Colorado
Wetland Resources

Wetlands cover only about 1.5 percent of Colorado but are ecologically and economically valuable to the State. Wetlands provide important wildlife habitat—during some part of their life cycle, as much as 90 percent of the State's fish and wildlife depend on riparian habitats that include wetlands (Redelfs, 1980), and wetlands provide stopover and breeding grounds to migratory waterfowl. Wetlands also provide flood attenuation, bank stabilization, and water-quality improvement (fig. 1). Colorado's tourist industry benefits from the scenic beauty of the State's wetlands and deepwater habitats and from the opportunities they afford for recreational activities that include hunting, fishing, bird watching, nature photography, camping, hiking, and boating. Because wetland vegetation generally is more lush and productive than that in uplands, some wetlands are considered prime grazing land. Peat is mined from wetlands for use as a garden soil amendment. In the past, much of the State's mineral wealth was mined from placer gold and heavy-mineral deposits in riparian zones. These benefits are provided by diverse wetlands distributed across Colorado's plains, mountains, and deserts.

TYPES AND DISTRIBUTION

Wetlands are lands transitional between terrestrial and deepwater habitats where the water table usually is at or near the land surface or the land is covered by shallow water (Cowardin and others, 1979). The distribution of wetlands and deepwater habitats in Colorado is shown in figure 2*A*; only wetlands are discussed herein.

Wetlands can be vegetated or nonvegetated and are classified on the basis of their hydrology, vegetation, and substrate. In this summary, wetlands are classified according to the system proposed by Cowardin and others (1979), which is used by the U.S. Fish and Wildlife Service (FWS) to map and inventory the Nation's wetlands. At the most general level of the classification system, wetlands are grouped into five ecological systems: Palustrine, Lacustrine, Riverine, Estuarine, and Marine. The Palustrine System includes only wetlands, whereas the other systems comprise wetlands and deepwater habitats. Wetlands of the systems that occur in Colorado are described below.

System	Wetland description
Palustrine	Wetlands in which vegetation is predominantly trees (forested wetlands); shrubs (scrub-shrub wetlands); persistent or nonpersistent emergent, erect, rooted, herbaceous plants (persistent- and nonpersistent-emergent wetlands); or submersed and (or) floating plants (aquatic beds). Also, intermittently to permanently flooded open-water bodies of less than 20 acres in which water is less than 6.6 feet deep.
Lacustrine	Wetlands within an intermittently to permanently flooded lake or reservoir. Vegetation, when present, is predominantly nonpersistent emergent plants (nonpersistent-emergent wetlands), or submersed and (or) floating plants (aquatic beds), or both.
Riverine	Wetlands within a channel. Vegetation, when present, is same as in the Lacustrine System.

There is no current (1993) estimate of statewide wetland acreage in each of the systems. Inventories of wetland and open-water areas conducted in the 1950's estimated that 3 percent was riverine, 14 percent was mixed lacustrine and palustrine, and 83 percent was palustrine (U.S. Fish and Wildlife Service, 1955; 1960). Palustrine wetlands in Colorado include forested wetlands in riparian areas and near springs and seeps; scrub-shrub wetlands, such as willow carrs (thickets) and bottomland shrublands; emergent wetlands, such as marshes, fens, alpine snow glades, and wet and salt meadows; and aquatic-bed wetlands in ponds and lakes (Colorado Department of Natural Resources, 1992).

Wetlands occupy about 1 million acres (1.5 percent) of Colorado (Dahl, 1990). In the Great Plains (fig. 2*B*), wetlands occur in the flood plains of the South Platte and Arkansas Rivers and in scattered locations throughout the plains. Wetlands generally are sparsely distributed in the Colorado Plateaus and Wyoming Basin. In the Southern and Middle Rocky Mountains, wetlands occur primarily in high mountain valleys and intermountain basins.

HYDROLOGIC SETTING

Wetlands form where there is a persistent water supply at or near the land surface. The location and persistence of the supply is a function of interdependent climatic, physiographic, and hydrologic factors such as precipitation and runoff patterns, evaporation, topography, and configuration of the water table.

Precipitation (fig. 2*C*) and runoff rates differ annually and with season and location. The average annual precipitation in Colorado ranges from about 7 inches in the San Luis Valley to about 60 inches in some mountainous areas. Most runoff occurs in spring and early summer and is greatest in the mountains. Greater precipitation and runoff in the mountains are the principal reasons for the greater acreage of wetlands in the intermountain basins than in other regions of the State. In the mountains, melting snow is the primary source of runoff, whereas in the eastern plains, runoff is mostly from rainfall (Petsch, 1986). The timing and volume of runoff affect the establishment and function of riparian wetlands. High streamflow, which results from snowmelt in the mountains during spring and early summer, is essential for the maintenance of normally func-

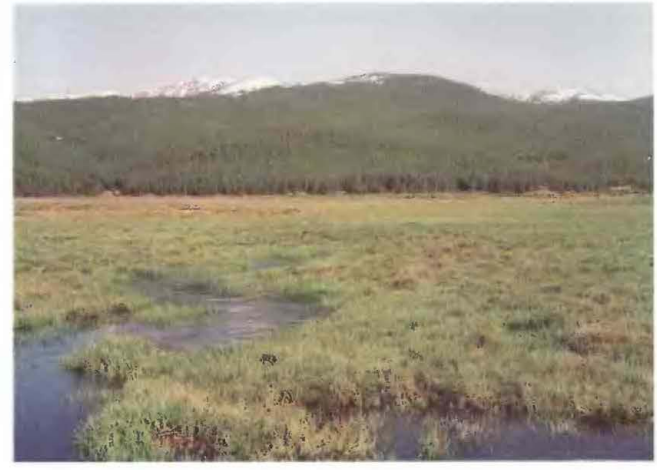
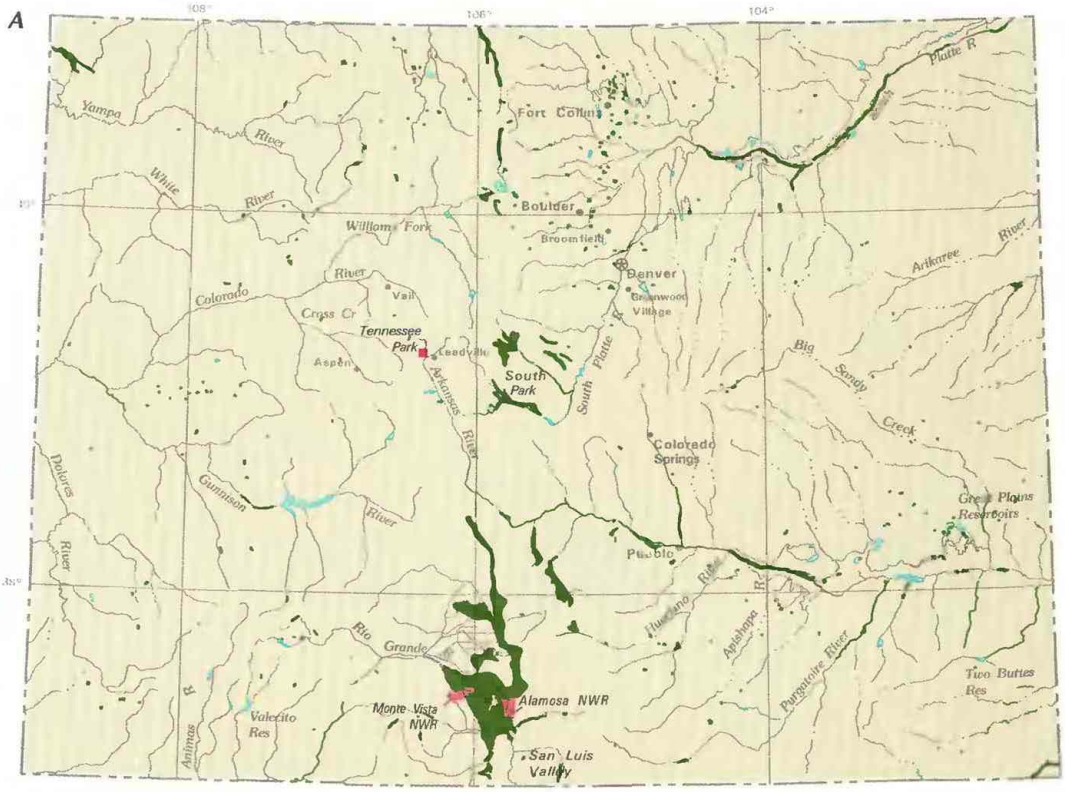
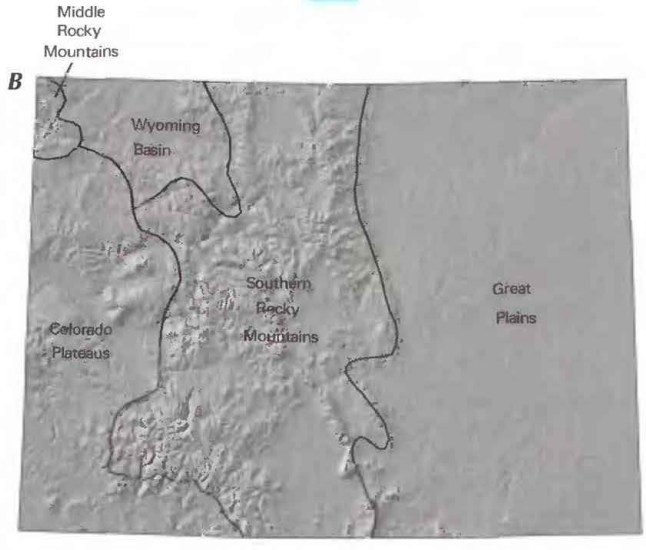


Figure 1. Wetland in Tennessee Park, about 4 miles northwest of Leadville. This wetland receives acidic mine drainage and was the subject of a study to determine the capacity of wetlands to improve the chemical quality of such drainage. *(Photograph by Katherine Walton-Day, U.S. Geological Survey.)*





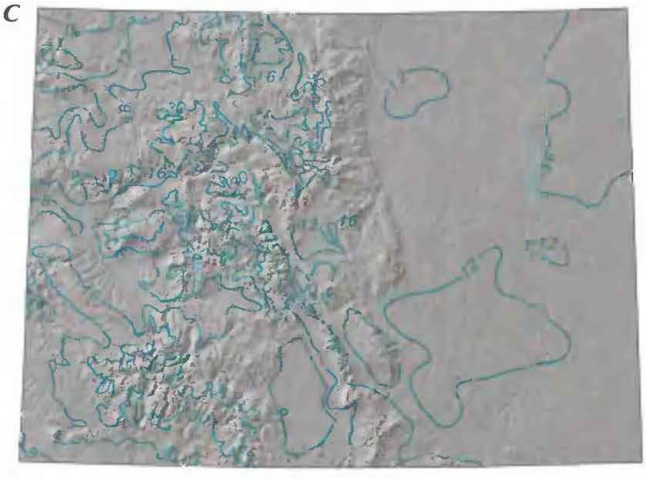


Figure 2. Wetland distribution in Colorado and physical and climatological features that control wetland distribution in the State. ***A***, Distribution of wetlands and deepwater habitats. ***B***, Physiography. ***C***, Annual precipitation. *(Sources: A, T.E. Dahl, U.S. Fish and Wildlife Service, unpub. data, 1991. B, Physiographic divisions from Fenneman, 1946; landforms data from EROS Data Center. C, Petsch, 1986.)*

tioning riparian ecosystems. Water-control projects such as reservoirs or irrigation canals, which reduce seasonal streamflow variation and eliminate periodic flooding, can adversely affect many streamside-wetland functions (Cooper, 1988).

Evaporation generally is greatest in eastern Colorado (fig. 2*D*). Evaporation decreases with altitude and is least in the mountains. Local evaporation patterns can affect wetland development. For example, on the windward side of ridges above timberline, strong winds redistribute snow to the leeward side and increase evaporation (Windell and others, 1986). The result is a dry environment on the windward side, whereas on the leeward side, accumulated snow melts slowly and creates a moist environment conducive to development of alpine wetlands.

In most of Colorado, evaporation exceeds precipitation annually, and, except in mountainous areas, there is a net statewide annual moisture deficit that inhibits wetland formation. The moisture deficit prevents the formation of bogs, which are emergent wetlands that have organic soils and receive moisture only from precipitation. In mountainous areas, where there is sufficient moisture for bog formation, steep topography and shifting stream channels prevent their development (Cooper, 1986).

Ground-water discharge from springs, shallow water tables, or both maintain wetlands in many areas of Colorado. The results of a study of wetlands in a river basin in the eastern plains indicated that most wetlands were along springfed streams that have perennial flow in reaches 1–2 miles in length (Cooper and Cottrell, 1989). In the intermountain basins, ground water is an important determinant of wetland location. Wetlands in the San Luis Valley (fig. 2*A*), an intermountain basin, are hydrologically supported by springs or ground-water mounds that form during spring and summer runoff (Cooper and Severn, 1992).

Climatic, topographic, and hydrologic characteristics differ among and sometimes within physiographic provinces. Colorado's diverse physiography results in diverse hydrologic settings for wetland formation.

In the Great Plains, wetlands occur in riparian zones of perennial streams, in oxbow lakes (abandoned stream meanders), in isolated depressions that have permanent or seasonal water supply, in playa lakes (primarily in the southern part of the region), and in association with reservoirs or channelized streams, rivers, and irrigation ditches.

In the Colorado Plateaus and Wyoming Basin, wetlands occur along perennial and intermittent streams, in oxbow lakes, around reservoirs, in springs and seeps, and where there is a shallow water table. Because of their semiarid to arid climate, these regions have a lower density and acreage of wetlands than does the rest of the State. As a result, the region's wetlands are disproportionately valuable to wildlife.

In the Rocky Mountains, wetlands form in two physiographically and climatically distinct settings: mountain valleys and intermountain basins. Mountain valleys generally are geologically young and, therefore, steep. The valleys have been shaped either by running water over their entire length or by glaciers at higher altitude and running water at lower altitude. Wetlands in mountain valleys occur in both glaciated and nonglaciated parts of the valleys in locations from cliff faces to valley floors. Glaciation (fig. 2*E*) in the alpine zone of some mountain valleys formed large cirque basins in which remnant glaciers or late-melting snow maintain spring, seep, and snowbed wetlands. Cirque lakes, or tarns, formed by glacial scouring, collect meltwater and attenuate downhill flow. Also in the alpine zone, ponds form in depressions behind slumping saturated soils or in depressions caused by the weight of accumulated snow. Below cirque basins, glaciated, steep-sided, U-shaped valleys have broad, flat floors and relatively low-gradient streams. Wetlands form on saturated cliff faces, at the sloping floor near the sides of the valley, in oxbow lakes, in glacial kettle ponds, in depressions on the surface of glacial moraines, in lakes created by terminal or lateral moraines, in landslide-formed lakes, in or near seeps and springs, and in beaver ponds. In steep, V-shaped, nonglaciated parts of mountain valleys, wetlands occur as narrow riparian wetlands, in or near springs and seeps, and in beaver ponds (Windell and others, 1986).

Intermountain basins, which were formed by tectonic forces, are filled by sediments derived from erosion of the surrounding mountains. The large, flat valleys are drained by low-gradient meandering streams and rivers. Wetlands in the intermountain basins form along these streams and rivers, in natural and constructed impoundments, in oxbow lakes, and in areas having a shallow water table maintained by underlying aquifers, annual flooding, or impermeable substrates (Windell and others, 1986).

The San Luis Valley is an intermountain basin in southern Colorado. Throughout much of the valley, the water table is shal-

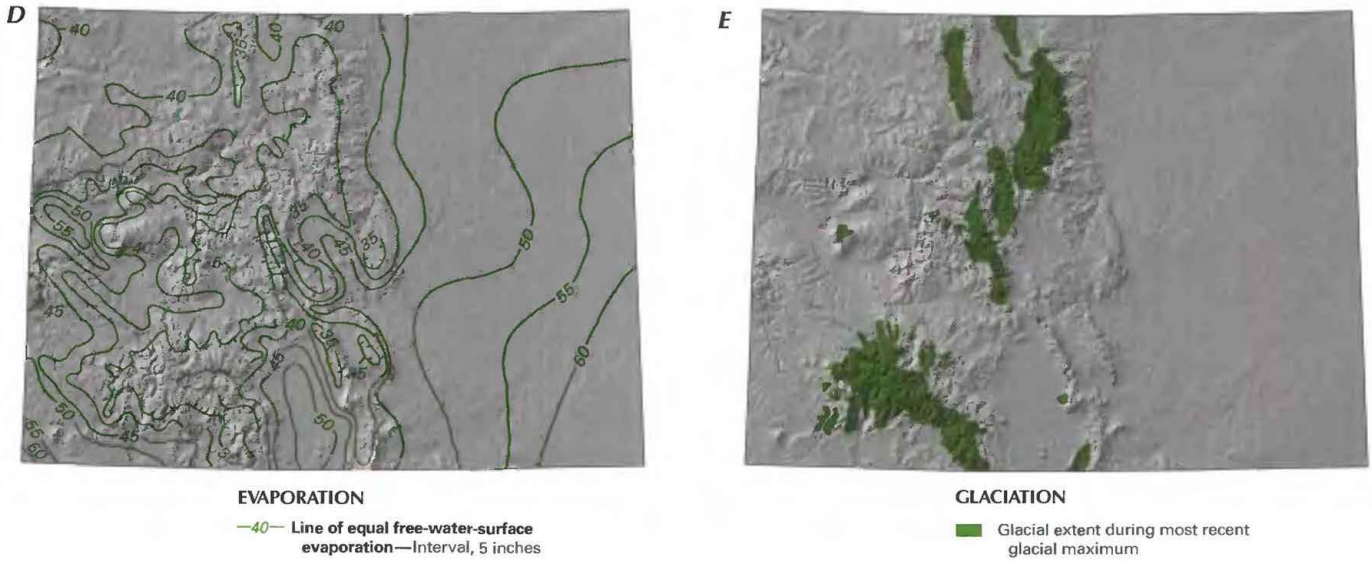


Figure 2. Continued. Wetland distribution in Colorado and physical and climatological features that control wetland distribution in the State. ***D***, Annual free-water-surface evaporation. ***E***, Extent of most recent glaciation. *(Sources: D, Farnsworth and others, 1982. E, Montagne, 1972.)*

low or at land surface, creating large areas of wetlands that have diverse vegetation (Cooper and Severn, 1992). Wetlands in the valley provide habitat for resident and migratory waterfowl and enhance water quality. The valley hosts endangered whooping cranes during migration and has the State's largest concentration of wintering bald eagles (U.S. Fish and Wildlife Service, 1990). The State's largest National Wildlife Refuges, Alamosa and Monte Vista, are located there. Ground water is used to irrigate the valley and augment surface-water flow in the Rio Grande. Recently, developers have sought to export ground water from the valley to urban areas. The State Engineer's office estimated that this project could cause permanent water-table drawdown of several feet over large areas in the northern valley (Cooper and Severn, 1992). Such declines could decrease wetland acreage by reducing the area of saturated or inundated soil and the duration of inundation in emergent wetlands (Cooper and Severn, 1992). Redelfs (1980) reported that changes in irrigation practices since the early 1970's already have reduced wetland acreage in the valley by 40 to 50 percent and have caused loss or drastic alteration of high-quality wetlands. The issue of new ground-water development illustrates the conflicts that occur frequently between development and wetland-conservation interests in the State.

Studies of wetland function have been conducted in a few Colorado wetlands. Rovey and others (1986) concluded that vegetation and water levels of wetlands in the Cross Creek area were dependent on stream hydrology. However, in another study of Cross Creek wetlands, Sundeen and others (1989) determined that the hydrology of those wetlands was largely independent of streams that flowed through them. Ruddy and Williams (1991) reached a similar conclusion about wetlands in the Williams Fork. Cooper (1990), in a study of wetland vegetation in South Park, delineated stands of rare vegetation whose main range is in wetlands of boreal and arctic Canada and Alaska. A study of the water-quality function of a subalpine wetland in the upper Arkansas River basin (indicated that the wetland removed iron from a stream affected by acidic mine drainage that flowed through the wetland (Walton-Day, 1991). An upper-montane wetland has been intensively studied to determine the processes that caused elevated uranium concentrations (Owen, 1990), and reconnaissance work has been conducted in many other such wetlands (Owen and others, 1992). Although these investigations of natural processes have added to what is known of Colorado's wetlands, the functions and values of the State's wetlands remain largely unstudied (Cooper and Severn, 1992).

TRENDS

The FWS has estimated that, from the 1780's to the 1980's, wetland area in Colorado decreased by 50 percent—from about 2 million to about 1 million acres (Dahl, 1990). In agricultural areas, conversion to cropland, dewatering for irrigation purposes, and overgrazing by livestock contribute to wetland losses. In urban areas, wetland losses are due to encroachment by residential and commercial construction, channelization, dewatering for municipal and industrial purposes, and contamination from inadequately treated sewage and industrial waste. In other areas, losses have been caused by ski-resort development, transmountain water diversions, drainage, river channelization, burning, clear cutting, mining and related activities that produce toxic acidic or alkaline drainage, peat mining, placer mining, water disposal, mine-tailing deposition, erosion and sedimentation, accidents such as drilling-mud spills or tailing-dam failures, sand and gravel mining, road and railroad construction, dams and reservoirs, and acidic precipitation (U.S. Fish and Wildlife Service, 1990, p. 9; Windell and others, 1986).

Some land-use practices have created new wetlands or enlarged existing ones. Leaking ditches, uncapped flowing wells, and seeps and return flows associated with irrigation have increased wetland acreage or improved wetland habitat, notably in the San Luis Valley (Windell and others, 1986), but also in other regions of the State (Hopper, 1968; Rector and others, 1979). Gravel-pit construction also has increased wetland acreage, and gravel mining and agricultural activities are totally or partially responsible for two-thirds of the wetlands inventoried in the Boulder, Colo., area (Cooper, 1988). Reservoir construction has undoubtedly increased the acreage of lacustrine wetlands.

CONSERVATION

Many government agencies and private organizations participate in wetlands conservation in Colorado. The most active agencies and organizations and some of their activities are listed in table 1.

Federal wetland activities.—Development activities in Colorado wetlands are regulated by several Federal statutory prohibitions and incentives that are intended to slow wetland losses. Some of the more important of these are contained in the 1899 Rivers and Harbors Act; the 1972 Clean Water Act and amendments; the 1985 Food Security Act; the 1990 Food, Agriculture, Conservation, and Trade Act; and the 1986 Emergency Wetlands Resources Act.

Section 10 of the Rivers and Harbors Act gives the U.S. Army Corps of Engineers (Corps) authority to regulate certain activities in navigable waters. Regulated activities include diking, deepening, filling, excavating, and placing of structures. The related section 404 of the Clean Water Act is the most often-used Federal legislation protecting wetlands. Under section 404 provisions, the Corps issues permits regulating the discharge of dredged or fill material into wetlands. Permits are subject to review and possible veto by the U.S. Environmental Protection Agency (EPA), and the FWS has review and advisory roles. Section 401 of the Clean Water Act grants to States and eligible Indian Tribes the authority to approve, apply conditions to, or deny section 404 permit applications on the basis of a proposed activity's probable effects on the water quality of a wetland.

Most farming, ranching, and silviculture activities are not subject to section 404 regulation. However, the "Swampbuster" provision of the 1985 Food Security Act and amendments in the 1990 Food, Agriculture, Conservation, and Trade Act discourage (through financial disincentives) the draining, filling, or other alteration of wetlands for agricultural use. The law allows exemptions from penalties in some cases, especially if the farmer agrees to restore the altered wetland or other wetlands that have been converted to agricultural use. The Wetlands Reserve Program of the 1990 Food, Agriculture, Conservation, and Trade Act authorizes the Federal Government to purchase conservation easements from landowners who agree to protect or restore wetlands. The Consolidated Farm Service Agency (formerly the Agricultural Stabilization and Conservation Service) administers the Swampbuster provisions and Wetlands Reserve Program. The National Resources Conservation Service (formerly the Soil Conservation Service) determines compliance with Swampbuster provisions and assists farmers in the identification of wetlands and in the development of wetland protection, restoration, or creation plans.

The 1986 Emergency Wetlands Resources Act encourages wetland protection through funding incentives. The act requires States to address wetland protection in their Statewide Comprehensive Outdoor Recreation Plans to qualify for Federal funding for State recreational land; the National Park Service provides guidance to States in developing the wetland component of their plans.

State wetland activities.—Although Colorado currently (1993) has no comprehensive wetlands-protection program, the State is assessing the need for a wetlands policy. Several State agencies actively participate in aspects of Federal programs, and some wetlands are protected under State programs.

The Water Quality Control Division of the Department of Health reviews section 404 permit applications to ensure compli-

Table 1. Selected wetland-related activities of government agencies and private organizations in Colorado, 1993

[Source: Classification of activities is generalized from information provided by agencies and organizations. •, agency or organization participates in wetland-related activity; ..., agency or organization does not participate in wetland-related activity. MAN, management; REG, regulation; R&C, restoration and creation; LAN, land acquisition; R&D, research and data collection; D&I, delineation and inventory]

Agency or organization	MAN	REG	R&C	LAN	R&D	D&I
FEDERAL						
Department of Agriculture						
Consolidated Farm Service Agency	...	•	..		..	..
Forest Service	•	..	•	•	•	•
Natural Resources Conservation Service		•	•		•	•
Department of Defense						
Army Corps of Engineers	•	•	•	•	•	•
Military reservations	•					
Department of the Interior						
Bureau of Land Management	•		•	•	•	•
Bureau of Reclamation			•		•	•
Fish and Wildlife Service	•		•	•	•	•
Geological Survey					•	
National Biological Service	...		...	.	•	...
National Park Service	•	...	•	•	•	•
Environmental Protection Agency		•			•	•
Native American Tribes						
Southern Ute	•	•	•		•	•
Ute Mountain		•				•
STATE						
Department of Agriculture					•	
Department of Health						
Hazardous Materials and Waste Management Division		•				
Water Quality Control Commission		•	...			
Water Quality Control Division		•	•			
Department of Highways			•		•	•
Department of Natural Resources						
Division of Parks and Outdoor Recreation						
Colorado Natural Areas Program	•			...	•	•
Division of Wildlife	•	•		•	•	•
Land Commissioners	•		...		..	
Division of Minerals and Geology		...	•		•	
State Forest Service		•	•			
SOME COUNTY AND LOCAL GOVERNMENTS		•				
PRIVATE ORGANIZATIONS						
Ducks Unlimited	•		•	..	•	•
The Nature Conservancy	•	...	•	•	•	•

ance with State water-quality laws. A permit is not issued by the Corps without certification of such compliance by the Division. Pursuant to section 305(b) of the Clean Water Act, the Division submits to the EPA and the U.S. Congress a biennial assessment of the State's surface-water quality, including that of wetlands.

The Colorado Department of Natural Resources has diverse wetland responsibilities. The Department's Division of Parks and Outdoor Recreation develops the Statewide Comprehensive Outdoor Recreation Plan. Pursuant to the requirements of the Emergency Wetlands Resources Act of 1986, the most recent plan (Colorado Department of Natural Resources, 1992) prioritizes wetland protection by wetland type and function. The Division's Colorado Natural Areas Program identifies and seeks protection for unique natural areas in the State. A "natural area" designation results in a maintenance agreement among landowners, the Colorado Natural Areas Program, and other interested parties. By 1992, about 5,000 acres of wetland were in designated natural areas (J.J. Coles, Colorado Natural Areas Program, oral commun., 1992). The Colorado Natural Areas Program has compiled inventories of plants and animals and plant associations of special concern in environments that include wetlands. The Division of Wildlife reviews section 404 permit applications and some local land-use issues to assess potential adverse effects on wildlife. Also, the Division regulates construction activities that affect streams and riparian areas, acquires wetlands through sales of Federal duck-hunting permits, and conducts habitat-improvement projects on public and private lands.

The activities of a few State agencies include restoration of former wetlands or creation of new wetlands. The Department of Highways uses best management practices to avoid or minimize disturbances to wetlands caused by highway maintenance and construction. Unavoidable damage to wetlands is mitigated through wetland restoration or creation. The Department has data-collection and monitoring programs to facilitate compliance with section 404 permitting requirements and to assess the effectiveness of mitigation projects. The Division of Minerals and Geology creates wetlands to treat water from abandoned mines. The State Forest Service helps private landowners develop or augment wetlands.

County and local wetland activities.—Most regulation of development activities in Colorado's wetlands is accomplished through Federal and State laws. However, Eagle and Pitkin Counties (which contain the towns of Vail and Aspen, respectively) and the cities of Boulder, Broomfield, Fort Collins, and Greenwood Village have adopted their own ordinances or guidelines to protect wetlands or to mitigate unavoidable wetland losses.

Private wetland activities.—Ducks Unlimited owns more than 2,200 acres of wetlands statewide (Ducks Unlimited, 1992). The Nature Conservancy owns about 1,600 acres (A.T. Carpenter, The Nature Conservancy, written commun., 1992). Other organizations that participate in wetland-protection activities in the State include the Colorado Native Plant Society, the Colorado Riparian Association, the Colorado Wildlife Federation, the Grand Canyon Trust, High Country Citizen's Alliance, the Sierra Club, Colorado Trout Unlimited, the Colorado Cattleman's Association, and Colorado Earth First! (Chew, 1991).

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FOR ADDITIONAL INFORMATION: District Chief, U.S. Geological Survey, Building 53, Box 25046, Mail Stop 415, Denver Federal Center, Denver, CO 80225; Regional Wetland Coordinator, U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, P.O. Box 25486, Denver Federal Center, Denver, CO 80225

Prepared by
Katherine Walton-Day,
U.S. Geological Survey