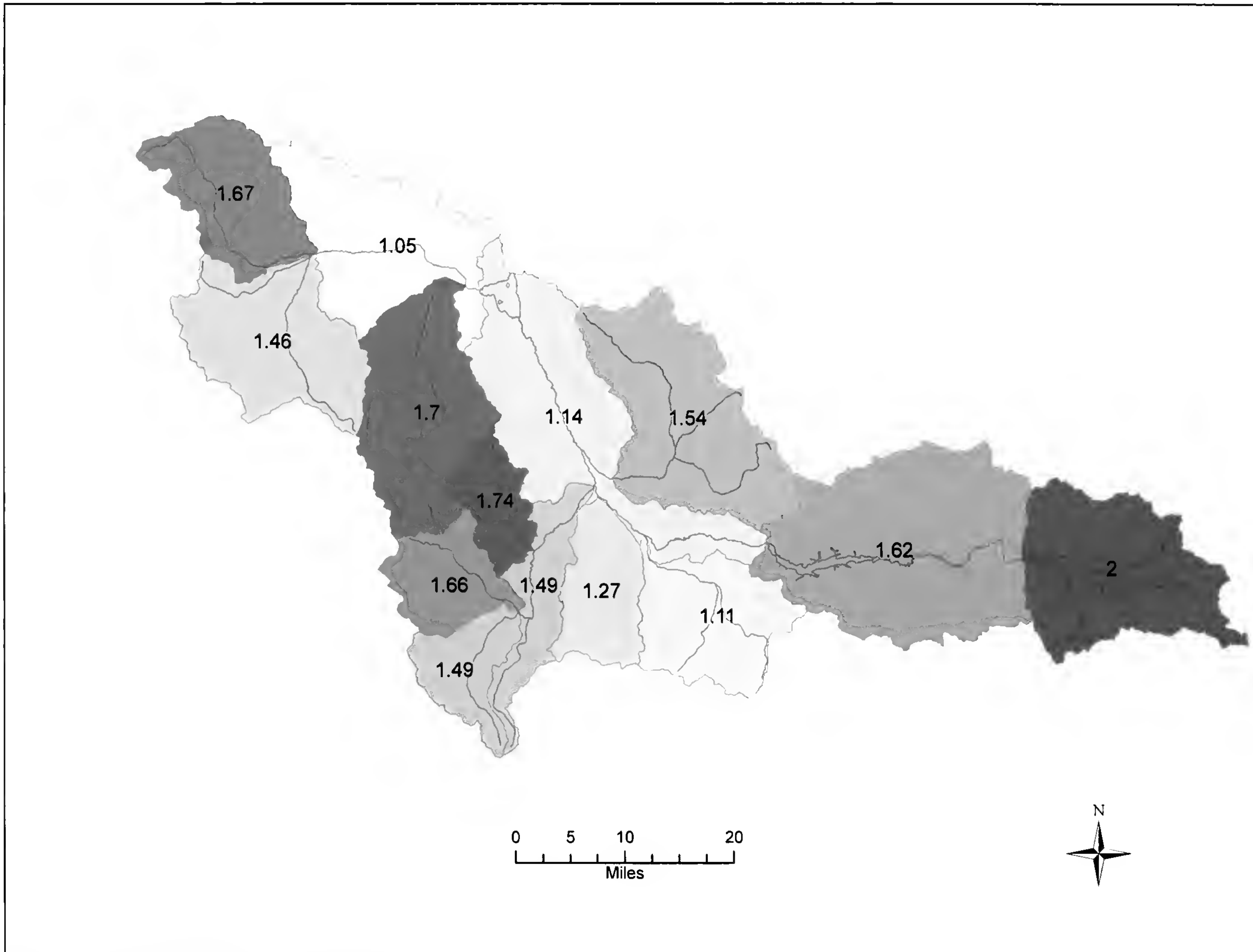


Figure 11. Composite Watershed Condition Index score.

condition than any other 5th code watershed; management practices may limit riparian grazing, and the land itself may be unsuitable for grazing, or may not be grazed at all. Rural land with no other agricultural use is typically designated as grazing land for tax purposes, regardless of whether it is actually grazed. Moreover, management practices and stocking rates will determine actual condition. Second, scores only indicate potential grazing threats, not impacts that may have already occurred. However, based on our field observations, the two watersheds with the highest scores, Lima Reservoir and Sage Creek, do have widespread grazing. Similarly, the Red Rock River watershed, which had the third highest score on this index, also had a relatively high score on the Riparian Loss Index, suggesting that grazing may have had negative impacts in the past.

Table 11. Riparian grazing threat index.

Lima Reservoir	1.00
Sage Creek	0.79
Red Rock River	0.69
Red Rock Lakes	0.62
Lower Horse Prairie Creek	0.46
Medicine Lodge	0.42
Upper Horse Prairie Creek	0.38
Junction Creek	0.37
Cabin Creek	0.26
Bloody Dick Creek	0.22
Big Sheep Creek	0.17
Little Sheep Creek	0.17
Muddy Creek	0.16
Nicholia Creek	0.15

Interpreting the Broad-scale Assessment Composite Indices

Although the composite assessment indices could be reduced to a single number, we have kept them separate because each represents a distinct and important piece of the watershed assessment. The Composite Natural Complexity Index provides a basis for assessing the raw material; the range of natural variability within the individual watersheds, which can be used as a surrogate for natural or background conditions. From a management standpoint, watersheds with high natural complexity are those where unique natural features are likely to occur, and may therefore warrant more detailed assessment. The Composite Watershed Condition Index represents overall change in natural conditions, allowing comparisons between individual watersheds and identification of factors that impact overall condition. The Riparian Grazing Threat Index is a measure of what can still be lost. This last index should be interpreted on its own, or at most in relation to the Composite Watershed Condition Index. For example, the Red Rock Lakes watershed has a high Composite Watershed Condition Index score, but also ranks fairly high on the Riparian Grazing Threat Index. This could indicate that high quality habitat values are at risk of being compromised by grazing, although on-site investigation would be needed to determine if this has been or can be offset by management. By contrast, the Muddy Creek watershed has low Natural Complexity, but a high Watershed Condition Index and a low Riparian Grazing Threat score.

Fine-scale Assessments

During the summer of 2008 MTNHP wetland ecologists surveyed 103 lentic and lotic sites in the Centennial Valley, using standard BLM protocols (PFC) for assessing function in wetlands and riparian areas. An additional 37 sites were surveyed as part of the aquatic assessments using a separate BLM protocol designed for use in macroinvertebrate-based evaluations; these results are reported separately below.

Of the 103 sites visited by the wetlands team, 83 were on land managed in whole or in part by the BLM; the remainder were on the Red Rock Lakes National Wildlife Refuge. The Centennial Valley was chosen as the focus for these assessments by the BLM field office in Dillon. Unlike the rest of the assessment area, the Centennial Valley is especially rich in wetlands, and wetlands have been mapped as part of the National Wetlands Inventory. Sampling sites were selected by drawing a spatially distributed random sample, stratified by most common wetland classes, from the National Wetlands Inventory. Individual rankings and comments are found in Appendices C-1 to C-3.

The results are summarized below.

Wetland and Riparian Assessments

Of the 103 lentic and lotic sites assessed with PFC methodology, we found:

- •74 in Proper Functioning Condition;
- •19 Functional at Risk with a downward trend;
- •3 Functional at Risk with an undetermined trend;
- •7 Nonfunctional.

All lotic sites sampled (8) were in Proper Functioning Condition.

Of 83 sampling sites believed to be or immediately adjacent to BLM-managed lands, we found:

- •56 in Proper Functioning Condition with a stable trend;
- •17 Functional at Risk with a downward trend;
- •3 Functional at Risk with an undetermined trend;
- •7 Nonfunctional

Overall, we found that the wetlands in the Centennial Valley exhibit a good degree of ecological integrity. Species richness is reasonably high (Appendix D), although most plant communities are dominated by plants with a high tolerance for disturbance. Most of the sites that were found to be in PFC were ranked as A or B in the ecological integrity assessments, and even those sites ranked as FAR were typically ranked B or C. In almost every case where a wetland was assessed as functional at risk, the reason was hydrologic modification, generally by livestock. With long winters and high moisture, Centennial Valley wetlands tend to have wet soils well into the grazing season, and are especially susceptible to pugging and hummocking . In many of the organic soils found in the Valley and its surroundings, hummocking and pugging create channels that drain water away from the wetlands. In many of these FAR wetlands, the hummocking is so severe that a person cannot walk through the wetland without great difficulty. Although these wetlands still support hydrophilic plants, they are gradually losing their ability to intercept and store surface water, trap sediments, and filter nutrients. If the hummocking and pugging increase, we anticipate loss of function within less than a decade in many cases. We also note that several of the FAR wetlands where we saw severe impacts are fens, a relatively uncommon wetland type in southwestern Montana. In four cases where wetlands were found to be functional at risk, we found that the factors affecting the wetlands were beyond BLM management control. In one case, adjacent private land use is severely impacting a fen (Figure 12); in the other three, the factors ranged from road encroachment to dredging to the effects of drought. Most of the Nonfunctional wetlands were also the result of factors beyond management control: drying out of old beaver ponds, drainage by roads, or succession from wet to dry meadows.

Figure 12. Land use adjacent to a fen.

In our initial wetland sample draw, we identified 100 wetlands from the National Wetlands Inventory mapping. Less that 80 of these were wetlands when we located them. In most cases, we attributed this to mapping errors: sites were more mesic than wet. In other cases, the loss appeared to be attributable to drought rather than to human factors, although soil compaction and heavy grazing may have played a factor in some instances.
We also noted that in general, invasive weeds are not common in assessment area. Canada thistle (*Cirsium arvense*) was the most common invasive. However, exotic grasses such as Kentucky bluegrass and smooth brome (*Bromus inermis*) have become widespread, and appear to be outcompeting native species in many riparian areas.

Figure 13. A proper functioning condition riparian site.

Figure 14. A functional at risk site with a downward trend.

Figure 15. A nonfunctional site.

In areas where cattle congregate or loaf along stream banks, we saw bare batches and examples of bank sheer. Still, in areas where grazing is light and water supplies are abundant, willows are well-established along most of the perennial creeks, and recruitment is generally good. Browsing by all species --cattle, moose and elk-- appears to be relatively limited.

Aquatic Assessments

As a second component of our fine-scale assessment work, we sampled and assessed aquatic community integrity based on macroinvertebrate and habitat sampling at lotic sites near where PFC assessments were carried out. Our goal was to identify and interpret key community indicators found at the sites using standardized protocols and biotic thresholds, and compare these against reference condition standards at the watershed-level and local-reach scale.

On-site habitat assessments were conducted using the rapid assessment protocol by the National Aquatic Assessment of the Bureau of Land Management (BLM) Buglab (scores 0-24) (http://www1.usu.edu/buglab/forms/Bug%20Protocol%20form.pdf). Following the BLM assessment protocols, the reach was divided into ten equally spaced transects. At each transect, we measured wetted width, bankfull width, channel depth at three locations, and amount of large woody debris and riparian shading. Basic water chemistry parameters (temperature, pH, conductivity, dissolved O^2) were recorded prior to sampling at the downstream end of the reach using a Horiba H-10 water monitor. These measurements allow characterization of local reach geomorphology, riparian and in-stream habitat, and other qualities that influence aquatic community integrity. Sites ranking higher using these protocols are determined to have higher quality local-scale habitat. Habitat assessments were performed during the same visit as the biological sampling. Habitat assessment scores greater than 20 are considered intact and properly functioning, while those with scores at or below 20 have one or more habitat / riparian impairments.

Macroinvertebrates were collected in lotic sites from 10 evenly spaced transects across the reach with a 500-micron D-frame net. The method utilized was the EPA EMAP_Reach-Wide Multi-habitat protocol outlined in Lazorchak et al. (1998). All 10 samples taken within the designated transects were composited into a bucket, and the organisms were washed onto a 500-micron sieve, transferred to a one liter Nalgene bottle, labeled and preserved in 95% ethanol, and brought to the MTNHP lab in Helena for processing. Lentic site macroinvertebrates were sampled using the multi-habitat, dipnet protocols outlined in the EPA RBP Assessment Manual (Barbour et al. 1999). This involved 20 (1/2 m) dipnet jabs partitioned in accordance to the dominant habitat types of the wetland (i.e., emergent vegetation, submerged vegetation, unconsolidated bottom, etc.). These samples were processed (sorting, identification, and data analysis) by David Stagliano at the Helena NHP lab. Processing of samples from lotic sites followed MT Department of Environmental Quality's protocols (MT DEQ 2005). Macroinvertebrates were identified to the lowest taxonomic level, and data were imported into EDAS (Jessup 2006). Biological metrics were calculated from the data using the newest multimetric macroinvertebrate (MMI) protocols (Jessup et al. 2005, Feldman 2006). The macroinvertebrate MMI score is based upon a series of metrics that measure attributes of benthic macroinvertebrate communities that are sensitive to anthropogenic changes in streams and rivers. There are currently no MT DEQ or EPA approved metrics for wetland macroinvertebrate assessments, so interpretation of invertebrate samples from lentic sites was largely informed by best professional judgment, given knowledge of expected communities, individual taxon tolerances, and assemblage metrics known to respond to anthropogenic stressors (species richness, taxa dominance, etc.) (Barbour et. al. 1999). We also analyzed a subset of lentic samples with the macroinvertebrate MMI to determine whether metrics developed for lotic sites might provide useful information. For both lentic and lotic sites, metric results were scored using the Montana DEQ bioassessment criteria and each sample was categorized as non-impaired or impaired according to threshold values (Table 12). The impairment threshold set by MT DEQ is 63 for the Mountain Stream Index, and 48 for the Low Mountain/Valley Index; any scores above this threshold are considered unimpaired. Although all lotic sites in the Centennial Assessment Basin fall within the mountain elevation class, the streams themselves have characteristics of the Foothills/Valleys ecoregion and the Small Foothills River Aquatic Ecological System (AES C001). Consequently, both MMI scores are reported and interpreted. We caution the reader to evaluate these scores in the context of the habitat assessments performed for this part of the study. Because of the mix of mountain and foothill features, the MMI FV may assign some mildly impaired Mountain streams an unimpaired score, while the Mountain MMI may falsely assign impaired rankings to unimpaired Foothills streams.

In our analysis of habitat condition, we found that 14 of the 37 (38%) aquatic assessment wetland sites had good habitat quality (i.e., Proper Functioning Condition) ranked by at least one of the habitat assessment methods (Table 13). Twenty of the sites (54%) were ranked impaired (Functional At Risk); six of these had a downward trend and four appeared to be improving. Three sites were impaired to the point of being Nonfunctional wetlands (8%). Highest site habitat scores using both BLM habitat assessment methods were measured at West Fork Corral Creek, where we sampled 3 lotic sites and 1 lentic wetland. Highest deductions to the riparian assessment scores were in stream sediments, bare ground, and

Table 12. Impairment determinations from the MMI.

Ecoregion	RIVPACS	MMI	Impairment Determination
Mountain	> 0.8 or < 1.2	>63	Not impaired
	< 0.8 or > 1.2	<63	Impaired
Low Valley	> 0.8 or < 1.2	>48	Not impaired
	< 0.8 or > 1.2	<48	Impaired

Table 13. Centennial Valley dragonfly and damselfly species.

	BLM_CEN_121	BLM_CEN_122	BLM_CEN_123	BLM_CEN_124	BLM_CEN_126	BLM_CEN_127	BLM_Cen_131	BLM_Cen_132	BLM_Cen_133	BLM_Cen_134	BLM_Cen_135	BLM_Cen_136	BLM_Cen_211	BLM_Cen_215	BLM_Cen_216	BLM_Cen_217
Damselflies																
Argia (Larvae)											X	X				
Amphiagrion abbreviatum												X				
Lestes congener	X				X		X	X	X					X		
Lestes disjunctus	X	X			X		X	X	X					X		
Lestes dryas		X	X	X												
Enallagma (Larvae)		X			X		X		X			X		X	X	X
Enallagma annexum		X	X			X	X	X	X	X					X	
Enallagma boreale		X	X	X					X							
Dragonflies																
Aeshna constricta		X					X	X								
Aeshna palmata		X	X	X	X	X			X							
Aeshna interrupta					X											
Sympetrum (Larvae)							X	X								
Sympetrum internum	X				X		X	X	X	X	X					
Sympetrum danae							X	X	X							
Sympetrum pallipes							X	X	X							
Leucorrhinia proxima							X	X	X						X	X
Ophiogomphus severus											X					
Somatochlora semicircularis													X			
Total Odonata	3	6	4	3	6	2	10	9	10	2	3	3	1	3	3	2

bank trampling by cattle intrusions into the riparian zone. These intrusions were specifically measured using the Livestock Use Index (LUI), which was very high for multiple streams and wetlands including East Fork Corral Creek and wetlands in the West Creek .

Overall, 118 macroinvertebrate taxa were reported from the BLM 2008 aquatic assessment sites. Average macroinvertebrate taxa richness per site was 22, and the highest taxa richness reported at 2 sites was 46 taxa. Using the Montana DEQ FV MMI, 15 of the 16 lotic sites sampled were ranked non-impaired (good to excellent biological integrity) and 1 was slightly impaired. Using the DEQ Mountain MMI, 6 of 15 were non-impaired, 5 slightly impaired and 4 moderately to severely impaired. The Foothills MMI may not be as sensitive to degraded conditions and changing macroinvertebrate communities. The macroinvertebrate communities ranked with the mountain MMI index seemed to correlate with riparian condition better, with slightly impaired macroinvertebrate communities reported more often at riparian areas ranked FAR. However, no significant relationship was detected between the lotic BLM Habitat Assessment Scores and either the DEQ MT MMI or FV metric scores (Figure 16). In fact, two of the highest macroinvertebrate MMI Scores (>70) were collected from lotic

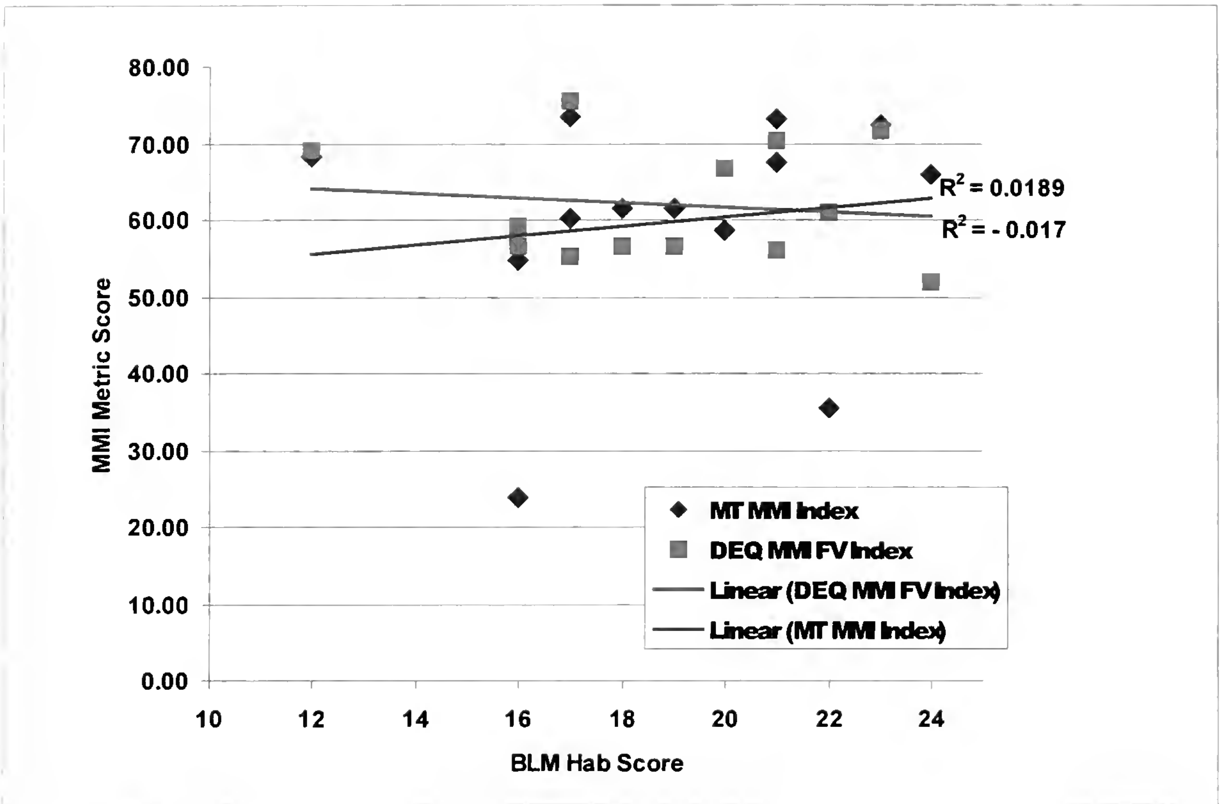


Figure 16. MMI scores vs. BLM habitat score (functional condition).

systems with moderately (HBI-17) to severely degraded (HBI-12) riparian and in-stream habitat conditions. Price Creek seems to be improving in biotic integrity; it was rated as slightly impaired in 2004 at a DEQ site sampled, and as unimpaired in our survey (MMI scores 45.5 (2004) to 66.8 (2008).

As an indicator of lentic wetland macroinvertebrate condition, the mountain macroinvertebrate MMI consistently ranked all sites as impaired whether they were properly functioning or not. The FV MMI tracked wetland condition fairly well, ranking 4 out of 5 PFC sites as unimpaired and 2 of 2 FAR sites as having slightly impaired macroinvertebrate communities. The use of dragonfly metrics has been proposed in wetland assessments based on increased species richness with aquatic habitat complexity. However, although we found several dragonfly and damselfly species at the assessment sites (Table 13), we found no significant difference between dragonfly species richness and different riparian functional condition (T test, p=0.495) (Figure 17).

Based on these assessments, we ranked aquatic sites from highest to lowest integrity by Aquatic Ecological System (AES) as follows:

•Intermountain Transitional River (AES B003)-1) Red Rock River (slightly impaired)

•Small Foothills River (AES C001)-1) West Fork Corral Creek, 2) East Fork Corral Creek, 3) Price Creek, 4) Pete Creek, 5) Price Creek, 6) West Creek

•Centennial Basin Perennial Spring (AES code S005)- 1) BLM Spring #136

Relationship Between Broad-scale and Fine-scale Assessments

In most cases, broad-scale assessments provide insight into cumulative impacts on wetland and aquatic ecosystems, while fine-scale assessments

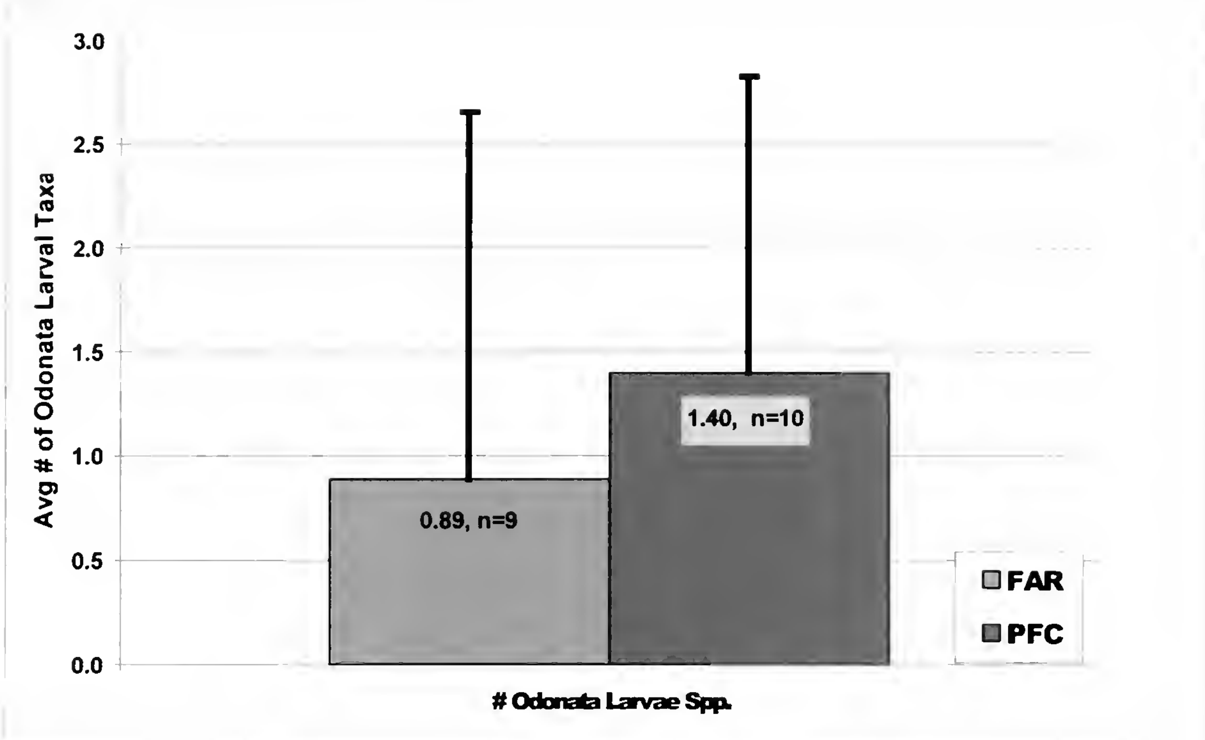


Figure 17. Odonata larval species richness by functional condition.

measure cumulative effects (Johnson 2005). Impacts may occur at a significant distance from their effects, as is often the case with upstream-downstream relationships observed in aquatic systems, or they may occur in close proximity. For example, impacts from land use activities in upstream watersheds may have effects downstream. Typically, the value of watershed-level assessments lies in identifying areas where impacts are currently occurring or may occur, rather than merely documenting effects that have already occurred. By combining both site-level and watershed-level assessments, it is possible to select areas where management can make a substantial difference in future wetland and aquatic health. Even when there are similar findings between the two levels of assessment, they need to be examined less for correlation than for the different perspectives they provide.

In this case, the correlation is quite pronounced. In our broad-scale assessment, both the Red Rock Lakes and Lima Reservoir watersheds had the highest overall scores on the Composite Natural Complexity, indicating similarities in baseline condition. However, the Red Rock Lakes watershed had a markedly higher score on the Composite Wetland Condition Index, suggesting that impacts were occurring across a broad scale. This is borne out by the fine-scale assessments. As can be seen in Figure 18, the wetlands assessed in the Red Rock Lakes watershed were mostly in Proper Functioning Condition, while many of the wetlands in the Lima Creek Reservoir watershed showed some level of impairment.

From our field surveys, it appears that landscape level stressors and site-specific stressors are related in these two watersheds. The Red Rock Lakes watershed is the more remote of the two, has fewer roads, and has been grazed less intensively over the past decades. The Lima Creek Reservoir watershed, by contrast, has more private land and more livestock operations, and consequently more roads to facilitate the movement of cattle. As noted above, most of the functional impairments we observed were associated with the timing and/or intensity of livestock use. On the positive side, however, this provides clear management opportunities for the BLM.

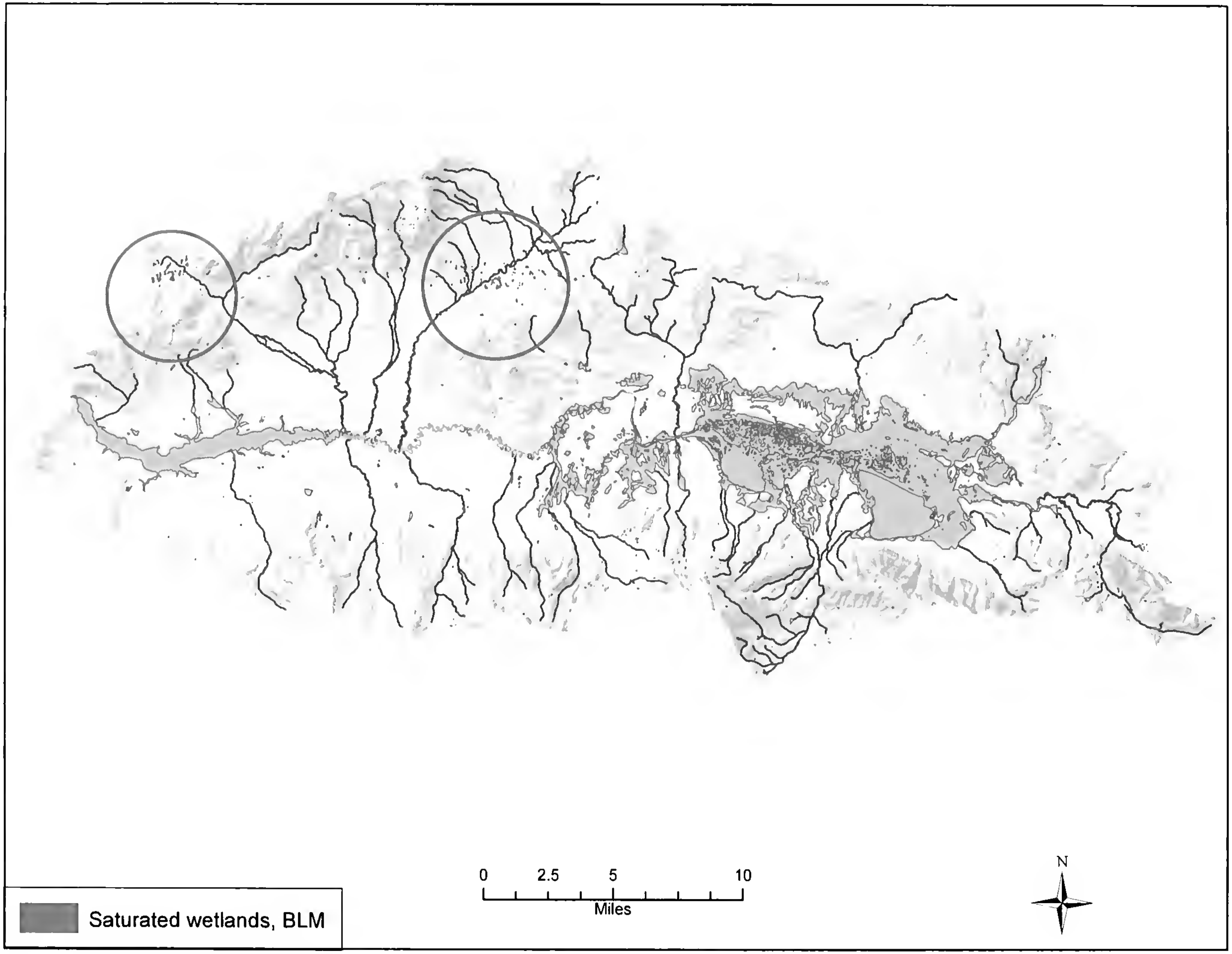


Figure 18. Centennial Valley PFC scores.

Management Opportunities

The BLM owns and administers a substantial proportion of land within the assessment area, and can play an important role in conserving or restoring natural functioning. Based on our broad-scale and fine-scale assessments in the Centennial Valley, we think that grazing management provides the best opportunity for protecting and restoring wetland function. Although wetlands and some riparian areas have been negatively impacted by grazing, our field surveys indicated that rangelands across the assessment area are in generally good to very good condition, and reflect conscientious grazing management.

In an area rich with wetlands, general exclusion of cattle through fencing is impractical. We would recommend instead that the BLM carry out wetland landscape profiling and targeted surveys to identify specific examples of sensitive wetland habitats, and develop grazing management strategies on a case-by-case basis. For example, we used a GIS to identify NWI-mapped wetlands with a "saturated" designation (PEMB or PSSB) on BLM lands in the Centennial Valley. These saturated wetlands are often fens or carrs, which are noted for their high diversity and potential for rare plant occurrences. Figure 19 shows two distinct clusters of saturated wetland along Long Creek and Clover Creek, with other examples scattered throughout Centennial Valley BLM lands. Inspection of these areas on aerial photos, followed by field evaluation, could determine if these areas are indeed significant wetlands in good or restorable condition. If this is the case, exclusion might be warranted. A similar exercise could identify seasonally flooded wetlands, where soils are more sensitive to grazing disturbance in the spring than later in the season. If there are concentrations of high-quality seasonally flooded wetlands, then grazing plans limiting early season access would be a good protection strategy. These management practices, coupled with frequent utilization monitoring, would provide effective protection of wetland functions and values in the area.

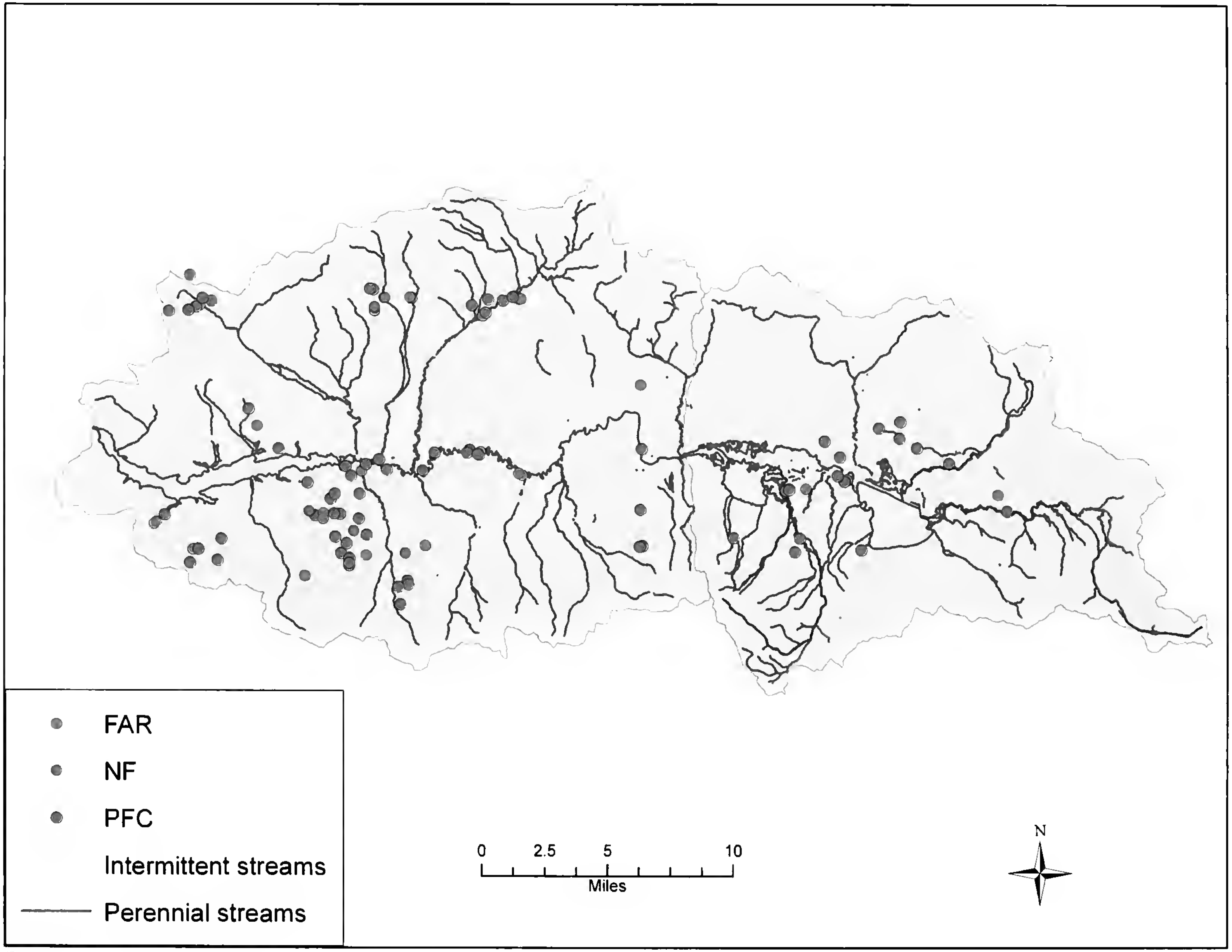


Figure 19. Centennial valley saturated wetlands.

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Appendix A. Montana Species of Concern in the Assessment Area

Scientific Name	**Common Name**
Amphibians	
Bufo boreas	Western Toad
Birds	
Accipiter gentilis	Northern Goshawk
Aechmophorus clarkii	Clark's Grebe
Ammodramus savannarum	Grasshopper Sparrow
Amphispiza belli	Sage Sparrow
Aquila chrysaetos	Golden Eagle
Ardea herodias	Great Blue Heron
Asio flammeus	Short-eared Owl
Athene cunicularia	Burrowing Owl
Botaurus lentiginosus	American Bittern
Bucephala islandica	Barrow's Goldeneye
Buteo regalis	Ferruginous Hawk
Buteo swainsoni	Swainson's Hawk
Calcarius mccownii	McCown's Longspur
Carpodacus cassinii	Cassin's Finch
Catharus fuscescens	Veery
Centrocercus urophasianus	Greater Sage-Grouse
Certhia americana	Brown Creeper
Chlidonias niger	Black Tern
Coturnicops noveboracensis	Yellow Rail
Cygnus buccinator	Trumpeter Swan
Empidonax alnorum	Alder Flycatcher
Falco peregrinus	Peregrine Falcon
Gavia immer	Common Loon
Grus americana	Whooping Crane
Haliaeetus leucocephalus	Bald Eagle
Himantopus mexicanus	Black-necked Stilt
Histrionicus histrionicus	Harlequin Duck
Hydroprogne caspia	Caspian Tern
Leucophaeus pipixcan	Franklin's Gull
Leucosticte atrata	Black Rosy-Finch
Leucosticte tephrocotis	Gray-crowned Rosy-Finch
Lophodytes cucullatus	Hooded Merganser
Melanerpes lewis	Lewis's Woodpecker
Mniotilta varia	Black-and-white Warbler
Nucifraga columbiana	Clark's Nutcracker
Numenius americanus	Long-billed Curlew
Nycticorax nycticorax	Black-crowned Night-Heron

Oreoscoptes montanus	Sage Thrasher
Otus flammeolus	Flammulated Owl
Pelecanus erythrorhynchos	American White Pelican
Picoides arcticus	Black-backed Woodpecker
Plegadis chihi	White-faced Ibis
Podiceps auritus	Horned Grebe
Selasphorus platycercus	Broad-tailed Hummingbird
Selasphorus rufus	Rufous Hummingbird
Spizella breweri	Brewer's Sparrow
Sterna forsteri	Forster's Tern
Sterna hirundo	Common Tern
Strix nebulosa	Great Gray Owl
Troglodytes troglodytes	Winter Wren
Fish	
Lota lota	Burbot
Oncorhynchus clarkii bouvieri	Yellowstone Cutthroat Trout
Oncorhynchus clarkii lewisi	Westslope Cutthroat Trout
Salvelinus namaycush	Lake Trout
Thymallus arcticus	Arctic Grayling
Mammals	
Brachylagus idahoensis	Pygmy Rabbit
Canis lupus	Gray Wolf
Corynorhinus townsendii	Townsend's Big-eared Bat
Gulo gulo	Wolverine
Lasionycteris noctivagans	Silver-haired Bat
Lasiurus cinereus	Hoary Bat
Lepus californicus	Black-tailed Jack Rabbit
Lynx canadensis	Canada Lynx
Marmota caligata	Hoary Marmot
Myotis thysanodes	Fringed Myotis
Perognathus parvus	Great Basin Pocket Mouse
Sorex merriami	Merriam's Shrew
Sorex nanus	Dwarf Shrew
Sorex preblei	Preble's Shrew
Spermophilus armatus	Uinta Ground Squirrel
Spermophilus elegans	Wyoming Ground Squirrel
Spilogale gracilis	Western Spotted Skunk
Thomomys idahoensis	Idaho Pocket Gopher
Ursus arctos	Grizzly Bear
Invertebrates	
Agapetus montanus	An Agapetus Caddisfly

Caenis youngi	A Mayfly
Euphydryas gillettii	Gillette's Checkerspot
Margaritifera falcata	Western Pearlshell
Lichens	
Rhizoplaca haydenii	Wamderlust Lichen
Plants	
Agastache cusickii	Cusick's Giant-hyssop
Amaranthus californicus	California Amaranth
Aquilegia formosa	Crimson Columbine
Astragalus ceramicus var. *apus*	Painted Milk-vetch
Astragalus convallarius	Timber Milk-vetch
Astragalus leptaleus	Park Milk-vetch
Astragalus scaphoides	Bitterroot Milk-vetch
Astragalus terminalis	Railhead Milk-vetch
Atriplex truncata	Wedge-leaved Saltbush
Balsamorhiza hookeri	Hooker's Balsamroot
Balsamorhiza macrophylla	Cut-leaf Balsamroot
Braya humilis	Low Braya
Calochortus bruneaunis	Bruneau Mariposa Lily
Carex idahoa	Idaho Sedge
Carex multicostata	Many-ribbed Sedge
Carex norvegica ssp. *stevenii*	Scandinavian Sedge
Castilleja crista-galli	Greater Red Indian-paintbrush
Castilleja nivea	Snow Indian-paintbrush
Chrysothamnus parryi ssp. *montanus*	Parry's Rabbitbrush
Cryptantha fendleri	Fendler's Cat's-eye
Cryptantha humilis	Round-spike Cat's-eye
Delphinium bicolor ssp. *calcicola*	Flat-head Larkspur
Delphinium glaucescens	Electric Peak Larkspur
Downingia laeta	Great Basin Downingia
Draba densifolia	Denseleaf Whitlow-grass
Draba globosa	Rockcress Draba
Elatine americana	American Waterwort
Elymus flavescens	Sand Wildrye
Erigeron asperugineus	Idaho Fleabane
Erigeron gracilis	Slender Fleabane
Erigeron leiomerus	Smooth Fleabane
Erigeron linearis	Linearleaf Fleabane
Erigeron parryi	Parry's fleabane
Erigeron tener	Tender Fleabane
Eriogonum caespitosum	Matted Wild Buckwheat

Eriogonum soliceps	Railroad Canyon Wild Buckwheat
Eupatorium occidentale	Western Joepye-weed
Gentiana fremontii	Moss Gentian
Gentianopsis simplex	One-flower Gentian
Hutchinsia procumbens	Prostrate Hymenolobus
Ipomopsis congesta ssp. *crebrifolia*	Compact Gilia
Kobresia simpliciuscula	Simple Kobresia
Kochia americana	Perennial Summer-cypress
Lomatium attenuatum	Taper-tip Desert-parsley
Lomatogonium rotatum	Marsh Felwort
Oenothera pallida var. *idahoensis*	Pale Evening-primrose
Orogenia linearifolia	Great Basin Indian-potato
Oxytropis parryi	Parry's Crazyweed
Pedicularis contorta var. *ctenophora*	Coil-beaked Lousewort
Pedicularis crenulata	Scallop-leaf Lousewort
Penstemon lemhiensis	Lemhi Beardtongue
Penstemon whippleanus	Whipple's Beardtongue
Phacelia incana	Western Phacelia
Physaria pulchella	Beautiful Bladderpod
Plagiobothrys leptocladus	Alkali Popcorn-flower
Potentilla plattensis	Platte River Cinquefoil
Primula alcalina	Alkali Primrose
Primula incana	Jones Primrose
Puccinellia lemmonii	Lemmon's Alkali Grass
Ranunculus jovis	Hillside Buttercup
Silene repens	Creeping Catchfly
Sphaeralcea munroana	White-stem Globemallow
Sphaeromeria argentea	Nuttall's False Sagebrush
Stellaria crassifolia	Fleshy Stitchwort
Stellaria jamesiana	Sticky False-starwort
Stipa lettermanii	Letterman's Needlegrass
Taraxacum eriophorum	Wool-bearing Dandelion
Thalictrum alpinum	Alpine Meadowrue
Thelypodium paniculatum	Northwestern Thelypody
Thelypodium sagittatum	Slender Thelypody
Thlaspi parviflorum	Small-flowered Pennycress
Townsendia florifera	Showy Townsend-daisy
Townsendia spathulata	Sword Townsendia
Viguiera multiflora	Many-flower Viguiera

Appendix B. MTNHP Rapid Ecological Integrity Assessment Forms

SITE INFORMATION

SITE NAME______________________________
SITE ID:______________________________
ASSESSMENT AREA SIZE IN M^2______________________
OWNERSHIP______________________________
HUC4:______________________________
HUC5______________________________

DATE OF VISIT:______________________
ASSESSED BY:______________________
____
PROJECT/PURPOSE______________________

ELEVATION:______________________________
GPS WAYPOINT______________________________
Datum______________________________
Lat:______________________________
Long:______________________________
(Use decimal degrees)

Stream order, if riverine______________
Fish sampled?______________
Macroinvertebrates sampled?__________
Sample ID, if yes____________

General site description, including surrounding uplands

____
____
____

Directions to site:

____
____

Soil drainage: **Well-drained** **Moderately well-drained** **Poorly drained** **Very poorly drained**

Total wetland area covered by standing water: **0** **1 to 25%** **26-50%** **51-75%** **76-100%**

PHOTOS:

#	Direction	Description
	N	
	E	
	S	
	W	

CLASSIFICATION

ECOLOGICAL SYSTEM______________________________
CONFIDENCE LEVEL: _________**Very High**______**High**______**Medium**________**Low**
DOMINANT ASSOCIATION(S):______________________________
____
____
____

HGM Wetland Type: (Circle one)

Riverine	**Depressional**	**Lacustrine Fringe**	**Slope**	**Mineral Flat**
Upper Perennial	Open		Open Spring	Playa
Lower Perennial	Closed		Riverine Spring	
Intermittent	Prairie Pothole		Fen	
Ephemeral			Hanging valley	
			Wet Meadow	
			Seep	

CONFIDENCE LEVEL: _________**Very High**______**High**______**Medium**________**Low**
Comments:____
____
____

COWARDIN TYPE(S):

System	**Subsystem**	**Class**	**Water regime**	**Modifier**	**%**

Site Name______________ LEVEL II ASSESSMENT--Marshes, wet meadows, potholes

Site ID________________

METRIC	EXCELLENT(A)	GOOD(B)	FAIR (C)	POOR(D)	SCORE
LANDSCAPE CONTEXT					
Connectivity					
Non-riverine	90-100% natural habitat within 500 m of wetland perimeter	60-90% natural habitat within 500 m of wetland perimeter	10-60% natural habitat within 500 m of wetland perimeter	<10% natural habitat within 500 m of wetland perimeter	___
Riverine	90-100% natural habitat within 500 m on either side and 500 m upstream and downstream	60-90% natural habitat within 500 m on either side and 500 m upstream and downstream	10-60% natural habitat within 500 m on either side and 500 m upstream and downstream	<10% natural habitat within 500 m on either side and 500 m upstream and downstream	___
Buffer					
Length	Buffer is > 75% of wetland perimeter	Buffer is > 50-75% of wetland perimeter	Buffer is 25-50% of wetland perimeter	Buffer is < 25% of wetland perimeter	___
Width	Average buffer width is > 200 m, adjusted for slope	Average buffer width >100-200 m, adjusted for slope	Average buffer width is 50 100 m, adjusted for slope	Average buffer width is <50 m, adjusted for slope	___
Condition	Buffer is >95% native vegetation with intact soils and little or no trash or refuse	Buffer is >75-95% native vegetation with intact or slightly distrubed soils, and minor evidence of human visitation or recreation	Buffer is > 25-75% native vegetation with slightly to moderately distrubed soils, and moderate human visitation or recreation	Buffer is < 25% native vegetation with severely disturbed soils, and substantial human visitation or recreation	___
SIZE					
Relative Patch Size	Wetland is > 95% of original size	Wetland is > 80-95% of original size	Wetland is 50-80% of original size	Wetland is <50% of original size	___
Absolute Patch Size	Wetland is very large compared to others of its type (e.g. top 10%)	Wetland is large compared to others of its type (e.g., top 10-30%)	Wetland is average compared to others of its type (e.g., 30-70%)	Wetland is too small to sustain full function and diversity	___
VEGETATION STRUCTURE (BIOTA)					
Structure	Vegetation at or near reference standard condition in structural proportions		Vegetation moderately altered from reference standard condition in structural proportions	Vegetation greatly altered from reference standard condition in structural proportions	___
Composition	Vegetation at or near reference standard condition in species present and their proportions. Regeneration good. Full suite of diagnostic species present.		Vegetation differs from reference standard condition but still largely native. Tolerant or weedy natives may be present. Many indicators absent.	Vegetation severely altered from reference standard. Some strata absent or dominated by weedy species. Most indicator species absent.	___
Relative Cover of Native Plant Species	>99% relative cover of native plants	95-99% relative cover of native plants	80-94% relative cover of native plants	50-79% relative cover of native plants	___
Invasive exotic species	No key invasive exotic plants present	<3% invasive exotic plants present	3-5% invasive exotic plants present	>5% invasive exotic plants present	___
Organic Matter Accumulation	Site has moderate amount of fine organic matter. New materials more prevalent than old materials. Layers in pools or topographic lows are thin.		Site is characterized by small amounts of coarse organic debris, with little organic matter recuritment, OR debris is somewhat excessive	Site has little coarse debris and only scant fine debris OR debris is excessive.	___

Site Name______________ LEVEL II ASSESSMENT--Marshes, wet meadows, potholes

Site ID________________

METRIC	EXCELLENT(A)	GOOD(B)	FAIR (C)	POOR(D)	SCORE
Patch Types (See below)	>7 abiotic/biotic patch types present in the wetland (>6 for potholes)	5 to 7 abiotic/biotic patch types present in the wetland (5 or 6 for potholes)	3 or 4 abiotic/biotic patch types present in the wetland	1 or 2 abiotic/biotic patch types present	___
Patch Interspersion	Horizontal structure consists of a very complex array of nested or interspersed irregular biotic/abiotic patches with no single dominant type.	Horizontal structure consists of a moderately complex array of nested or interspersed irregular biotic/abiotic patches with no single dominant type	Horizontal structure consists of a simple array of nested or interspersed irregular biotic/abiotic patches with no single dominant type	Horizontal structure consists of one dominant patch type with no interspersion	___
HYDROLOGY					
Water Source	Water source is precipitation, groundwater, natural runoff OR system naturally lacks water during growing season No indication of direct artifical water source or point source discharge	Water source is mostly natural, but site receives occasional or small amounts of inflow from human sources e.g., road runoff, storm drains, irrigation). No large point source discharge into site	Water source is primarily runoff, irrigation, pumped water, impounded water, or other artificial hydrology Major point sources discharging into wetland may be present.	Water flow has been substantially diminished by impoundments, diversions, or withdrawals from wetland or adjacent areas OR the water source is so altered that wetland vegetation is gone	___
Hydroperiod	Hydroperiod is characterized by natural periods of filling/inundation and drawing down.	Filling or inundation is greater and of greater or lesser duration than under natural conditions, but the site is subject to natural drying	Filling or inundation is natural, but drawdown and drying more rapid, OR filling/inundation is of lower than natural magnitude or duration, but site is subject to natural drying	Filling or inundation and drawdown/drying both deviate from natural regimes.	___
Hydrologic Connectivity	Rising water in site has unrestricted access to adjacent upland, without levees, excessively high banks, artificial barriers, or other obstructions to lateral movement of flood flows.	Rising water has partially restricted (<50%) access to upland due to unnatural features OR flood drainage back into wetland is incomplete due to impoundments or barriers.	Rising water has significantly restricted (50-90%) access to upland due to unnatural features.	All water stages in the wetland are contained by artifical banks, levees, walls, or berms or >90% of wetland has barriers to drainage. There is essentially no hydrologic connection to uplands.	___
PHYSIOCHEMICAL					
Soil Surface Integrity	Bare soil areas are limited to naturally caused disturbances such as flood deposition or game trails.	Bare soil due to human impacts is present but minimal. Water is not ponding or channelled	Unnatural areas of bare soil are common. Ponding or channeling may be present in shallow disturbances	Unnatural areas of bare soil are extensive and ponding or channeling is likely. Surface disturbances are deep and widespread.	___
Water Quality	Water is clear with no sheen, scum, or hint of green. Plants that respond to enrichment are minimally present or absent.	Water has a minimal greenish tint, cloudiness, or sheen. Plants that respond to enrichment are present but not dominant.	Water has a moderate greenish tint, sheen, or turbidity with common algae. Plants that respond to enrichment are common	Water has a strong greenish tint, sheen, or turbidity Surface algal mats or other vegetation block light to the bottom.	___

Patch types:	**Lacustrine Fringe**	**Pothole**	**Slope**	**Flat**
	Open water-stream	Open water	Open water-stream	Open water
	Oxbow/backwater	Shallow emergent	Oxbow/backwater	Mud/salt flat
	Secondary channel	Saline meadow	Secondary channel	Salt flat
	Deep emergent plants	Hummocks or mounds	Deep emergent plants	Deep emergent plants
	Shallow emergent plants	Submerged or floating	Shallow emergent plants	Shallow emergent plants
	Beaver dam	Transitional meadow	Hummocks or mounds	Saline meadows
	Trees	Tall emergent	Shrubs	Greasewood
	Shrubs		Springs/seeps	Hummocks or mounds
	Springs/seeps		Submerged/floating veg	Submerged or floating vegetation
	Submerged/floating veg		Transitional meadow	
	Transitional meadow			

Site Name_______________
Site ID__________________

STRESSORS	
Land use within 300m of wetland edge	**Percent land use**
Urban residential	
Industrial/commercial	
Military/airport	
Dryland farming	
Crop agriculture	
Orchards/nurseries	
Logging operation/timber removal	
Feedlot	
Dairy	
Enclosed livestock grazing	
Open range grazing	
Sports field or park	
Active recreation (OHV, mountain biking, shooting)	
Resource extraction	
Recent fire (<5 years)	
Boating (motorized)	
Transportation with 500m of wetland edge	**Distance from edge**
Lightly travelled road	
Moderately travelled road	
Heavily travelled road	
Pedestrian trail	
Horse trail	
Railroad	
Land use within site	**% of site**
Mowing	
Livestock grazing	
Excessive herbivory	
Excessive human visitation	
Tree cutting/sapling removal	
Pesticide or herbicide application	
Recent fire (<5 years)	
Recent flood	
Invasive animals or plants	
Hydrology within 300m	**Impact (High/Medium/Low)**
Point source discharge	
Non-point source discharge	
Flow diversion or unnatural inflow	
Dams	
Flow obstructions	
Weirs, headgates	
Dredged inlet or channel	
Engineered channel	
Dike/levee	
Groundwater pumping	
Ditches	
Soil disturbance witin 300m	**Impact (High/Medium/Low)**
Filling or dumping	
Grading/compaction/roadwork	
Plowing or discing	
Logging or clearing	
Unnatural areas of bare soil	
Trash or refuse	
Pugging, hummocking, or erosion	

LEVEL III ASSESSMENT--Marshes, wet meadows, potholes

Procedure:

1. In each inundation zone, you will identify all species in 15 1 meter x 1/2 meter plots.
    a. If there is only 1 inundation zone (e.g., a wet meadow), place the plots in a concentric circle from the middle of the wetland to the outer edge.
    b. If there are two inundation zones, pace the circumference (or length) of the outer zone, and divide by 15 to get plot spacing. Then place an additional 15 plots in a concentric circle from the inside edge of the outer zone to the innermost extent of emergent vegetation.

2. In each square plot, identify all plant species and record its cover using the following cover classes:

Range	Class
Solitary or few	1
0 to 1%	2
1-2%	3
2-5%	4
5-10%	5
10-25%	6
25-50%	7
50-75%	8
75-95%	9
95-100%	10

3. Draw the approximate shape of the assessment area and the distribution of plots on the aerial photograph, if available. If not, sketch it below.

SITE ID:____________________
ZONE: _______ OF __________

PLOT #

1	2	3	4	5	6	7	8

9	10	11	12	13	14	15

SITE ID:____________________
ZONE: _______ OF __________
PLOT #

1	2	3	4	5	6	7	8

9	10	11	12	13	14	15

Appendix C-1. Site Information, Wetland Assessments

Site ID	Ownership	5th Code HUC	Visit-Date	Assessed-By	Elevation (m)	Latitude	Longitude	Site_ID	Drainage	Water	Hydrogeomorphic Type
BLM000	Private/BLM	Lima Reservoir	7/31/2008	KN, NB	2026	44.615	-111.927	BLM000	Very poorly drained	51-75%	Depressional-Open
BLM001	BLM	Lima Reservoir	8/2/2008	KN, NB	2152	44.581	-112.161	BLM001	Poorly drained	1-25%	Riverine-Upper Perennial
BLM002	BLM	Lima Reservoir	7/31/2008	KN, NB	2028	44.609	-112.189	BLM002	Moderately well drained	0	Riverine-Ephemeral
BLM003	BLM	Lima Reservoir	7/31/2008	KN, NB	2044	44.598	-112.147	BLM003	Moderately well drained	0	Depressional-Open
BLM004	BLM	Lima Reservoir	7/31/2008	NB, KN	2021	44.618	-112.176	BLM004	Moderately well drained	0	Depressional-Open
BLM005	BLM	Lima Reservoir	7/30/2008	KN, NB	2018	44.648	-112.065	BLM005	Moderately well drained	0	Riverine-Lower Perennial
BLM006	BLM	Lima Reservoir	7/30/2008	KN, NB	2015	44.646	-112.093	BLM006	Moderately well drained	0	Riverine-Lower Perennial
BLM007	Private/BLM	Lima Reservoir	7/31/2008	KN, NB	2027	44.611	-112.194	BLM007	Moderately well drained	0	Riverine-Ephemeral
BLM008	BLM	Lima Reservoir	7/30/2008	KN, NB	2013	44.636	-112.102	BLM008	Moderately well drained	0	Riverine-Lower Perennial
BLM009	BLM	Lima reservoir	7/31/2008	KN, NB	2024	44.610	-112.182	BLM009	Poorly drained	0	Riverine-Ephemeral
BLM010	BLM	Lima Reservoir	8/2/2008	KN, NB	2132	44.588	-112.167	BLM010	Moderately well drained	0	Riverine-Intermittent
BLM011	BLM	Lima reservoir	7/30/2008	KN, NB	2020	44.647	-112.056	BLM011	Moderately well drained	0	Riverine-Lower Perennial
BLM012	BLM	Lima Reservoir	8/2/2008	KN, NB	2055	44.582	-112.267	BLM012	Poorly drained	1-25%	Depressional-Open
BLM013	BLM	Lima Reservoir	7/30/2008	KN, NB	2019	44.645	-112.057	BLM013	Moderately well drained	0	Depressional-Open
BLM014	BLM	Lima Reservoir	7/30/2008	KN, NB	2016	44.636	-112.131	BLM014	Poorly drained	0	Riverine-Lower Perennial
BLM015	BLM	Lima Reservoir	8/2/2008	KN, NB	2029	44.595	-112.264	BLM015	Poorly drained		Riverine-Intermittent
BLM016	BLM	Lima Reservoir	8/2/2008	KN, NB	2128	44.585	-112.160	BLM016	Moderately well drained	0	Riverine-Upper Perennial
BLM017	BLM	Lima Reservoir	8/2/2008	KN, NB	2133	44.585	-112.165	BLM017	Moderately well drained	0	Riverine-Lower Perennial
BLM018	BLM	Lima Reservoir	7/31/2008	NB, KN	2041	44.597	-112.127	BLM018	Well-drained	0	Riverine-Intermittent
BLM019	BLM	Lima Reservoir	7/31/2008	NB, KN	2027	44.607	-112.182	BLM019	Poorly drained	0	Lacustrine Fringe
BLM020	BLM	Lima Reservoir	7/31/2008	KN, NB	2016	44.622	-112.173	BLM020	Poorly drained	26-50%	Depressional-Open
BLM021	BLM	Lima Reservoir	8/2/2008	NB,KN	2139	44.582	-112.161	BLM021	Poorly drained	26-50%	Depressional-Open
BLM022	BLM	Lima reservoir	8/18/2008	KN	2018	44.622	-112.153	BLM022	Poorly drained	0	Depressional-Open
BLM023	BLM	Lima Reservoir	8/18/2008	KN	2025	44.610	-112.169	BLM023	Moderately well drained	0	Depressional-Open
BLM024	BLM	Lima Reservoir	8/18/2008	KN	2027	44.608	-112.154	BLM024	Moderately well drained	0	Depressional-Open
BLM025	BLM	Lima Reservoir	8/19/2008	KN	2162	44.559	-112.079	BLM025	Poorly drained	26-50%	Riverine-Upper Perennial
BLM026	BLM	Lima Reservoir	8/19/2008	KN	2019	44.632	-112.160	BLM026	Moderately well drained	0	Depressional-Open
BLM027	BLM	Lima Reservoir	8/19/2008	KN	2014	44.634	-112.152	BLM027	Moderately well drained	0	Riverine-Intermittent
BLM028	BLM	Lima Reservoir	8/20/2008	KN	2055	44.686	-111.928	BLM028	Very poorly drained	51-75%	Riverine-Intermittent
BLM029	BLM	Lima Reservoir	8/20/2008	KN	2023	44.650	-111.926	BLM029	Very poorly drained	76-100%	Lacustrine Fringe
BLM030	BLM	Red Rock Lakes	8/20/2008	KN	2093	44.592	-111.801	BLM030	Poorly drained	0	Depressional-Open
BLM031	BLM	Lima Reservoir	8/21/2008	KN	2016	44.628	-112.195	BLM031	Poorly drained	26-50%	Riverine-Intermittent
BLM032	BLM	Lima Reservoir	8/21/2008	KN	2015	44.603	-112.318	BLM032	Poorly drained	26-50%	Riverine-Intermittent
BLM033	BLM	Lima Reservoir	8/21/2008	KN	2014	44.604	-112.317	BLM033	Moderately well drained	0	Riverine-Intermittent
BLM034	BLM	Lima Reservoir	8/21/2008	KN	2012	44.608	-112.310	BLM034	Poorly drained	0	Depressional-Open
BLM035	BLM	Lima reservoir	8/21/2008	KN	2043	44.600	-112.157	BLM035	Very poorly drained	51-75%	Riverine-Intermittent
BLM036	BLM	Lima Reservoir	8/22/2008	KN	2019	44.647	-112.219	BLM036	Moderately well drained	0	Depressional-Closed
BLM037	BLM	Lima Reservoir	8/22/2008	KN	2016	44.660	-112.237	BLM037	Poorly drained	0	Depressional-Open
BLM038	BLM	Lima Reservoir	8/22/2008	KN	2295	44.594	-111.925	BLM038	Very poorly drained	0	Depressional-Closed

Site ID	Ownership	5th Code HUC	Visit-Date	Assessed-By	Elevation (m)	Latitude	Longitude	Site_ID	Drainage	Water	Hydrogeomorphic Type
BLM039	BLM	Lima reservoir	8/22/2008	KN	2264	44.594	-111.927	BLM039	Poorly drained	0	Depressional-Closed
BLM040	BLM	Lima Reservoir	8/23/2008	KN	2136	44.577	-112.200	BLM040	Poorly drained	1-25%	Riverine-Upper Perennial
BLM042	BLM	Lima Reservoir	8/23/2008	KN	2166	44.574	-112.196	BLM042	Poorly drained	1-25%	Riverine-Upper Perennial
BLM043	BLM	Lima Reservoir	8/23/2008	KN	2170	44.553	-112.217	BLM043	Poorly drained	1-25%	Riverine-Upper Perennial
BLM044	BLM	Lima Reservoir	8/23/2008	KN	2186	44.551	-112.212	BLM044	Poorly drained	1-25%	Riverine-Upper Perennial
BLM046	BLM	Lima Reservoir	8/23/2008	KN	2194	44.549	-112.209	BLM046	Poorly drained	1-25%	Riverine-Upper Perennial
BLM047	BLM	Lima Reservoir	8/24/2008	KN	2171	44.727	-112.143	BLM047	Very poorly drained	26-50%	Riverine-Upper Perennial
BLM048	BLM	Lima Reservoir	8/24/2008	KN	2171	44.727	-112.143	BLM048	Very poorly drained	51-75%	Riverine-Upper Perennial
BLM049	BLM	Lima Reservoir	8/24/2008	KN	2172	44.728	-112.143	BLM049	Very poorly drained	26-50%	Riverine-Upper Perennial
BLM050	BLM	Lima Reservoir	8/24/2008	KN	2186	44.729	-112.143	BLM050	Poorly drained	1-25%	Riverine-Upper Perennial
BLM051	BLM	Lima Reservoir	8/24/2008	KN	2245	44.732	-112.134	BLM051	Moderately well drained	26-50%	Riverine-Upper Perennial
BLM052	BLM	Lima Reservoir	8/24/2008	KN	2262	44.734	-112.136	BLM052	Moderately well drained	0	Mineral Flat-Wet Meadow
BLM053	BLM	Lima Reservoir	8/24/2008	KN	2262	44.734	-112.135	BLM053	Moderately well drained	26-50%	Riverine-Upper Perennial
BLM054	BLM	Lima Reservoir	8/24/2008	KN	2410	44.739	-112.145	BLM054	Poorly drained	76-100%	Slope-Open Spring
BLM055	BLM	Lima Reservoir	8/24/2008	KN	2433	44.739	-112.147	BLM055	Poorly drained	26-50%	Slope-Open Spring
BLM056	BLM	Lima Reservoir	8/24/2008	KN	2225	44.736	-112.110	BLM056	Poorly drained	1-25%	Riverine-Upper Perennial
BLM057	BLM	Lima Reservoir	8/24/2008	KN	2219	44.734	-112.114	BLM057	Poorly drained	0	Depressional-Open
BLM058	BLM	Lima Reservoir	8/24/2008	KN	2233	44.735	-112.115	BLM058	Poorly drained	0	Depressional-Open
BLM059	BLM	Lima Reservoir	8/24/2008	KN	2215	44.731	-112.125	BLM059	Poorly drained	1-25%	Slope-Riverine Spring
BLM060	Private/BLM	Lima Reservoir	8/24/2008	KN	2213	44.730	-112.125	BLM060	Poorly drained	26-50%	Slope-Riverine Spring
BLM061	BLM	Lima reservoir	8/25/2008	KN	2195	44.559	-112.119	BLM061	Poorly drained	0	Depressional-Open
BLM062	BLM	Lima Reservoir	8/25/2008	KN	2184	44.572	-112.114	BLM062	Poorly drained	0	Depressional-Open
BLM063	BLM	Lima Reservoir	8/25/2008	KN	2192	44.570	-112.113	BLM063	Poorly drained	0	Depressional-Open
BLM064	BLM	Lima Reservoir	8/25/2008	KN	2137	44.569	-112.121	BLM064	Poorly drained	1-25%	Riverine-Upper Perennial
BLM065	BLM	Lima Reservoir	8/25/2008	KN	2110	44.588	-112.116	BLM065	Moderately well drained	0	Depressional-Open
BLM066	BLM	Lima Reservoir	8/25/2008	KN	2090	44.593	-112.163	BLM066	Poorly drained	1-25%	Riverine-Intermittent
BLM067	BLM	Lima Reservoir	8/25/2008	KN	2076	44.597	-112.172	BLM067	Very poorly drained	1-25%	Slope-Fen
BLM068	BLM	Lima Reservoir	9/25/2008	NB, MB	2100	44.586	-112.147	BLM068	Poorly drained	0	Riverine-Upper Perennial
BLM069	BLM	Lima Reservoir	9/23/2008	NB, MB	2022	44.670	-112.244	BLM069	Very poorly drained	51-75%	Riverine-Lower Perennial
BLM070	Private/BLM	Lima Reservoir	9/24/2008	NB, MB	2019	44.642	-112.138	BLM070	Moderately well drained	1-25%	Riverine-Lower Perennial
BLM071	BLM	Lima Reservoir	9/25/2008	NB, MB	2111	44.581	-112.289	BLM071	Moderately well drained	0	Depressional-Open
BLM072	BLM	Lima Reservoir	9/25/2008	NB, MB	2028	44.593	-112.100	BLM072	Poorly drained	0	Depressional-Open
BLM074	BLM	Lima Reservoir	9/24/2008	NB, MB	2012	44.637	-112.165	BLM074	Poorly drained	0	Riverine-Lower Perennial
BLM075	BLM	Lima Reservoir	9/24/2008	NB. MB	2020	44.646	-112.067	BLM075	Very poorly drained	0	Riverine-Lower Perennial
BLM077	Private/BLM	Lima Reservoir	9/24/2008	NB, MB	2019	44.633	-112.022	BLM077	Poorly drained	51-75%	Riverine-Lower Perennial
BLM078	Private/BLM	Lima Reservoir	9/23/2008	MB, NB	2284	44.725	-112.309	BLM078	Moderately well drained	0	Riverine-Upper Perennial
BLM079	BLM	Lima Reservoir	9/23/2008	NB, MB	2263	44.731	-112.275	BLM079	Poorly drained	1-25%	Riverine-Upper Perennial
BLM080	BLM	Lima Reservoir	9/23/2008	MB, NB	2191	44.728	-112.284	BLM080	Poorly drained	0	Depressional-Open
BLM081	BLM	Lima Reservoir	9/23/2008	MB, NB	2210	44.727	-112.288	BLM081	Poorly drained	1-25%	Riverine-Upper Perennial

Site ID	Ownership	5th Code HUC	Visit-Date	Assessed-By	Elevation (m)	Latitude	Longitude	Site_ID	Drainage	Water	Hydrogeomorphic Type
BLM082	BLM	Lima Reservoir	9/23/2008	NB, MB	2215	44.732	-112.282	BLM082	Moderately well drained	1-25%	Riverine-Intermittent
BLM083	DNRC/BLM	Lima Reservoir	9/23/2008	MB, NB	2261	44.725	-112.294	BLM083	Poorly drained	1-25%	Riverine-Intermittent
BLM084	BLM	Blacktail Deer Creek	9/23/2008	NB, MB	2205	44.746	-112.293	BLM084	Poorly drained	1-25%	Riverine-Upper Perennial
BLM086	Private/BLM	Lima Reservoir	9/24/2008	NB	2012	44.639	-112.148	BLM086	Very poorly drained	0	Riverine-Lower Perennial
BLM087	BLM	Lima Reservoir	18991230	NB, MB	2026	44.610	-112.173	BLM087	Moderately well drained	0	Depressional-Open
BLM088	BLM	Lima Reservoir	9/24/2008	NB, MB	2020	44.635	-112.025	BLM088	Poorly drained	1-25%	Riverine-Lower Perennial
BLM090	BLM	Lima Reservoir	9/25/2008	NB, MB	2035	44.588	-112.287	BLM090	Poorly drained	26-50%	Slope-Open Spring
BLM091	BLM	Lima Reservoir	9/25/2008	NB, MB	2037	44.589	-112.282	BLM091	Very poorly drained	76-100%	Slope-Open Spring
BLM092	BLM	Lima Reservoir	9/24/2008	NB, MB	0	44.645	112.059	BLM092	Poorly drained	0	Riverine-Lower Perennial
BLM093	Private/BLM	Lima Reservoir	6/23/2008	LV	2092	44.725	-112.056	BLM093	Poorly drained	1-25%	Slope-Open Spring
BLM094	BLM	Lima Reservoir	6/23/2008	LV	2096	44.728	-112.055	BLM094	Moderately well-drained	0%	Riverine-Upper Perennial
BLM095	BLM	Lima Reservoir	6/24/2008	LV	2051	44.735	-112.028	BLM095	Poorly drained	1-25%	Depressional-Open
BLM096	BLM	Lima Reservoir	6/24/2008	LV	2140	44.736	-112.026	BLM096	Very poorly drained	1-25%	Slope
BLM097	BLM	Lima Reservoir	6/25/2008	LV	2109	44.734	-112.046	BLM097	Moderately well-drained	1-25%	Riverine-Upper Perennial
BLM098	BLM	Lima Reservoir	6/25/2008	LV	2116	44.737	-112.032	BLM098	Moderate well-drained	0%	Riverine-Upper Perennial
BLM099	BLM	Lima Reservoir	6/25/2008	LV	2116	44.734	-112.066	BLM099	Very well drained	0%	Depression-Open
BLM100	BLM	Lima Reservoir	6/25/2008	LV	2140	44.734	-112.052	BLM100	Moderate well-drained	0%	Depressional-Open
RRL01	USFWS	Red Rock Lakes	8/3/2008	NB, KN	2021	44.627	-111.810	RRL01	Very poorly drained	1-25%	Lacustrine Fringe
RRL02	USFWS	Red Rock Lakes	8/3/2008	NB, KN	2023	44.628	-111.807	RRL02	Very poorly drained	26-50%	Lacustrine Fringe
RRL03	USFWS	Red Rock Lakes	8/3/2008	KN, NB	2020	44.627	-111.807	RRL03	Poorly drained	0	Lacustrine Fringe
RRLA1	USFWS	Red Rock Lakes	8/1/2008	KN, NB	2023	44.633	-111.760	RRLA1	Very poorly drained	26-50%	Lacustrine Fringe
RRLA10	USFWS	Red Rock Lakes	7/29/2008	KN, NB	2032	44.663	-111.735	RRLA10	Moderately well drained	0	Depressional-Open
RRLA11	USFWS	Red Rock Lakes	7/28/2008	KN, NB	2149	44.599	-111.851	RRLA11	Moderately well drained	0	Riverine-Intermittent
RRLA12	USFWS	Red Rock Lakes	7/29/2008	NB, KN	2028	44.643	-111.678	RRLA12	Moderately well drained	0	Depressional-Open
RRLA13	USFWS	Red Rock Lakes	8/1/2008	KN, NB	2039	44.625	-111.638	RRLA13	Moderately well drained	0	Depressional-Open
RRLA14	USFWS	Red Rock Lakes	7/29/2008	KN, NB	2028	44.652	-111.704	RRLA14	Poorly drained	0	Depressional-Open
RRLA15	USFWS	Red Rock Lakes	7/29/2008	KN, NB	2032	44.657	-111.718	RRLA15	Moderately well drained	0	Depressional-Open
RRLA16	USFWS	Red Rock Lakes	7/29/2008	KN, NB	2026	44.646	-111.766	RRLA16	Moderately well drained	0	Depressional-Open
RRLA18	USFWS	Red Rock Lakes	8/3/2008	NB, KN	2040	44.599	-111.798	RRLA18	Poorly drained	26-50%	Riverine-Lower Perennial
RRLA19	USFWS	Red Rock Lakes	8/4/2008	KN, NB	2024	44.593	-111.748	RRLA19	Very poorly drained	1-25%	Depressional-Open
RRLA2	USFWS	Red Rock Lakes	8/1/2008	KN, NB	2023	44.632	-111.762	RRLA2	Very poorly drained	0	Lacustrine Fringe
RRLA3	USFWS	Red Rock Lakes	8/1/2008	NB, KN	2020	44.635	-111.768	RRLA3	Very poorly drained	26-50%	Lacustrine Fringe
RRLA5	USFWS	Red Rock Lakes	8/3/2008	KN, NB	2019	44.626	-111.810	RRLA5	Very poorly drained	0	Lacustrine Fringe
RRLA6	USFWS	Red Rock Lakes	8/3/2008	NB, KN	2024	44.628	-111.793	RRLA6	Moderately well drained	0	Depressional-Open
RRLA7	USFWS	Red Rock Lakes	7/29/2008	KN, NB	2027	44.655	-111.779	RRLA7	Moderately well drained	0	Depressional-Open
RRLA8	USFWS	Red Rock Lakes	8/1/2008	KN, NB	2045	44.616	-111.630	RRLA8	Poorly drained	0	Riverine-Lower Perennial
RRLA9	USFWS	Red Rock Lakes	7/29/2008	NB, KN	2034	44.667	-111.717	RRLA9	Moderately well drained	0	Depressional-Open

Appendix C-2. PFC and EIA Scores

SITE ID	RANKING (N/A =Not assessed with this Protocol)	TREND IF FAR	FACTORS OUTSIDE BLM CONTROL?	FACTORS	EIA SCORE (N/A =Not assessed with this Protocol)
BLM001	PFC				B
BLM002	PFC				B
BLM003	PFC				B
BLM004	PFC				A
BLM005	PFC				A
BLM006	PFC				A
BLM007	NF				B
BLM008	PFC				A
BLM009	FAR	D	No		B
BLM010	PFC				A
BLM011	FAR	D	No		B
BLM012	PFC				B
BLM013	FAR	D	No		B
BLM014	PFC				A
BLM015	PFC				A
BLM016	PFC				A
BLM017	N/A				A
BLM018	N/A				C
BLM019	FAR	D	No		B
BLM020	PFC				A
BLM021	PFC				B
BLM022	PFC				A
BLM023	PFC				N/A
BLM024	PFC				A
BLM025	N/A				B
BLM026	PFC				C
BLM027	FAR	D	No		B
BLM028	FAR	D	No		B
BLM029	PFC				A
BLM030	PFC				B
BLM031	PFC				A
BLM032	FAR	D	No		B
RRL03	PFC				A
BLM033	NF				B
BLM034	PFC				N/A
BLM035	NF				C
BLM036	PFC				N/A
BLM037	FAR	D	No		N/A

SITE ID	RANKING (N/A =Not assessed with this Protocol)	TREND IF FAR	FACTORS OUTSIDE BLM CONTROL?	FACTORS	EIA SCORE (N/A =Not assessed with this Protocol)
BLM038	PFC				B
BLM039	PFC				A
BLM040	N/A				B
BLM042	FAR	D	No		B
BLM043	N/A				A
BLM044	N/A				A
BLM046	N/A				A
BLM047	FAR	D	No		B
BLM048	N/A				B
BLM049	FAR	D	No		B
BLM050	NF				C
BLM051	N/A				A
BLM052	NF				C
BLM053	NF				C
BLM054	PFC				A
BLM055	PFC				A
BLM056	N/A				B
BLM057	PFC				B
BLM058	FAR	D	No		C
BLM059	N/A				B
BLM060	N/A				A
BLM061	PFC				A
BLM062	PFC				N/A
BLM063	PFC				N/A
BLM064	PFC				A
BLM065	NF				B
BLM066	PFC				A
BLM067	PFC				A
BLM068	FAR	UNK	No		B
BLM069	PFC				A
BLM070	PFC				B
BLM071	PFC				B
BLM072	FAR	UNK	Yes	Road encroachment	B
BLM074	PFC				N/A
BLM075	PFC				A
BLM077	FAR	D	Yes	Dredging	B
BLM078	PFC				B
BLM079	PFC				A

SITE ID	RANKING (N/A =Not assessed with this Protocol)	TREND IF FAR	FACTORS OUTSIDE BLM CONTROL?	FACTORS	EIA SCORE (N/A =Not assessed with this Protocol)
BLM080	FAR	D	No		B
BLM081	PFC				A
BLM082	PFC				B
BLM083	PFC				A
BLM084	PFC				B
BLM086	PFC				N/A
BLM087	PFC				N/A
BLM088	FAR	UNK	No		B
BLM090	FAR	D	No		B
BLM091	PFC				A
BLM092	PFC				A
BLM093	FAR	D	Yes	Private land activities	C
BLM094	PFC				B
BLM095	PFC				B
BLM096	FAR	D	No		C
BLM097	PFC				B
BLM098	PFC				B
BLM099	PFC				B
BLM100	PFC				B
RRLA1	PFC				A
RRLA10	PFC				A
RRLA11	PFC				B
RRLA12	PFC				A
RRLA13	FAR	D	No		B
RRLA14	PFC				A
RRLA15	PFC				B
RRLA16	PFC				A
RRLA18	PFC				B
RRLA19	PFC				A
RRLA2	PFC				A
RRLA3	PFC				A
RRLA5	PFC				A
RRLA6	FAR	D	Yes	Drought	B
RRLA7	PFC				A
RRLA8	PFC				A
RRLA9	PFC				B
RRL01	PFC				A
RRL02	PFC				A

Appendix C-3. Site Comments

Site_ID	Site Description
BLM000	Wetland on edge of small lake
BLM001	Wetland is site of former beaver activity, lots of downed wood, some beaver shews evident
BLM002	Site overgrazed wet meadow
BLM003	Wet meadow
BLM004	Site is wet, meadow in drainage
BLM005	Wet meadow along river
BLM006	Wet meadow adjacent to stream channel
BLM007	Meadow
BLM008	Wet meadow adjacent to Red Rock River
BLM009	Heavily grazed, site N side of Mud Lake, severe pugging, erosion of north shore likely restricts water from upland
BLM010	Wet meadow along intermittent stream
BLM011	Wet meadow has severe hummocking
BLM012	Small mesic meadow influenced by the road, weedy, meadow fed by at least one stream
BLM013	Wet meadow with severe hummocking
BLM014	Wetland part of Red Rock River floodplain
BLM015	Mesic meadow, follows intermittent stream, channel was flowing
BLM016	Wet meadow adjacent to perennial stream
BLM017	Small, flowing perennial stream
BLM018	Dry stream channel, an intermittent trib. of Price Creek, blocked by some sort of diversion
BLM019	Heavily grazed, wetland adjacent to Mud Lake
BLM020	Large wetland, 1.5km NE of Mud Lake, connected to Mud Lake hydrologically, high water in past spring
BLM021	Site is old beaver pond, with dam to the N.
BLM022	Meadow connected hydrologically to Sand Creek/Mud Lake
BLM023	Western portion is more of a wet meadow veg.
BLM024	Meadow very hummocked, no true hydrophytes present
BLM025	Site along Peet Creek, weedy, old 2-track road to the W
BLM026	Wetland is a small depression, very few hydrophytes
BLM027	Drainage of Red Rock River
BLM028	Wet meadow has standing water, cows present and have been loafing in water, severe pugging
BLM029	Narrow transitional meadow
BLM030	Wetland small depression, likely receives most of its water from surface run-off
BLM031	
BLM032	Wetland part of large depression-wet meadow with standing water at W end, adjacent to drainage
BLM033	Wetland is intermittent stream S of Lima Reservoir, severe hummocking has allowed for ARTCAN establishment
BLM034	Wetland is dried mudflat just S of large “slough” S of Lima Reservoir
BLM035	Wetland part of intermittent stream, cattle loaf in water

Site_ID	Site Description
BLM036	
BLM037	Wetland is small pond S of Shineberger Creek, N of Lima Reservoir
BLM038	Wetland is small pond-wilderness study area
BLM039	Wetland is small pond in wilderness study area
BLM040	Site is Corral Creek
BLM042	Heavily grazed and very weedy
BLM043	Site is along Corral Creek
BLM044	Corral Creek
BLM046	Corral Creek
BLM047	Wetland is on a trib. of Wolverine Creek, may have been a beaver pond, severe pugging and hummocking from cows
BLM048	Evidence of very old beaver chews, entire area may have been influenced by beaver, but no current signs
BLM049	Wetland along trib. of Wolverine Creek, severe pugging and hummocking from cows, may have been beaver pond long ago
BLM050	Wetland along trib. of Wolverine Creek, site is drying 2-track on W side limiting the stream, no true channel
BLM051	Site along West Creek, signs of old beaver activity
BLM052	Site is historic wet meadow, but likely not flooded during season
BLM053	Upper end of West Creek, site may have been old beaver pond, but has not been inundated for years, willows heavily browsed with no regen., site is heavily grazed
BLM054	Small pond created by beaver, beaver dam not active, watersource spring from intermittent stream.
BLM055	Along West Creek
BLM056	Site is a section in Middle Creek, 2-track rd. through site, veg. heavily grazed, cutbanks severe
BLM057	Small wet meadow on S side of fence line
BLM058	Small toe-slope wetland, severely hummocked and degraded by cattle and 2-track rd.
BLM059	Site is small toe-slope, spring-fed drainage
BLM060	Did not cross fence
BLM061	
BLM062	Wetland is in forked drainage, sodic soils
BLM063	Wetland is small depression, sodic soils
BLM064	Site is small drainage, signs of cattle-trails and hummocking
BLM065	Small toe-slope wetland, .75 miles to S of southside of Centennial Rd.
BLM066	Small intermittent stream\
BLM067	Site is along intermittent stream, lots of moss
BLM068	Depressional wetland, part of site excavated to create cattle pond-pond is pugged and mostly bare, berm to N of site restricting most water outflow
BLM069	Depressional wetland, stream running through site, grazed, hummocking.
BLM070	Wet meadow bordering Red Rock River, weedy, grazed

Site_ID	Site Description
BLM071	Open depression N of S. Centennial Rd., weedy, good interspersion, hummocking, grazed
BLM072	Depressional wetland along S. Centennial Rd., deep hummocking seems to cause water pooling/channeling, culvert present under rd.
BLM074	Floodplain adjacent to Red Rock River, inundated temporarily, dry by Sept., pugged by cattle
BLM075	Oxbow of Red Rock River, grazed, hummocking deep in site and buffer
BLM077	Recently dredged, moved soil spread and compacted along outer channel perimeter, severe-ly grazed, channel pugged by cattle, hummocking present
BLM078	Stream adjacent, grazed, grasses trampled and flattened
BLM079	Stream in valley atop hills, emergents growing 0-5m away from stream
BLM080	Wet meadow on slope of hill, medium hummocking, grazed, area probably saturated in spring, though not currently
BLM081	Stream wetland between two hills, good diversity, but hummocking in/around stream caus-ing altered water flow patterns, grazed
BLM082	Wet meadow, stream on W edge of site maintains good wetland indicator plant diversity, grazed
BLM083	Hummocking present along stream and downhill area, grazed
BLM084	Rd. along N side of site
BLM086	Large floodplain, probably mostly inundated earlier in the year, saline indicators present
BLM087	Open depression more of a transitional meadow/mesic wet meadow, hummocking present and may be worse due to cattle
BLM088	Heavily grazed, severe hummocking in and adjacent to site
BLM090	Spring stream at base of southern hills feeds site, opens into valley with aquatic bed and emergent veg, grazed, hummocking present
BLM091	Open depression wetland, surrounded by dry, hummocked upland (40-50% bare ground), water present in Sept., lots of mass growing among hummocks, water flows out to S.
BLM092	Oxbow of Red Rock River. Pugging/hummocking extensive in some areas. Good intersper-sion.
BLM093	Slope wetland with peat formation; area immediately east of fence has been destroyed by cattle. Adjacent area denuded, deeply hummocked. Probably affecting hydrology in site.
BLM094	Good mesic/wet meadow on floodplain of Long Creek; grazing minimal but corrals nearby. Soils undisturbed. Some redox features suggest periodic high water tables.
BLM095	Appears to be drying; some soil saturation, considerable redox evidence and areas of deep organic matter. Cattle trails in and out but little pugging.
BLM096	Saturated soils and peat formation, amphibian breeding observed, tadpoles evident. Exten-sive pugging and hummocking by cattle breaking down structure and draining wetland.
BLM097	Very good riparian/PSS site with dense cover, little evidence of grazing, well-vegetated banks, considerable structural diversity. Depth to water <20", good hydric indicators
BLM098	Good riparian wet meadow, high plant diversity with lots of FACW, little evidence of graz-ing except moose, good bank stability and soils.
BLM099	Wet meadow in small depression. Multiple seeps in area. Soils loamy clay. Gleying evident in pit; seasonally flooded depression in mesic uplands.

Site_ID	Site Description
BLM100	Wet meadow in depression amidst alluvial fans. Lightly grazed in 2007. Soils undisturbed. Plant community indicates more grazing in past years.
RRL01	Extensive marsh SE of lower Red Rock Lake-small ponds
RRL02	Extensive marsh-small aquatic bed sites
RRL03	Extensive marsh
RRLA1	Extensive CARUTR marsh
RRLA10	Large wet meadow N of upper Red Rock Lake, N of large ditch
RRLA11	Oped forest, small intermittent stream, cattle present, weedy, old earthen berm to form cattle pond no longer functioning
RRLA12	Large wet meadow N of upper Red Rock Lake
RRLA13	"South Tucks Pond"- Ducks Unlimited "enhancement" project, rarely holds water
RRLA14	Small depression surrounded by wet meadow
RRLA15	Wet meadow on south side of "Pintail Ditch"- heavily grazed by cattle this year (very recent, within past 2 weeks), lots of moss
RRLA16	Large wet meadow
RRLA18	Odell Creek
RRLA19	Artificial pond
RRLA2	Drier end of marsh, mesic meadow within 20m
RRLA3	Extensive marsh border the Red Rock Lakes system, small pond within marsh
RRLA5	Extensive marsh, Boreal chorus frogs everywhere, small pond within marsh
RRLA6	Mesic wet meadow
RRLA7	Wet meadow, plant spp. associated with cattle grazing. Natural hummocking present, plus some due to livestock grazing.
RRLA8	Riparian area-wet meadow, very weedy
RRLA9	Small wet meadow site adjacent to Centennial Sandhills

Appendix D. Species Richness at BLM Sites

SiteID	Number of Species		SiteID	Number of Species
BLM000	4		BLM039	12
BLM001	32		BLM040	14
BLM002	17		BLM042	8
BLM003	15		BLM043	19
BLM004	16		BLM044	15
BLM005	26		BLM046	13
BLM006	25		BLM047	3
BLM007	11		BLM048	8
BLM008	26		BLM049	7
BLM009	8		BLM050	6
BLM010	32		BLM051	4
BLM011	15		BLM052	10
BLM012	28		BLM053	7
BLM013	18		BLM054	3
BLM014	24		BLM055	26
BLM015	39		BLM056	11
BLM016	28		BLM057	10
BLM017	34		BLM058	6
BLM018	12		BLM059	5
BLM019	29		BLM060	9
BLM020	7		BLM061	17
BLM021	21		BLM062	11
BLM022	11		BLM063	12
BLM023	18		BLM064	15
BLM024	9		BLM065	5
BLM025	41		BLM066	10
BLM026	10		BLM067	9
BLM027	22		BLM068	7
BLM028	9		BLM069	11
BLM029	10		BLM070	15
BLM030	10		BLM071	18
BLM031	8		BLM072	17
BLM032	14		BLM073	5
BLM033	7		BLM074	11
BLM034	2		BLM075	11
BLM035	5		BLM077	8
BLM036	3		BLM078	14
BLM037	5		BLM079	13
BLM038	7		BLM080	9

SiteID	Number of Species		SiteID	Number of Species
BLM081	13		BLM092	16
BLM082	17		BLM093	24
BLM083	20		BLM094	19
BLM084	26		BLM095	22
BLM086	23		BLM096	18
BLM087	11		BLM097	29
BLM088	12		BLM098	24
BLM090	20		BLM099	22
BLM091	12		BLM100	18