Arizona
Wetland Resources

Less than 1 percent of Arizona's landscape has wetlands (Arizona State Parks, 1989). Since the late 1800's, streams and wetlands throughout Arizona have been drained or modified, resulting in the loss of more than one-third of the State's original wetlands (Dahl, 1990). Despite their limited extent, wetlands are a valuable resource for the State's people and wildlife.

Benefits derived from the State's wetlands include flood control, streambank stabilization, water-quality improvement, water supply, wildlife habitat, recreation, and education. Riparian wetlands can lessen the severity of floods by retaining stormwater and releasing it slowly. Riparian vegetation can stabilize streambanks and reduce erosion. Wetlands can improve water quality by decreasing the sediment and pollutant load in the water that filters through the wetland (Carter, 1986). Rivers, lakes, and artificial stock ponds are sources of water for public supply, irrigation, and livestock use.

Wetlands are among the most valuable wildlife habitats in Arizona (Arizona State Parks, 1989). The variety and concentration of wildlife in wetlands are the result of abundant water, diverse vegetation (which provides adequate cover), and the dynamic and transitional nature of constantly changing water levels. Wetlands provide essential habitat for many waterfowl and other birds (including shorebirds and tropical migrants), amphibians, fish, and mammals. Some of the threatened or endangered species that depend directly or indirectly on Arizona wetlands include the bald eagle, humpback chub, Apache trout, Gila topminnow, Yuma clapper rail, Hualapai Mexican vole, and ocelot (Arizona State Parks, 1989).

Recreational use of wetlands benefits the State economically. Arizona's streams and wetlands offer diverse recreational experiences, including boating, hunting and fishing, camping, hiking, and wildlife watching. During 1978, in more than 46,000 visits to just three wetlands in southern Arizona, nonresident wildlife watchers generated more than $5 million in tourist revenue, or approximately $12,370 per acre (Arizona State Parks, 1989). Some wetlands, such as Montezuma Well (fig. 1), also are of historical, archeological, and cultural interest and provide opportunities for education and research. Many Arizona tourist attractions are prehistoric and historic settlements that developed around streams and wetland areas that provided fish, game, and water.

Figure 1. Montezuma Well, a lacustrine spring-fed wetland/deepwater habitat that has formed in a sinkhole. Located in a semiarid basin, this wetland was one of the few sources of water for prehistoric inhabitants of the area. *(Photograph by Eleanor Robbins, U.S. Geological Survey.)*

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 Arizona 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 systm, wetlands are grouped into five ecological systems: Palustrine, Lacustrine, Riverine, Estuarine, and Marine. The Palustrine System includes only wetlands, whereas the other sytems comprise wetlands and deepwater habitats. Wetlands of the systems that occur in Arizona 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.

Palustrine wetlands are represented in Arizona by riparian wetlands that include oxbow lakes, marshes, cienegas, and bosques and nonriparian wetlands such as tinajas. Palustrine wetlands also include artificially created wetlands such as farm ponds and cattle stock ponds. Riparian wetlands are in a transitional zone between the stream or lake and the dry desert upland. These habitats, the most extensive Arizona wetland habitat type, form as a result of consistently wet surface or subsurface conditions. Oxbow lakes are former river channels that are sustained by floodwater from the nearby main stem of a river. Cienegas are riparian spring-fed marshes that are surrounded by upland and characterized by permanently saturated, organic soils (Arizona State Parks, 1989). Cottonwood and willow bosques (forests) are largely restricted to the flood plains of perennial and intermittent streams. The forests are sustained by winter and spring flooding. Some streams are sustained by ground-water pumpage and have provided a scattering of aquatic communities in arid parts of Arizona that were once devoid of surface water. Tinajas, also known as rock pools, are small depressions scoured in bedrock by boulders moved by flash floods (Arizona State Parks, 1988).

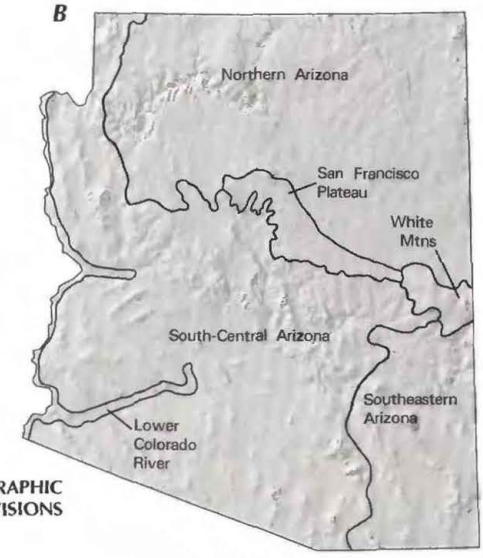
Lacustrine wetlands in Arizona include playas and caldera lakes. Playas, also referred to as sinks or sinkholes, are dry, unvegetated lakebeds in closed basins. The surface water of playa

lakes comes from direct precipitation and runoff; over time, the surface water evaporates and leaves tightly compacted fine sediments that compose the lake bottom. During wetter years, these areas can be flooded. Caldera lakes are formed by the collapse of basalt crust over a volcanic vent.

Riverine wetlands in Arizona occur in perennial, ephemeral, and intermittent streams. Perennial streams contain flowing water throughout the entire year. Intermittent streams are streams that flow seasonally. Ephemeral streams, called washes, flow occasionally and only as a result of surface runoff from precipitation.

HYDROLOGIC SETTING

Extreme aridity and seasonally varying precipitation are the climatic characteristics that most significantly affect wetland formation and distribution in Arizona. The State's few perennial streams arise mainly at higher altitudes, where there is more moisture and lower evaporation rates. As these streams descend to the desert plains, evaporative losses and seepage to the ground-water system greatly reduce or eliminate surface flows.



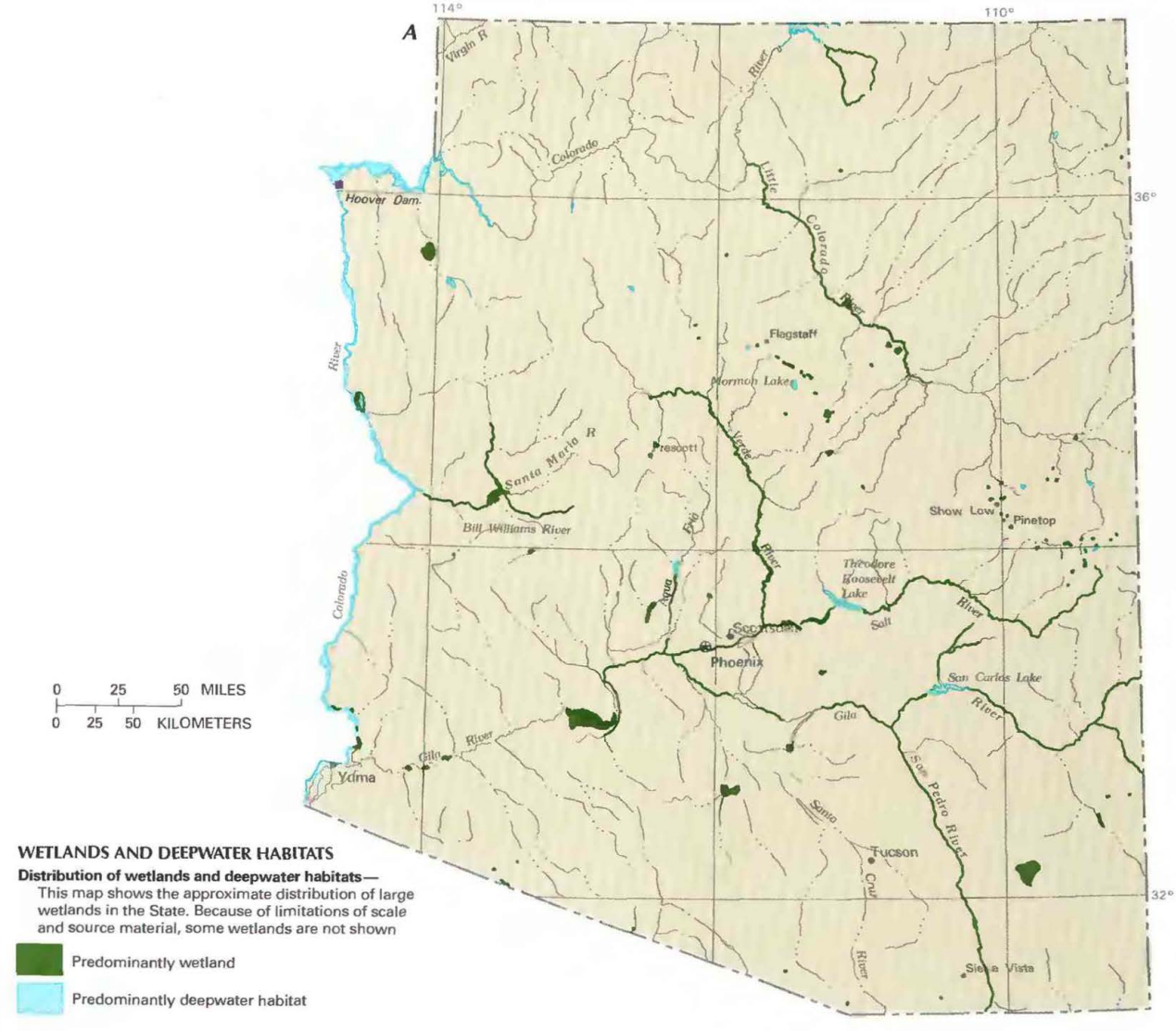


Figure 2. Wetland distribution in Arizona and physiography of the State. ***A***, Distribution of wetlands and deepwater habitats. ***B***, Physiography. *(Sources: A, T.E. Dahl, U.S. Fish and Wildlife Service, unpub. data, 1991. B, Physiographic divisions from Brown, 1985; landforms data from EROS Data Center.)*

Most wetlands in Arizona require more moisture than that provided by local precipitation. Such moisture is available in drainages and their flood plains (riparian zones) (fig. 3), on poorly drained lands, and in and near other wet areas such as ponds, margins of lakes, and springs and their outflows.

Arizona can be divided into six physiographically distinct regions for purposes of discussing wetland hydrology (fig. 2*B*). These six regions are the (1) White Mountains, (2) the San Francisco Plateau, (3) Northern Arizona, (4) South-Central Arizona, (5) Southeastern Arizona, and (6) the Lower Colorado River.

White Mountains.—The White Mountains region is the wettest part of the State; precipitation averages more than 23 inches per year, of which more than 50 percent falls as snow (Brown, 1985). Snow is the main source for most of Arizona's perennial streams. Most of the vegetated wetlands in the region are above 8,000 feet in the cold boreal or subalpine climatic zone (Arizona State Parks, 1989). Many of the wetlands have been flooded by reservoirs. The water in these reservoirs typically is clear and promotes abundant aquatic vegetation (Brown, 1985). Reservoir wetlands in the White Mountains region are the nesting habitat of more than 70 percent of the waterfowl present in Arizona (Brown, 1985). Playas are present east of Show Low, below 5,500 feet in altitude (Arizona State Parks, 1989). Riparian wetlands in the region are on flood plains of high-altitude creeks and other drainages.

San Francisco Plateau.—Annual precipitation in the San Francisco Plateau region averages about 19 inches, and about 75 percent falls as snow (Arizona State Parks, 1989). Because of a permeable substrate of basalt and cinder, the San Francisco Plateau has few perennial streams. Most wetlands are in intermountain grasslands or open woodlands and have a seasonal water regime that depends on winter precipitation and snowmelt. Palustrine emergent, scrub-shrub, and forested wetlands form around caldera lakes. Caldera lakes typically are found at altitudes between 6,900 and 7,200 feet (Arizona State Parks, 1989). An example is Mormon Lake, which is southeast of Flagstaff and is the State's largest natural water body.

Northern Arizona.—The Northern Arizona region has a cold-temperate to boreal climate (Arizona State Parks, 1988). At least four types of palustrine wetlands exist in this region. These wetlands include small seasonal lakes in the southern part of the Northern Arizona region, tule-fringed sinkholes (emergent wetland), marshes of the Little Colorado River and a few of its tributaries, and riparian forested wetlands (Brown, 1985; Platts and Jensen, 1986).

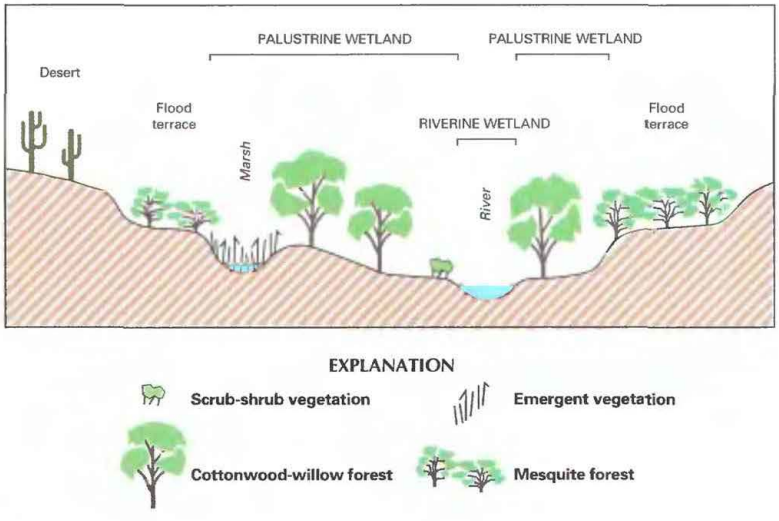


Figure 3. Hydrologic setting of wetlands in riparian areas of the Sonoran Desert. *(Source: Arizona State Parks, 1988.)*

South-Central Arizona.—The South-Central Arizona region has a warm-temperate to tropical-subtropical climate (Arizona State Parks, 1988). Most of the wetlands in this region have disappeared during the 20th century because of large-scale surface-water diversions and extensive ground-water pumping required to support municipal and agricultural development. Oxbow lakes and associated marshes were once fairly common in the flood plains of the major rivers in this area, particularly along the lower Verde, Salt, and Gila Rivers. Most of the wetlands in this part of the State are directly associated with the free-flowing, unmodified stream segments in the more mountainous regions and with ephemeral and intermittent streams at lower altitudes. Forested wetlands are common in this region.

Southeastern Arizona.—Summer precipitation in Southeastern Arizona is more predictable than in other parts of the State and generally exceeds winter precipitation. Historical accounts of this area describe many extensive ponds and shallow grassy marshes (Arizona State Parks, 1989). Channelization and ground-water withdrawals have drained most of the marshes, and those that remain have been stripped of vegetation and reduced in size. Seasonal playa lakes are common in this region. A few cienegas and other marshes exist in the northern part of the region, but similar wetlands have disappeared or have been eliminated in the eastern part of the region (Arizona State Parks, 1989). Many of the cienegas and marshes are directly connected to linear riparian corridors associated with streams. Wetlands in the region occur at altitudes between 3,200 and 4,600 feet (Arizona State Parks, 1989).

Lower Colorado River.—The Lower Colorado River region has a tropical-subtropical climate (Arizona State Parks, 1988). In the extreme northwestern part of the region, wetlands are directly associated with the Colorado River and the Virgin River. Historically, oxbow lakes and associated marshes were common in this area. Construction of Hoover Dam in 1935, however, eliminated the natural fluctuations of the Colorado River, which deprived many oxbow lakes of their major source of water. The result has been a decrease in wetlands associated with oxbow lakes.

TRENDS

Arizona's landscape was not always as dry as it is today. Little more than a century ago, Arizona had a natural river-drainage system that flowed year-round and spanned nearly every part of the State (Arizona State Parks, 1989). Perennial streams sustained the Native American and Hispanic cultures that occupied the State and provided water for a fledgling Anglo-American pioneer community. Arizona has lost many of its natural wetlands as the increasing requirements of agriculture, mining and other industry, and cities have resulted in the modification of the State's aquatic landscape. All the major rivers and many of the lesser streams have been impounded, regulated, and diverted (Arizona State Parks, 1989). Many other perennial streams and wetlands have disappeared because ground-water pumping has drained the aquifers, and other land-use practices have altered the hydrology of the drainage basins. Some of these changes were implemented for flood control, water storage, and hydroelectric power. Others changes resulted from land-use practices and water-management actions (Arizona State Parks, 1989). Regardless of the causes, the restructuring of Arizona's stream and wetland systems has affected the natural extent and distribution of these resources. The result has been greatly diminished opportunities for stream- and wetland-based recreation and degraded open-space quality in and around urban communities. Further, diminished natural-runoff re-

tention caused by wetland alteration or destruction has led to faster rising streams and higher flood peaks; these conditions have eliminated native fish and wildlife species in some areas.

Dahl (1990) estimates that, from predevelopment times until the 1980's, wetland acreage in Arizona decreased by more than one-third. Harvesting of trees for fuel and building supplies, overgrazing, conversion to croplands, inundation by impoundments, desiccation caused by diversions, invasion of nonnative plant species, plant eradication for increased water yield and flood control, floodplain development for urban needs, sand and gravel mining, and channelization and flood control have directly affected riparian wetlands. Losses of nonflowing surface water and aquatic habitat in cienegas also have been extensive.

Trends that will affect the future of wetlands in Arizona are the increasing population and urbanization; the changing attitudes about land-, water-, and riparian-resource uses; the diversifying economy; and the shifting and increasingly complex patterns of water use. The population and urbanization trends can be expected to affect stream and wetland resources because the demand for wetland recreation will continue to increase, and municipal development will increase pressure to encroach on riparian areas for residential, commercial, and industrial activities.

CONSERVATION

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

Federal wetland activities.—Development activities in Arizona 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, 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 Natural 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.

Table 1. Selected wetland-related activities of government agencies and private organizations in Arizona, 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	•		•	•	•	•
National Biological Service					•	
Geological Survey	..		..	...	•	..
National Park Service	•	...	•	•	•	•
Environmental Protection Agency		•				•
TRIBAL						
Some Indian tribes	•	•				•
STATE						
Department of Environmental Quality	•	•	•		•	
Department of Water Resources	...	•	...	..	•	...
Game and Fish Department	•	•	•	•	•	•
Outdoor Coordinating Commission	•	.		..		..
State parks	•	•		•		•
COUNTY AND LOCAL						
Counties	...•		•		•	
Municipalities		•				•
Salt River Project					•	
PRIVATE ORGANIZATIONS						
Desert Fishes Council	..				•	•
Ducks Unlimited	•			..		
Johnson Historical Museum of the Southwest	•			•	..	
National Audubon Society	•				•	..
Arizona Riparian Council	•				•	•
Arizona Wildlife Federation	•			..	..	..
The Arizona Nature Conservancy	•			•	•	•
Whittell Trust		.	.	•		.

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.—The Arizona Game and Fish Department is responsible for the management of fish and wildlife throughout the State except within Indian reservations (Arizona State Parks, 1989). The Department of Environmental Quality is responsible for setting, monitoring, and enforcing water-quality standards for all navigable waters, their major tributaries, and all ground water of the State. The Department of Water Resources has authority for general control and supervision of the waters in Arizona and the appropriation and distribution of such waters.

Through the actions of the Game and Fish Department, Department of Environmental Quality, Department of Water Resources, and State Parks, the State has taken steps to conserve streams and wetlands and promote their recreational use but has not established

a comprehensive policy pertaining to these resources. The Riparian Area Advisory Committee, made up of agencies, associations, citizen groups, and academia, currently (1993) is working on a full report to the Governor that will address a statewide policy and recommendations.

County and local wetland activities.—The framework exists within county and city governments to incorporate wetland areas as assets to the local community. Local governments can establish policies to protect wetlands by restricting nearby development and land uses. Arizona municipalities that have programs or policies to facilitate the protection of wetlands and riparian areas include Scottsdale, Prescott, Tucson, Sierra Vista, Show Low, and Pinetop.

The quasi-public Salt River Project's activities have major implications for streams and wetlands in Arizona (Arizona State Parks, 1989). The reservoirs and irrigation projects that the Project administers have inundated or otherwise drastically altered tens of thousands of acres of native riparian areas and hundreds of miles of free-flowing streams (Arizona State Parks, 1989). In recent years, however, the Project has been active in the Arizona Riparian Council and in work to establish methods of measuring and permitting critical instream flows. Additionally, the Project's environmental policy includes protection of aquatic ecology and cooperation with Federal, State, and local agencies responsible for environmental protection.

Private wetland activities.—Programs from private groups focus mainly on the acquisition and management of stream and riparian areas, education and information exchange, wetland restoration, and advocacy for wetland recreation and conservation. The Nature Conservancy, an international nonprofit organization, seeks to protect rare plants and animals by preserving the habitats they need to survive—critical lands in the United States and beyond our borders. The Arizona Riparian Council provides an important communication channel for professionals working in the area of riparian-habitat management. Through the work of its subcommittees, the Council has begun to address coordination and consistency problems within the existing decentralized statewide riparian-management system.

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