



CHANGES TO THE COKEVILLE MEADOWS NWR ECOSYSTEM

This study obtained information on contemporary: 1) physical features, 2) land use and management, 3) hydrology, 4) vegetation communities, and 5) fish and wildlife populations of Cokeville Meadows NWR and the surrounding region where it was available. This information chronicles the history of land and ecosystem changes at and near the refuge from the Presettlement period and provides perspective on when, how, and why alterations have occurred to ecological processes in the NWR and surrounding lands. Data on chronological changes in physical features and land use/management of the region are most available and complete (e.g., NWR annual narratives, sequential aerial photographs, etc.) while data documenting changes in fish and wildlife populations generally are limited.

Meadows region (USFWS 1992). Early people in the region subsisted largely by hunting and gathering and probably had little influence on ecosystem processes or attributes other than to occasionally set fires in grasslands (Thompson and Pastor 1995).

The first European occupancy of the region began with Robert Stuart and the Astorians in 1812, followed by the Ashley explorations in 1823 (USFWS 1992). Early explorations and abundant furbearing mammals in the Bear River Valley led to expansion of trapping and enabled scattered settlements in the region were established from 1824 to 1840. Contemporary towns and river/reservoirs in southwestern Wyoming such as Bridger, Sublette, Fontanelle, La Barge, and Smith were named after early trappers (Haines 1996). From 1840 to 1869, larger numbers of European emigrants moved through the Bear Valley

SETTLEMENT AND LAND USE CHANGES

Native people apparently occupied the Cokeville Meadows region at various times over the past 10-12,000 years (Thompson and Pastor 1995). The “Shoshonean” Native American culture was present in the region up to the time of early exploration and occupancy of the area by European emigrants in the early to mid 1800s. The combined riverine and adjacent upland topography and diverse and seasonally productive plant and animal communities attracted historic people to the Bear River Valley. Considerable archeological evidence documents extensive settlement and seasonal camp sites in the Cokeville

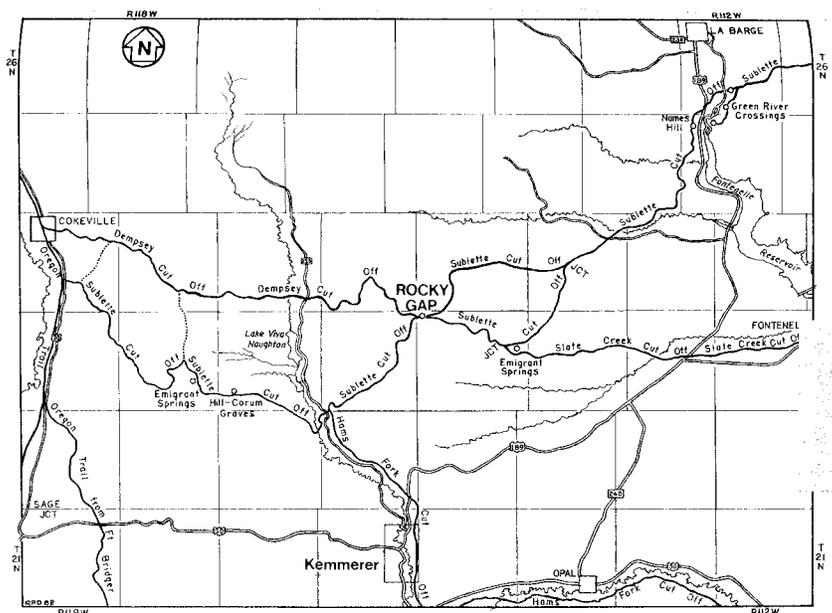


Figure 18. Map of Oregon Trail segments at and near Cokeville Meadows.

in westward migration to the Oregon Territory and the Pacific region along what became the Oregon Trail. Segments of the Oregon Trail pass through the acquisition boundary of Cokeville Meadows NWR (Fig. 18). The Oregon Trail entered what is now the south acquisition boundary adjacent to the Bear River and ran parallel to the river up to the present B-Q Dam. Then the trail continued north between the McFarland and Twin Creek irrigation ditches to near Big Knob. Then the trail turned northeast to a point along U.S. Highway 30 near Antelope Creek. A second major entry point of the Oregon Trail into the Bear River Valley was by way of the "Sublette Cutoff" (Fig. 18). This major shortcut to the main Oregon Trail entered the valley from the Ham's Fork River Plateau and either intersected the main Oregon Trail where Sublette Creek meets Highway 30 about three miles south of Cokeville or entered Cokeville directly from the east (Fig. 18).

In 1847, the first Mormon emigrants began moving into the region enroute to the Great Salt Lake region. Most emigrants during this time simply passed through the Bear River Valley and true settlements in the Bear River Valley did not begin until the completion of the transcontinental railroad in 1869. Subsequent settlement by Mormons' in the Bear River Valley established ranching in the area. The completion of the Oregon Shortline Railroad through the Bear River Valley near Cokeville, WY in 1882 permanently established occupancy in the region (Strack 2006). The town of Cokeville was established in 1874.

The settlement chronology of the Cokeville Meadows region suggests little ecological change from European human causes occurred in the region until the late 1800s. Even then the sparse human population, limited growing season, and small infrastructure apparently limited ecosystem changes to the area, except for early diversions of water for human and livestock use and eventually more extensive grazing (Young 1899, Veatch 1907). Lincoln County, WY, where Cokeville Meadows NWR is located, had fewer than 16,000 people by the late 1980s. Nearly 80% of Lincoln County currently is in public ownership, the largest percentage (nearly 50%) being owned by the U.S. Bureau of Land Management. Eventually, a network of road/highway and railroad lines transected the Cokeville region; U.S. Highway 30 forms the eastern boundary of the refuge. The region also has become laced with utility and pipeline corridors, including several lines within Cokeville Meadows NWR. The economy of

the Cokeville area has historically been dominated by agricultural interests, mostly related to livestock production (Veatch 1907).

HYDROLOGICAL AND VEGETATION COMMUNITY CHANGES

The early development of the Cokeville Meadows NWR region included construction of transportation corridors along the edges of the Bear River Valley. Highways, roads, and railroads were developed in the region in the late 1800s and changed the way that water moved into floodplains from the east and west. These barriers to water movement eventually led to changes in topography and local erosion and sedimentation. Water and sediment changes altered the extensive coalescing alluvial fan system on the east side of the Bear River Valley near Cokeville Meadows NWR where the railroad and U.S. Highway 30 are located. Water entry into the floodplain now is restricted to specific locations that changed the pattern of water and sediment distribution compared to historic conditions.

The combination of irrigation development and land use changes beginning in the early 1900s greatly altered hydrology in the Bear River Valley and its floodplains. The most important of these changes was construction of a network of dams, ditches, small levees/dikes, and water-control structures that diverted Bear River (and tributary) flows into floodplain areas for agricultural and urban uses. The first major diversion of Bear River water near Cokeville Meadows NWR was construction of the Pixley Dam across the Bear River channel soon after water rights in Wyoming were adjudicated at the time of statehood. Most additional water diversion structures were constructed in the 1930s and 1940s to move water onto wet meadow/grassland habitats in the floodplain to enhance forage and hay production during summer. The last major dam development on the Bear River was a reconstruction of the B-Q Dam in 1968. Typically, the low-level dams on the Bear River allow local ranchers to divert water into contour distribution ditches that branch from the diversion site and overflow onto relatively flat floodplain grassland and meadow areas. By 1998 about 70% of land within the Cokeville Meadows NWR acquisition boundary was irrigated (Fig. 19). After water is moved to grassland and meadow areas, surface water gradually evaporates and lands dry so that hay can be harvested in late summer and

early fall. Some irrigated areas also support cow-calf operations and pastureland.

Early diversion and delivery of irrigation water to individual ranchers required the formation of corporations to operate and maintain water delivery systems and infrastructure (Wyoming Water Development Commission 2001). Since territorial times, many irrigation companies and sub companies have been formed along the Bear River. Most of these companies are incorporated as nonprofit organizations and water is delivered on a rotational basis or to the user on demand. Water users in the Cokeville Meadows region depend on four principal points of diversion for their water supply. These are the Woodruff Narrows Reservoir, B-Q Dam, and Pixley Dam on the Bear River and the Covey Canal on the Smith's Fork River. Major diversion canals/ditches from the Bear River include, in a downstream order, the B-Q West Slough, McFarland Ditch, and B-Q Eastside Ditch above the B-Q Dam; Pixley Ditch above Pixley Dam, and the Cook Canal. The major diversion ditch on the Smith's Fork River is the Covey Canal. Currently, over 100 miles of ditches exist in the Bear River Valley in the vicinity of Cokeville Meadows NWR. Irrigation companies historically associated with these supply systems included the Woodruff Narrows Company, Beckwith-Quinn Canal Company, West Side Canal Company, Pixley Canal Company, Covey Canal Company, Mau Canal Company, and the Smith's Fork Irrigation District. The Beckwith-Quinn and Pixley Canal Companies no longer exist and the Mau and Covey Canal Companies are now incorporated into the Smith's Fork Irrigation District.

Over 100 groundwater wells have been drilled in the Bear River Valley in the Cokeville Meadows NWR region and they supply water for agricultural and urban uses (Fig. 19). Ten of these wells are located on Cokeville Meadows NWR lands. Pumping from the alluvial aquifer in the Cokeville Meadows area reduces flow in the Bear River (Franz 2005).

In years when Bear River stream flow is below average, about 84% of water pumped from existing wells is derived from water that otherwise would have seeped in the Bear River. About 16% of this is directly used by floodplain wetland and meadow plants (Glover 1990). The largest reduction in Bear River flow caused by well extraction of groundwater occurs during August, which corresponds with the period of maximum pumping for alfalfa and small grain production. The amount of groundwater pumped is relatively small compared to total groundwater discharge into the Bear River, but undoubtedly has some effect on instream flow attributes of the Bear River in late summer. Simulation models of this

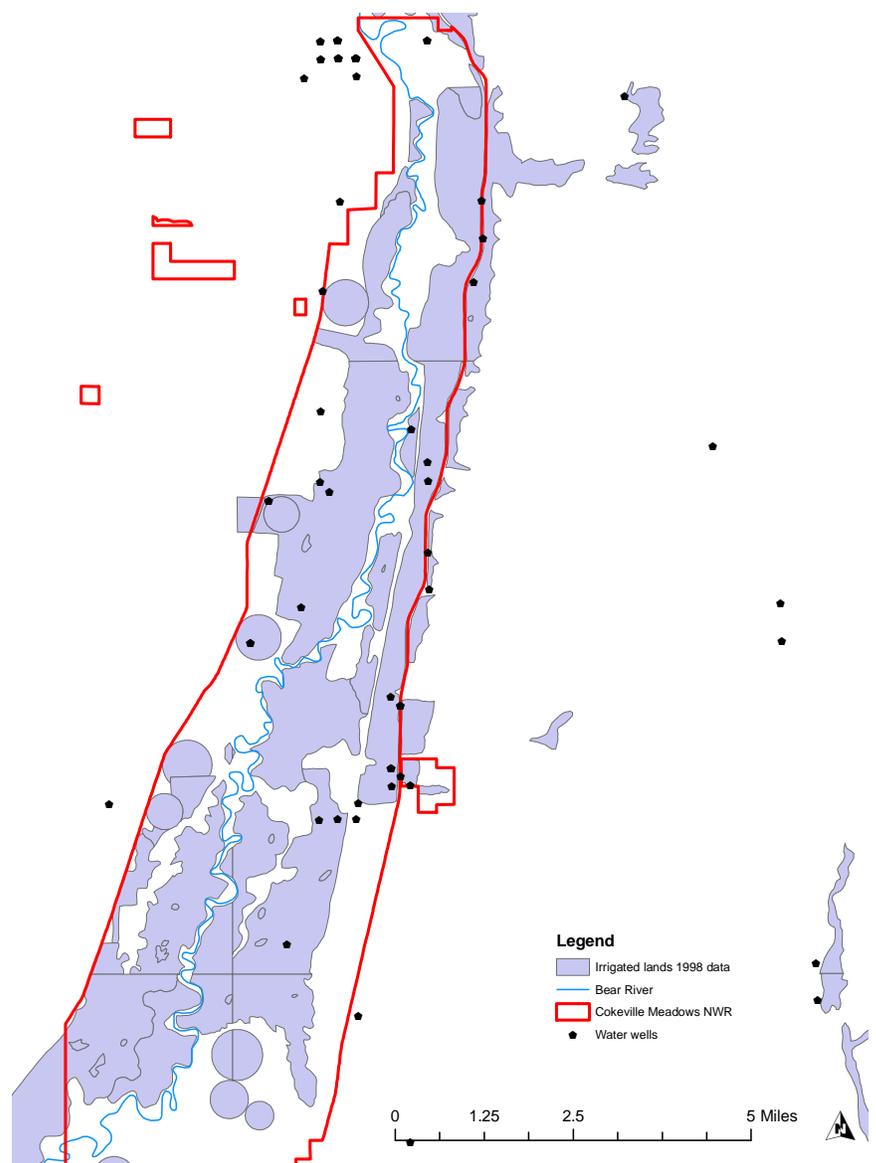


Figure 19. Location of irrigated lands and wells in the Cokeville Meadows region in 1998.

effect indicate that stream flow would be reduced by about 3.4 ft³/second during August with carryover of about 0.5 ft³/second to the following years irrigation season (Glover 1990).

In 1993, total water use in Lincoln County, Wyoming was about 405,000 Mgal (million gallons) (Ogle et al. 1996). Shallow ground water wells supplied most public-supply water for domestic, commercial, and industrial uses. Surface water supplied an estimated 153,000 Mgal of the total estimated 158,000 Mgal used for irrigation of hay, pasture, and crop lands. Livestock water use was only 203 Mgal and mining used about 153 Mgal (Ogle et al. 1993).

Floodplain topography and drainage systems, including depressions and abandoned channels in the Cokeville Meadows NWR area, have been altered by culvert and bridge crossings, railroad beds, and

some channelization of tributaries. Overall, the fluvial system of the Bear River has been altered by historic land use changes throughout its watershed. These fluvial changes have caused altered ground and surface water hydrological regimes, increased sediment loading and coliform contamination of surface waters, and altered vegetation communities (e.g., Smith and Maderick 1993). The valleys and lower hill slopes near Cokeville Meadows NWR have been extensively grazed and farmed for several decades; higher elevation valleys and mountains also have been extensively grazed and are partly deforested.

Current land use in the Cokeville Meadows NWR acquisition boundary is dominated by shallowly flooded wet meadow habitats in the floodplain and sagebrush-grassland habitats on alluvial fans and upland terraces (Fig. 20). Nearly 4,000 acres of mostly terrace and alluvial fan areas have been converted to irrigated cropland and alfalfa fields. About 2,100 acres in the Cokeville Meadows NWR acquisition boundary are in deeper “wetland” depressions and abandoned channel areas in the floodplain.

A set of “seniority rights” govern water use in the Bear River Valley during limited water periods; these being adjudicated at the time of Wyoming statehood. Other additional water rights have not been adjudicated, but are in good standing, including pumping of groundwater for irrigation, using center-pivot or roller irrigation structures. All water management and uses of water in the Bear River Basin are governed by the Bear River Compact, which determines water rights and obligations in Wyoming, Idaho, and Utah with respect to Bear River water (Jibson 1991). The original Compact was signed in 1958 and was amended by Congress in 1980. The Bear River Commission administers the Compact and water rights within each state are adjudicated and administered in accordance with state law subject to limitations in the Compact. In the 1980s proposals were advanced to construct water storage reservoirs on the Smith’s Fork River, but these were not built because of inadequate economic benefits.

Currently, 50 separate water rights are present on Cokeville Meadows NWR lands. These water rights historically were present

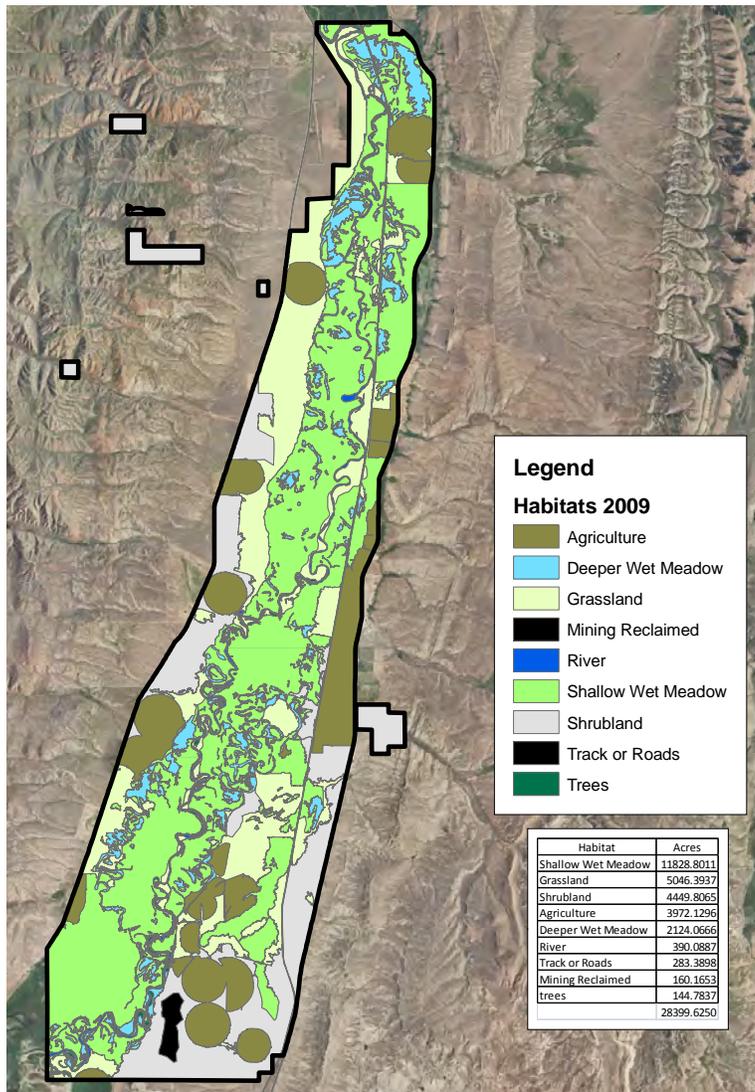


Figure 20. Map of habitat types present in 2009.

on lands acquired or now in NWR management (Appendix B). The earliest water rights on Cokeville Meadows NWR lands date to 1880 and provide use of Bear River water via the Pixley Irrigation Ditch.

Irrigation of meadows and other floodplain areas within the Cokeville Meadows NWR acquisition boundary is accomplished by inserting boards into the B-Q and Pixley water-control structures in early summer, both of which span the entire Bear River channel. Bear River water then backs up behind the structures and is diverted into irrigation ditches on both sides of the river. These ditches include larger distribution ditches that are 3-4 feet deep and several feet wide and small terminal ditches that may be only a foot or so deep. Select primary ditches, levees, and water-control structures along with other water management features on existing Cokeville Meadows NWR lands are shown in Fig. 21. Flow in the major ditches is monitored daily. At the end of the irrigation season, usually on 10 July, the boards are removed from the B-Q and Pixley dams and surface water drains back into canals and ditches (and back into the Bear River), infiltrates into the alluvial groundwater, or evaporates. Concurrently with removal of boards in the B-Q and Pixley dams, surface water is drained from fields and floodplain wetlands/depressions (including abandoned Bear River channels and oxbows) by removing dirt plugs or opening small water-control structures in individual fields/sites. Fields are allowed to dry until about 1 August when the wet meadow hay is cut and harvested. Only one cutting of hay is harvested due to the short growing season. In most years, over 70% of seasonally flooded acres become dry enough to harvest hay in late summer. The meadows typically then are used for pasture during late summer and fall. The only exception to this general irrigation pattern is continued irrigation of alfalfa until about 15 August each year.

Some small grain crops that are grown on higher terrace and alluvial fan elevations are irrigated with ground water pumped into center pivot or roller-type irrigation systems.

Following the development of the irrigation water conveyance systems in the Cokeville Meadows NWR region, beginning in the early 1900s, the seasonal flooding of Cokeville Meadows NWR floodplain habitats became more consistent among years and was extended longer into summer than in historic times. Currently, irrigation flooding of meadows occurs from late April through early July in normal run-off years and the extent of seasonally flooded acres is increased to include almost all lands between

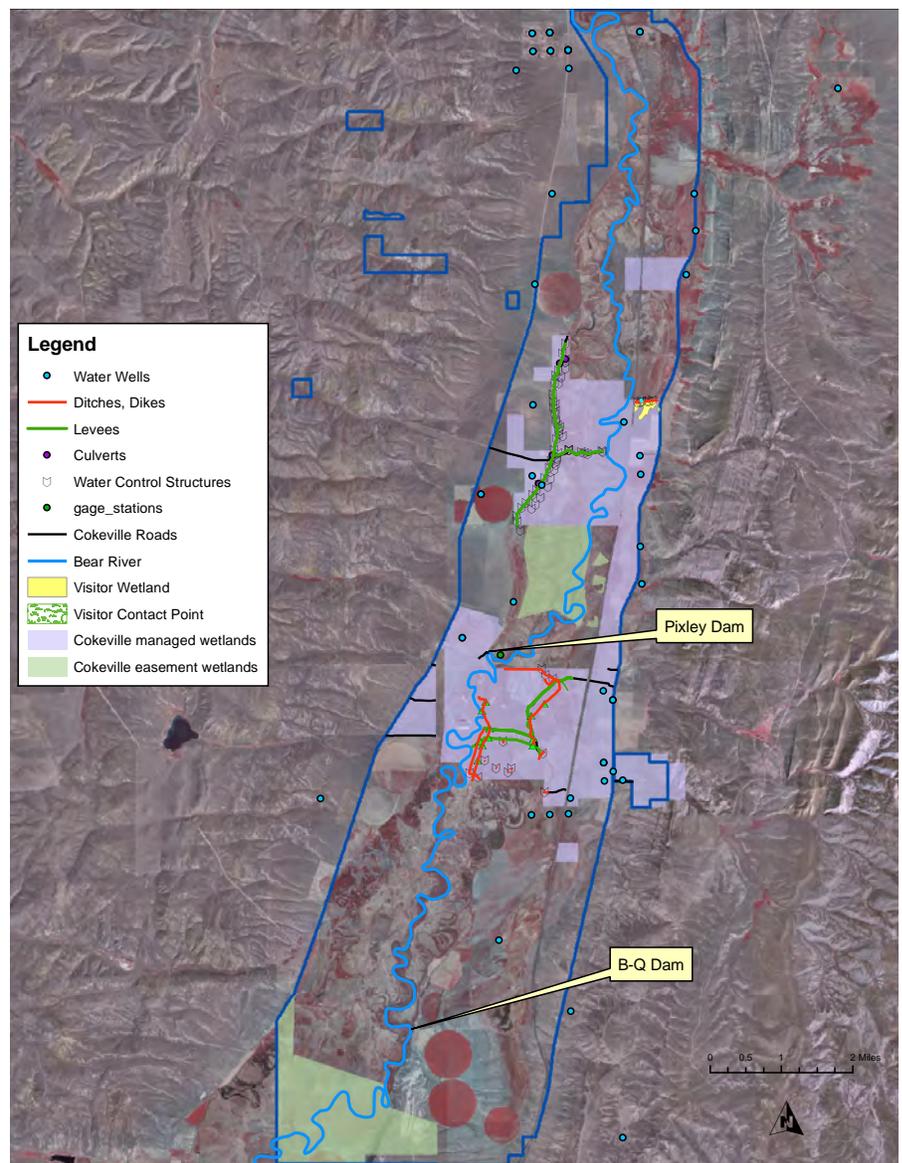


Figure 21. Location of primary water-control structures, ditches and dikes on Cokeville Meadows NWR and the location of managed and easement lands.

the conveyance system and the Bear River (Fig. 19). Consistently extending the period of surface flooding into summer months allowed encroachment of extensive stands of native perennial rushes and sedges into higher elevation meadow areas and also caused expansion of persistent emergent wetland plant species in floodplain depressions and along drainages. The more extensive and prolonged flooding also may have prevented the accumulation of surface alkalinity in some areas and shifted grass and wetland plant species to slightly fresher types. The high water table on the relatively flat floodplain prevented tillage and production of domestic grain crops, but simultaneously created ideal conditions for introduced grasses, especially creeping foxtail (*Alopecurus arundinaceus*) (NRCS 2007). Many canal systems have relatively low gradients and they hold water into the fall, and in some wet years, throughout the year. Therefore, the semipermanently flooded water conditions in canals and associated impounded areas or low depressions, such as abandoned Bear River channels, have become dominated by cattail and bulrush. In addition to more extended summer flooding regimes, the extensive annual haying and grazing in the last 100 years also may have changed the presence and distribution of native meadow and grass species at Cokeville Meadows and concurrently promoted expansion of introduced and invasive plant species.

Over time, several noxious invasive and poisonous plants have become established on or near Cokeville Meadows NWR. Death camas (*Camassia quamash*), tall larkspur (*Delphinium exalatum*), halogeton (*Halogeton glomeratus*), and locoweed (*Oxytropis* sp.) are major poisonous plants in the region. While few livestock deaths attributed to vegetation poisoning have been reported in the area, the potential for poisoning exists if the species are not controlled (USFWS 1992). Predominant invasive noxious plants in the region include Canada thistle (*Cirsium arvense*), whitetop (*Lepidium draba*), musk thistle (*Carduus nutans*), and Russian knapweed (*Centaurea repens*).

ACQUISITION AND DEVELOPMENT OF COKEVILLE MEADOWS NWR

In February 1989, the State of Wyoming Legislature approved an act enabling the USFWS to acquire about 27,000 acres of land south of Cokeville for the establishment of Cokeville Meadows NWR

(USFWS 1992). This Act included a set of conditions to regulate the acquisition process and subsequent management actions; the primary conditions were:

- Acquisition would be limited to 27,000 acres along the Bear River in Lincoln County, south of Cokeville, WY.
- Acquisition would be conducted on a willing seller-willing buyer basis and condemnation would not be used except in a mutually agreed upon title action. Land owners could reserve oil, gas, coal and other mineral rights together with rights of exploration and development.
- State-owned land could be purchased or leased as a refuge for migratory birds with oil, gas, coal and other mineral rights reserved to the state.
- Consent for refuge acquisition was conditional on executing agreements with the Wyoming State Engineer stating that the USFWS would agree to abide by state water law and the Bear River Compact in acquiring and exercising water rights; would not consider the enabling legislation as establishing a reserved water right; would not condemn rights for the NWR; and would address historic use practices.
- Consent for acquisition does not imply consent for development of the NWR.

Immediately after the above Act became effective, the USFWS began negotiation of agreements with the State of Wyoming on water rights and usage and Cokeville Meadows NWR subsequently was established in 1993. The refuge currently contains 9,259 acres in fee title (6,466 acres), conservation easements (1,672 acres), FmHA lands (758 acres), and a State of Wyoming land lease (363 acres). The enabling U.S. Congressional legislation for the refuge identified three purposes. These included: 1) the conservation of wetlands of the Nation to maintain public benefits and to fulfill international obligations of various migratory bird treaties and conventions, 2) Western Intermountain ecosystem conservation, and 3) migratory bird populations. The Environmental Impact Statement written for the refuge (USFWS 1992) identified constraints at the time and provided an evaluation of ecosystems to

integrate multiple uses including conservation of fish and wildlife populations, livestock grazing and haying management, oil/gas/mineral development, recreation, and local community economics.

Cokeville Meadows NWR has authorization to expand to 26,657 acres; the balance from current NWR area is owned by multiple land owners (Fig. 22). The USFWS potentially could acquire over 20,000 acres with the remainder in easements and joint administration with other agencies/entities. Since development of the refuge began in the early 1990s, management of refuge lands has sought to partly impound some wetland areas for waterfowl production; create and enhance foraging habitats and areas for migratory waterfowl, sandhill cranes, eagles and raptors, songbirds, and shorebirds; provide nesting habitat for waterbirds; protect roosting sites for bald eagles; protect and enhance lek sites for sage grouse (*Centrocercus urophasianus*); and provide winter range for ungulates (Cokeville Meadows NWR, unpublished annual narratives).

Many wetland developments have occurred on the refuge including construction of levees, water-control structures, ditches, and dams. Recent construction activities have sought to improve irrigation systems, roads, and visitor access (Appendix C). The refuge is divided into various water management districts and includes about 5 miles of low elevation dikes and over 40 water-control structures. Typically, wetland developments have constructed infrastructure to divert Bear River water into floodplain depressions or flats and to partly impound these sites to prolong the duration of surface water during spring and summer. Impounded wetland areas often retain water until diversion of irrigation water into floodplain meadows is discontinued in July, and many deeper depression including oxbows may retain surface water throughout the year, at least in wet years. Certain impoundments have water-control structures to allow drainage or partial dewatering of the site either in late summer to allow

some haying or grazing, or to manage vegetation for either seed producing annual/perennial plants or emergent species.

Existing irrigated hay land and pasture has been mostly maintained on Cokeville Meadows NWR since its establishment, although some small areas were originally to be converted to dense nesting cover for waterfowl (USFWS 1992). About 50% of hayable meadows are hayed by adjacent landowners under permit. Invasive and noxious weeds including Canada thistle, musk thistle, and Russian knapweed are controlled by permittees on the refuge. About 400 acres of small grains are grown on the refuge by permittee farmers and

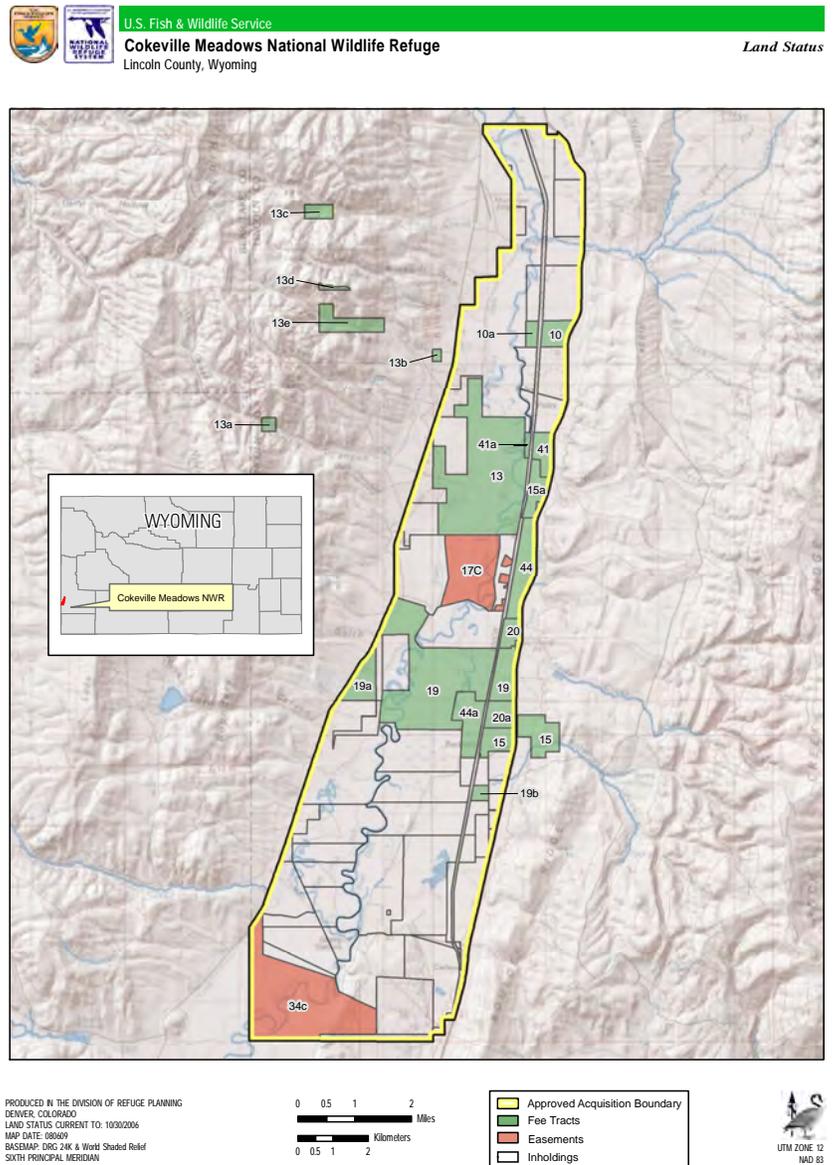


Figure 22. Ownership of lands at Cokeville Meadows NWR.

alfalfa and alfalfa/grass mixes are grown on about 1,400 acres.

ANIMAL POPULATIONS

Little quantitative information is available to assess changes in the presence, abundance, and distribution of animal species over time in the Cokeville Meadows region (e.g., USFWS 2007). Historically, the Bear River Valley, including the Cokeville Meadows NWR region, supported large numbers of waterfowl, waterbirds, and sandhill cranes, especially during spring migration periods (Drewein and Bizeau 1974, Bellrose 1980, USFWS 1992, Nicholoff 2003). In wet years many wetland-associated bird species nested in the region. Long-term trends in waterbird use of the region are unknown, but more annually consistent and prolonged water regimes in the Cokeville Meadows region, caused by annual diversion of river water onto floodplains to irrigate hay and pastureland may have increased use and production of some species over time, such as redhead (*Aythya americana*), canvasback (*Aythya valisineria*), black tern, black-crowned night heron, black-necked stilts (*Himantopus mexicanus*), and white-faced ibis. For example, production of redheads in the larger Bear River Valley during the 1970s and 1980s was among the highest of any western U.S. region in some years (Weller 1964, USFWS 1992). Breeding waterfowl surveys at Cokeville Meadows NWR in recent years have often counted a few thousand ducks and up to 1,100 Canada geese. Up to 500 sandhill cranes may be present on the refuge during migration periods, with up to 100 cranes attempting to nest on the refuge in some years (USFWS 1992, Subcommittee on Rocky Mountain Greater Sandhill Cranes 2007). Recent trends in waterfowl and crane numbers at Cokeville Meadows are difficult to assess given the lack of systematic surveys, but at least duck numbers appear to be lower than in previous periods. Mediated long-term dynamics of wetland flooding and drying regimes appear to have promoted denser, less diverse, wetland plant communities where nutrients are bound in emergent vegetation biomass and cover-open water interspersions are reduced. These vegetation changes generally reduce wetland productivity and waterfowl use/production. Intensive fall and spring grazing and high populations of some predator species such as red fox and striped skunk

also may be depressing nest success and production (USFWS 1992). Cokeville Meadows is within the historic range of the trumpeter swan (*Cygnus columbianus*), but their occurrence now is rare. Other waterbirds are abundant on Cokeville Meadows NWR during spring and summer including several nesting species. Few counts of these breeders are made, but American bittern, long-billed curlew, black terns, white-faced ibis, snowy egret and black-crowned night herons commonly are present in more permanent water sites.

Little information is available on non-waterbird bird species, except for annual surveys of sage grouse leks. The total number of lek sites on the refuge has not changed in recent years, but some individual lek sites have been abandoned (USFWS 1992, Cokeville Meadows NWR, unpublished records). Abandoned sites usually are in sites with intensive grazing/haying and where native vegetation has shifted to more introduced or invasive species. Upland grassland and sagebrush habitats in the Cokeville Meadows region are degraded from past extensive grazing and some sites have been converted to small grain or alfalfa production. Likely, other animal species associated with these grassland and sage habitats have declined (Smith et al. 1984).

Populations of at least some mammal species have changed at Cokeville Meadows from historic periods. Species such as bison (*Bison bison*), wolf (*Canis lupus*), cougar (*Felis concolor*), and black-footed ferret formerly occurred in the region, but at present no known wild population of ferrets or bison occur in the region nor are sustained populations of wolf or cougar present. Regional populations of some ungulates, such as deer and elk, may be higher than in former times while others such as moose and pronghorn are lower. Likewise, populations of species such as red fox (*Vulpes fulva*), striped skunk, raccoon, muskrat, and beaver (*Castor canadensis*) likely are greater now than in Presettlement times, but other species including badger (*Taxidea taxus*), bats, and marmots (*Marmota* sp.) may have lower population sizes.

Few native fish remain in the Bear River or its tributaries. Currently many warm-water and introduced species such as sunfish are present in area rivers and streams. Non-native rainbow, brook, brown, and MacKinaw trout now are present in the Bear River. Bonneville cutthroat trout are present in suitable river habitat, but the pure strain native cutthroat trout has virtually

disappeared downstream of Pixley Dam (USFWS 1992). Common carp (*Cyprinus carpio*) are present throughout the Bear River system, including deeper floodplain wetlands, and their presence has suppressed production and diversity of rooted aquatic vegetation and associated aquatic invertebrates. Few amphibians and reptiles are common in the region and no information is available to understand changes, if any, for these species.



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