

Western Pacific Islands

Wetland Resources

The western Pacific Ocean contains thousands of small volcanic islands and coral atolls, many of which are now or were formerly under the jurisdiction of the United States. Herein, those islands are called the Western Pacific Islands. Wetlands are of great economic importance on many of these islands because of the wetland cultivation of taro, a staple food crop. Wetlands also provide important wildlife habitat on the larger islands (fig. 1) (U.S. Army Corps of Engineers, 1981; Guam Department of Parks and Recreation, 1988). Despite the economic importance of wetlands in the western Pacific region, not much information is available concerning wetland resources on most of the islands. This summary, therefore, is restricted to several major islands for which some published information is available.

TYPES AND DISTRIBUTION

Wetlands are lands transitional between terrestrial and deep-water 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 the Western Pacific Islands is shown in figure 2A; 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 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 the Western Pacific Islands are described below.

System	Wetland description
Palustrine	Nontidal and tidal-freshwater 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	Nontidal and tidal-freshwater wetlands within an intermittently to permanently flooded lake or reservoir larger than 20 acres and (or) deeper than 6.6 feet. Vegetation, when present, is predominantly nonpersistent emergent plants (nonpersistent-emergent wetlands), or submersed and (or) floating plants (aquatic beds), or both.
Riverine	Nontidal and tidal-freshwater wetlands within a channel. Vegetation, when present, is same as in the Lacustrine System.
Estuarine	Tidal wetlands in low-wave-energy environments where the salinity of the water is greater than 0.5 part per thousand (ppt) and is variable owing to evaporation and the mixing of seawater and freshwater.
Marine	Tidal wetlands that are exposed to waves and currents of the open ocean and to water having a salinity greater than 30 ppt.

The FWS has mapped wetlands on Guam, Rota, Tinian, Aguijan, and Saipan in the Mariana Islands (fig. 2). With the exception of Guam, estimates of total wetland areas are not available for these islands.

Wetlands on Guam were inventoried by the Guam Department of Parks and Recreation (1988). Using the FWS wetland maps, the Department of Parks and Recreation estimated a total of about 14,000 acres of wetland. Most of this total, about 9,000 acres, consists of marine coral reefs. Palustrine wetlands cover about 3,500 acres, equivalent to less than 3 percent of the land area of Guam. Most of the palustrine wetlands are forested with mangroves.



Figure 1. Lake Susupe, a lacustrine wetland on Saipan in the Commonwealth of the Northern Mariana Islands. (Photograph by S.K. Izuka, U.S. Geological Survey.)

Wetlands mapped by the FWS on Saipan are primarily marine and palustrine wetlands. Marine wetlands include coral reefs along most of the shoreline and in the lagoons on the west side of the island. Palustrine wetlands are located mostly near the western shore at altitudes below 30 feet. The largest freshwater wetland is the Lake Susupe wetland near Chalan Kanoa in the southwestern part of the island (fig. 2); this wetland includes lacustrine, palustrine emergent, and palustrine scrub-shrub wetlands. Small estuarine, lacustrine, and riverine wetlands have been mapped along the western and eastern shores of the island. A few small and isolated riverine and palustrine wetlands have been mapped in the mountainous interior.

Wetlands on Tinian are marine and palustrine. The marine wetlands are predominantly coral reefs and rocky shores around much of the coast. The palustrine wetlands are mostly emergent and are concentrated in two closed depressions that resulted from the collapse of limestone solution cavities. These wetlands are known as the Magpo and Lake Hagoi wetlands. Tinian has no streams and, therefore, no riverine or estuarine wetlands. Several small marine and palustrine wetlands also have been mapped on the nearby small island of Aguijan.

Numerous marine, palustrine, and riverine wetlands were mapped on Rota. The marine wetlands include reefs and rocky shores. Reefs surround almost the entire island. Palustrine wetlands are mainly emergent and are concentrated in the southwestern end of the island, where collapse of limestone solution cavities has created several closed depressions on the plateau known as the Sabana. Riverine wetlands are confined to the few steep streams that flow over volcanic terrain in the south of the island.

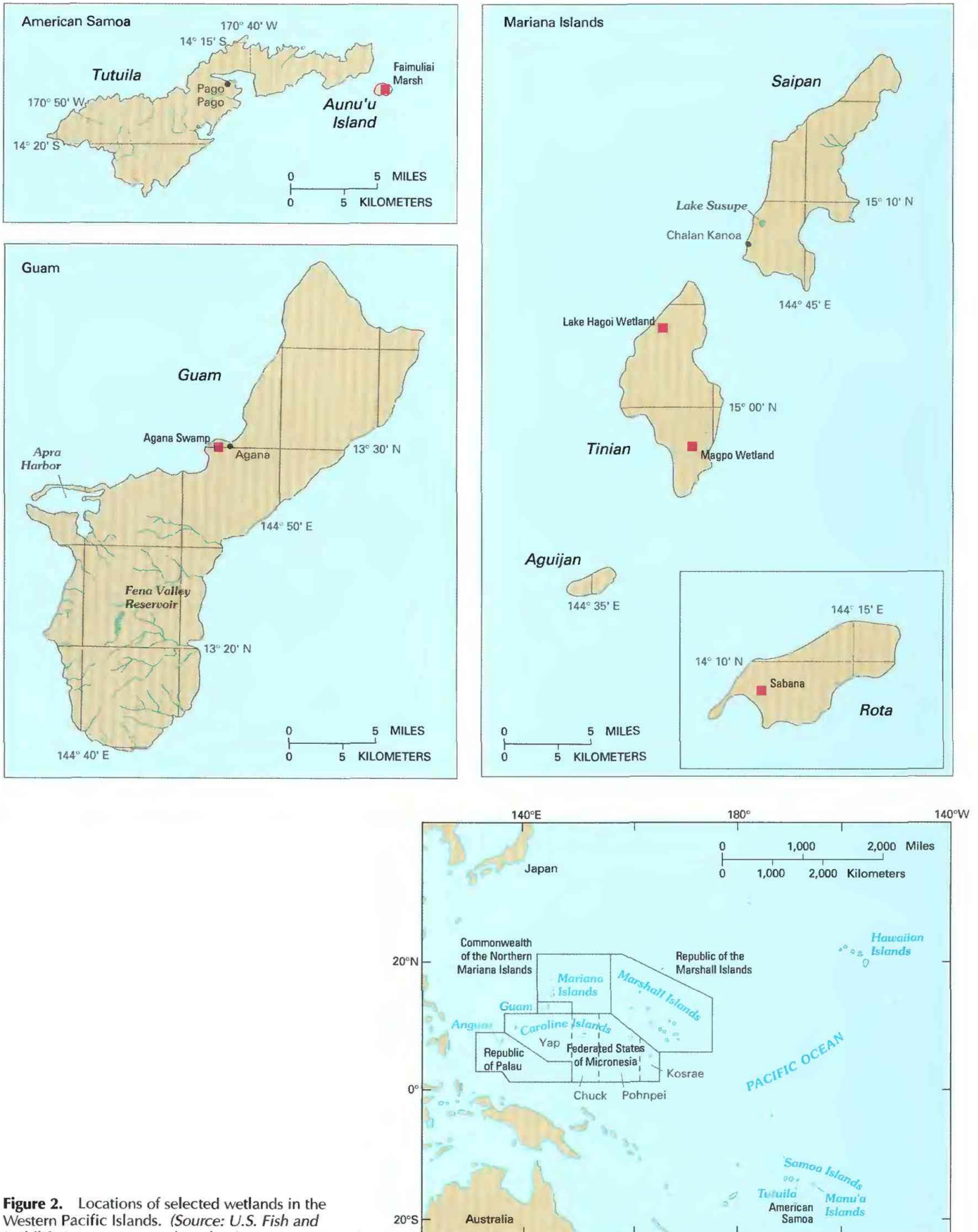


Figure 2. Locations of selected wetlands in the Western Pacific Islands. (Source: U.S. Fish and Wildlife Service, National Wetlands Inventory maps.)

Wetlands in American Samoa (fig. 2) were inventoried for the American Samoa Department of Parks and Recreation by Ridings (1987) on the basis of surveys by the FWS. Total wetland area was estimated to be 240 acres, which is less than 1 percent of the land area of American Samoa. Wetlands were classed as coastal marshes or as mangrove forests. American Samoa's coastal marshes, as described by Ridings (1987), are palustrine (freshwater) emergent wetlands. The total area of coastal marshes was estimated to be 89 acres. Mangrove forests are estuarine forested and scrub-shrub wetlands and comprise a total of 131 acres.

A second inventory of wetlands in American Samoa, based on field surveys and aerial-photograph interpretation, gave an estimate of 463 acres of wetlands in 1991 on Tutuila and Aunu'u Island (fig. 2) (BioSystems Analysis, Inc., 1991). Wetland areas were listed for 10 wetlands on Tutuila and 4 wetlands on Aunu'u Island.

The difference between the estimates of Ridings (1987) and BioSystems Analysis, Inc. (1991) may be due to differences in methodology and classification. Marine wetlands and wetlands on the Manu'a Islands were not included in either survey.

HYDROLOGIC SETTING

The Western Pacific Islands have a tropical climate that is affected by prevailing northeasterly trade winds north of the equator and southeasterly trade winds south of the equator. The islands have distinct dry and wet (monsoon) seasons. On the islands discussed in this report, rainfall ranges from 80 to 250 inches annually, depending on location, and annual runoff ranges from 26 to 200 inches (Aldridge, 1986).

Bedrock of the Western Pacific Islands consists mainly of limestone and two types of volcanic rocks (Detay and others, 1989). The Mariana Islands have cores of low-permeability, andesitic volcanic rocks covered in most places by high-permeability limestone (Valenciano, 1985). Atolls in the Caroline and Marshall Islands (fig. 2) are formed of coral sand and limestone (Anthony and others, 1989; Detay and others, 1989). The islands of American Samoa are predominantly steep, volcanic edifices formed of low- to high-permeability basaltic lava flows rimmed with narrow coastal benches formed of wave-deposited sediments (Bentley, 1975).

Most of the wetlands in the Western Pacific Islands are marine, estuarine, or palustrine wetlands in coastal areas. Both the land surface and the water table in these areas are near sea level owing to the proximity of the ocean and discharge of ground water from fresh to brackish basal ground-water lenses (Valenciano, 1985). The balance between rainfall and evaporation, generally steep slopes, and the high permeability of limestone and basaltic bedrock does not favor the retention of water near the land surface in upland areas except where collapse of limestone caves has created closed depressions or where less-permeable volcanic rocks crop out.

Mariana Islands.—The largest coastal wetlands, such as Agana Swamp on Guam and Lake Susupe on Saipan (fig. 2), probably originated as marine embayments or lagoons (Ayers and Clayshulte, 1983). These wetlands were isolated from the ocean when sea level declined and were subsequently filled with carbonate and organic sediments. Tidal effects on water levels in these coastal wetlands apparently are small (U.S. Army Corps of Engineers, 1981; Ayers and Clayshulte, 1983).

The hydrogeology of Agana Swamp on Guam was investigated by Ayers and Clayshulte (1983). They inferred that the water level in the swamp was maintained largely by rainfall and surface-water runoff. They also found that the swamp was hydraulically connected to the basal freshwater lens that forms the primary ground-water source for the island, and they hypothesized that the swamp functioned as a ground-water recharge zone during wet periods and a discharge zone during dry periods.

Lake Susupe on Saipan (figs. 1 and 2) is a lacustrine wetland, about 3 feet above sea level, surrounded by palustrine emergent and forested wetlands. The lake is shallow, and the lake bottom is mostly below sea level. Except during major storms, surface water does not flow into the lake from the surrounding uplands or into the sea from the lake. Apparently, the lake surface is continuous with the water table. The lake gains water from rainfall and runoff and loses water owing to ground-water recharge and evaporation (U.S. Army Corps of Engineers, 1981).

The Magpo wetland on Tinian (fig. 2) is a major source of water for that island. The land surface and water table of this wetland are at or near sea level. The wetland was considered to be a ground-water recharge zone for the principal aquifer in a recent proposal for a watershed protection plan by the Coastal Resource Management Office of the Commonwealth of the Northern Mariana Islands (J.P. Villagomez, Coastal Resource Management Office, written commun., 1992).

Samoan Islands.—Coastal marshes in American Samoa occur inland from beach berms and lack surface-water connections to the sea. Marsh sediments generally are poorly permeable, and marsh water levels are only slightly affected by tides (Ridings, 1987). The soil of these marshes is almost always saturated (Ridings, 1987). Mangrove forests in American Samoa grow mainly at the mouths of streams (Ridings, 1987).

Caroline Islands.—Templin and others (1949) described a large freshwater swamp (palustrine forested wetland) on the island of Anguar in the Republic of Palau (fig. 2). The water table was reported to be within a few inches of the land surface most of the time and 2 to 4 feet below the surface during the driest periods. During some severe storms, the swamp was inundated by seawater. The swamp was noted to be favorable for cultivation of taro. Wetland taro cultivation in Palau (Belau) was described by Gressitt (1952).

Artificial wetlands used for cultivation of taro and other crops in the Caroline Islands were described by Niering (1956). These wetlands consist of pits dug below the water table and partially filled with decayed vegetation. The size of these pits ranged from a few square feet to 11 acres. The number of artificial wetlands created for taro cultivation in the Caroline Islands was reported to be increasing because of increases in population (Niering, 1956).

Marshall Islands.—Wetlands in the Marshall Islands were described by Hatheway (1953). These included mangrove swamps and freshwater swamps. Mangrove swamps (estuarine forested wetlands) occurred in areas of saline or brackish water where ocean waves had created closed depressions owing to successive deposition of dunes or boulder ridges. Freshwater swamps (palustrine forested and scrub-shrub wetlands) and marshes (emergent wetlands) include pits dug for taro cultivation as well as naturally formed peat bogs that contain organic soils.

Wetlands on atolls in the Marshall Islands were briefly described by Fosberg (1953). Most of these wetlands were artificial marshes consisting of pits dug below the water table, partially filled with decayed vegetation, and planted in taro. Natural marshes and a peat bog also were noted. Fosberg (1953) distinguished these two wetland types on the basis of substrate; marshes have a muck bottom and bogs consist of fibrous peat. Both of these wetland types are palustrine emergent wetlands.

TRENDS

Very little information concerning trends in wetland conditions is available for the Western Pacific Islands. Information available from published sources is mostly qualitative but does provide some indications of wetland changes in historic times.

A large part of Agana Swamp on Guam was filled to provide room for expansion of the town of Agana (Ayers and Clayshulte,

1983). The swamp was also affected by dredging in 1933–34, when a channel was cut through the swamp. Dredging resulted in considerable drying of the swamp surface, decreased ground-water levels near the swamp, and increased flow in the Agana River, which flows through the swamp (Ayers and Clayshulte, 1983).

Lake Susupe on Saipan also was subject to filling and draining during the Japanese occupation (1914–44) (U.S. Army Corps of Engineers, 1981). Much of the wetland was used for cultivation of sugarcane during this period. The lake and surrounding wetlands were considered for use as a flood-control basin in 1981 and are presently (1993) being evaluated as a source of municipal water supply.

Wetland losses in American Samoa were assessed by Ridings (1987). Only one-third to one-half of the total area of coastal marsh was reported to be in its natural condition. Faimulivai Marsh on Aunu'u Island was considered the only coastal marsh not disturbed by taro cultivation or other agricultural uses. However, Ridings (1987) considered further disturbance of coastal marshes for agricultural purposes unlikely as a result of demographic and economic shifts (Ridings, 1987). About one-third of the original area of mangrove forest was reported lost due to firewood cutting, land clearing, and filling for home sites and government land (Ridings, 1987). Contamination of streams flowing into wetland areas was also considered a threat to mangrove forests. Continued decrease in mangrove forests was predicted.

Trends in wetlands between 1961 and 1991 on Tutuila and Aunu'u Island in American Samoa were recently evaluated by BioSystems Analysis, Inc. (1991). Their report indicated a net loss of 137 acres. On the basis of their estimates from aerial photography, this loss represents a 28-percent reduction in area (BioSystems Analysis, Inc., 1991).

CONSERVATION

Wetland management in the western Pacific is complex because many islands of the former U.S. Trust Territory of the Pacific are now governed by independent national governments. The Federated States of Micronesia and the Republic of the Marshall Islands (fig. 2) are now independent nations governing most of the Caroline and Marshall Islands. Guam and American Samoa are U.S. territories, and the Northern Mariana Islands are a U.S. commonwealth. The Republic of Palau (Belau) remains at present (1993) a U.S. trust territory. Only islands under the jurisdiction of the United States are discussed below.

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

Federal wetland activities.—Development activities in wetlands of the Western Pacific Islands that are under the jurisdiction of the United States 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; the 1986 Emergency Wetlands Resources Act; and the 1972 Coastal Zone Management 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.

Table 1. Selected wetland-related activities of government agencies and private organizations in the Western Pacific Islands, 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	●
Natural Resources Conservation Service	●	●	●
Department of Commerce						
National Oceanic and Atmospheric Administration						
.....	●	●	●	...
Department of Defense						
All military reservations						
.....	●
Army Corps of Engineers	●	●	●	...	●	●
Navy (Guam)	●	...	●	...	●	...
Department of the Interior						
Fish and Wildlife Service						
.....	●	...	●	●	●	●
Geological Survey	●	...
Environmental Protection Agency	●
TERRITORIAL AND COMMONWEALTH						
American Samoa						
Department of Marine and Wildlife Resources	●	●	...	●	...
Department of Parks and Recreation	●
Department of Public Works	●
Economic Development Planning Office	●	●
Environmental Protection Agency	●
Village leaders and councils	●
Zoning Board	●
Commonwealth of the Northern Mariana Islands						
Coastal Resource Management Office	●
Commonwealth Utilities Commission	●
Department of Commerce and Labor	●
Department of Health	●
Department of Natural Resources	●	●	...
Historical Preservation Commission	●
Public Works Department	●
Guam						
Bureau of Planning	●
Department of Agriculture	●	●	...
Environmental Protection Agency	●	●
Territorial Land Use Commission	●
PRIVATE ORGANIZATIONS						
The Nature Conservancy	●	...	●

Environmental Protection Agency (EPA), and the FWS has review and advisory roles. Section 401 of the Clean Water Act grants to States, eligible Indian Tribes, U.S. Trust Territories, Commonwealths, and other U.S. territories 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 Conser-

vation 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.

The 1986 Emergency Wetlands Resources Act and the 1972 Coastal Zone Management Act and amendments encourage wetland protection through funding incentives. The Emergency Wetlands Resources Act requires States and U.S. territories to address wetland protection in their Statewide Comprehensive Outdoor Recreation Plans to qualify for Federal funding for recreational land; the National Park Service provides guidance in developing the wetland component of their plans. Coastal States and U.S. territories that adopt coastal-zone management programs and plans approved by the National Oceanic and Atmospheric Administration are eligible for Federal funding and technical assistance through the Coastal Zone Management Act.

The FWS is planning a National Wildlife Refuge on Guam. This refuge will include wetlands as well as terrestrial habitats. There are no existing National Wildlife Refuges under United States jurisdiction in the western Pacific.

The U.S. Navy manages wetlands on Guam in the vicinity of Apra Harbor. The Navy is planning a wetlands-enhancement project in cooperation with FWS (Stephanie Aschmann, U.S. Navy, written commun., 1992).

The U.S. Geological Survey collects hydrologic data in wetlands in the Mariana Islands. A bathymetric survey of Fena Valley Reservoir on Guam was completed in 1990 (Nakama, 1992). Water-quality samples were collected in Lake Susupe on Saipan in 1990. Monitoring wells are being drilled in the Magpo wetland on Tinian.

Territorial and Commonwealth activities.—Guam has at present (1993) no laws specifically protecting wetlands, but Executive Order 90–13 in June 1990 established the Guam Environmental Protection Agency as the lead agency for wetland protection in Guam. The Guam Environmental Protection Agency is responsible for the inventory and classification of wetlands and development of rules and regulations for wetland uses. The Agency provides water-quality certification for permits issued by the Corps. The Agency also has established water-quality standards specific to wetlands and instituted a wetlands education program. Fish and Wildlife Service wetland maps are used to identify wetland areas, but Guam Environmental Protection Agency staff revise wetland delineations for specific development sites. Development projects on Guam require permits from the Territorial Land Use Commission in addition to federally required permits. The commission may require mitigation of wetland losses. The Guam Environmental Protection Agency, the Bureau of Planning, and the Department of Agriculture, Division of Aquatic Resources and Wildlife, act as advocates before the commission for wetland concerns.

Wetland regulation in the Commonwealth of the Northern Mariana Islands (fig. 2) is coordinated by the Coastal Resource Management Office under the authority of the Federal Coastal Zone Management Act. The Office issues consolidated permits for wetland developments and may require mitigation. The Office consists of the directors of the Division of Environmental Quality, the Department of Natural Resources, the Commonwealth Utility Corporation, the Historical Preservation Commission, the Public Works Department, and the Department of Commerce and Labor. The Office has produced its own wetland maps. The Department of Environmental Quality is responsible for section 401 water-quality certification of projects under the Clean Water Act and monitors streams and coastal waters weekly. The Department of Health, under which the Department of Environmental Quality operates, has established local water-quality standards.

In American Samoa, wetlands are protected by the land-use permit system administered by the Economic Development Planning Office, which is developing a wetland-management plan under the authority of the Coastal Zone Management Act (BioSystems Analysis, Inc., 1991). As part of this plan, wetlands were mapped for all islands in American Samoa (Sheila Wiegman, American Samoa Environmental Protection Agency, written commun., 1993). The American Samoa Environmental Protection Agency acts in an advisory role in the Economic Development Planning Office permitting process and also provides section 401 water-quality certification for Corps permits. The American Samoa Environmental Protection Agency also develops water-quality standards and issues permits for activities affecting wetland water quality. The Department of Marine and Wildlife Resources also acts in an advisory role for Economic Development Planning Office permits affecting wetlands and conducts habitat improvement and wetland-research projects. The Department of Parks and Recreation has jurisdiction over all areas between mean high tide and a depth of 60 feet and enforces rules protecting these areas. The Department of Public Works reviews permit applications for dredging, filling, and excavation. The Zoning Board defines zones, which may include wetlands, where some land-use activities are prohibited. Local leaders and village councils also have authority to enforce regulations pertaining to public health and natural resources.

The Republic of Palau has at present (1993) no wetland-protection program. The Palau Environmental Quality Protection Board is cooperating with the EPA in an effort to initiate a wetlands program.

Private organizations.—The Nature Conservancy has a project in the Republic of Palau to protect freshwater marshes for crocodile habitat. The Nature Conservancy is also working with local governments on Pohnpei and Kosrae in the Federated States of Micronesia to protect wetlands.

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