

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS
INTRODUCTION
by Derek W. Stinson

Area: 478 sq.km.

Population: 43,000 in 1990.

The Commonwealth of the Northern Mariana Islands (CNMI) comprises 14 of the 15 Mariana Islands, an archipelago in Micronesia situated between latitudes 14°10' and 20°31' North. Guam, the southernmost of the Mariana Islands, is presently a U.S. Territory and politically separate. Saipan, the capital of the CNMI, lies approximately 2,400 km south of Tokyo and 2,600 km east of Manila. Two geologically different island arcs make up the CNMI. The five southernmost islands are geologically oldest, and primarily consist of uplifted limestone. The remaining nine northern islands are entirely volcanic material, and some exhibit sporadic volcanic activity. Pagan, the largest of the northern islands, has several cones and older collapsed calderas. Two major eruptions have occurred on Pagan this century, and about half of the island is relatively barren cinder fields and lava flows. Saipan, the largest island (120 sq.km), has a rugged limestone ridge running along its northern two-thirds, the highest point of which is 436 m. Saipan has extensive sand beaches on its western side, protected by a barrier reef and lagoon. Tinian (100 sq.km) is mostly relatively flat and consists of level limestone terraces with three high sections, the highest point of which is 178 m. Tinian's coastline is mostly rocky and unprotected from wave action.

The climate is warm and humid with little seasonal or daily variation in temperature, the temperatures generally remaining between 25 and 30°C. Most of the 2,000-2,500 mm of annual rain falls in the rainy season, from June to November. The CNMI is in an area of typhoon formation, and tropical storms are common in the rainy season and early part of the dry season. Northeast trade winds generally blow during the dry season, from December to May. As is typical of small oceanic islands, the terrestrial fauna is relatively depauperate, but with a high degree of endemism. In recent years, a subsistence economy has become a rapidly expanding tourist economy.

Summary of Wetland Situation

Lake Susupe and the large contiguous reed marsh and swamp on the western coastal plain of Saipan comprise over 60% of the freshwater wetlands in the CNMI. Smaller marshes on Saipan, the Pagan lakes, and Lake Hagoi and a swamp on Tinian make up most of the remainder. There are a few small stands of mangroves (*Bruguiera gymnorrhiza*) on Saipan which may have been much more extensive in the past.

In addition to loss of wetlands through filling during this century, wetlands were affected by cultivation of sugar cane and rice during the Japanese period (1914-1944). Waste water from a sugar mill drained into Lake Susupe and probably deposited large quantities of organic matter in the lake. Little wetland agriculture is practised now, and most wetlands are covered with thick stands of reeds (*Phragmites karka*). In addition to agriculture and development impacts to wetlands, the exotic mosquito fish (*Gambusia affinis*) and tilapia (*Sarotherodon mossambicus*) were introduced, and probably greatly altered the aquatic ecosystems. *Gambusia* was probably introduced by the U.S. military for mosquito control during World War II (Eldredge, 1988; Maciolek, 1984). Tilapia were introduced for small-scale aquaculture during the 1950s. Both fishes have become notorious for the ecological havoc they cause where they have been introduced (Courtenay & Robins, 1989; Myers, 1965). The high level of infestation of tilapia and circumstantial evidence suggest that tilapia have played a role in the decline of the Mariana Common Moorhen (*Gallinula chloropus guami*) and the extinction of the Marianas Mallard (*Anas oustaleti*) (Stinson *et al.*, 1991b). Poaching and egg collection also played a major role in the extinction of the Mallard.

Except for a small amount of agriculture, wetlands are subject to little use. In the near future, portions of publicly owned marsh may be used for taro cultivation in an experimental moorhen habitat improvement programme administered by the CNMI Department of Natural Resources. Although subject to little economic activity, the value of the wetlands for flood control and groundwater recharge should not be underestimated. Underground sources for public water supply are limited; the wetlands are sites of groundwater recharge and help to reduce salt water intrusion. While allowing recharge, the wetlands store great quantities of storm run-off during heavy rains. The marshes also filter out large quantities of eroded material that might otherwise increase siltation of the coastal lagoon and reef resulting in coral die-off.

The freshwater wetlands of Saipan and Tinian are essential to the survival of the Mariana Common Moorhen, a U.S. and CNMI Endangered Species. The Nightingale Reed-warbler (*Acrocephalus luscinius luscinius*) on Saipan, also listed as an Endangered Species, uses reedy marshes and wetland edges, but is not restricted to wetland habitats. The Guam population, which seems to have been primarily restricted to wetland habitats, is now extinct (Reichel *et al.*, 1992). The wetlands of the CNMI are also used by a great variety of migrants.

The greatest threats to wetlands are development and drawdown for water use. At present, wetlands are effectively protected by both federal and local laws. Wetlands would almost certainly be subject to greater development pressures should any political changes reduce the involvement of federal agencies. There is reportedly an investigation being conducted to determine the feasibility of using the waters of Lake Susupe for public water supply. Such use would undoubtedly result in: (a) a reduction in the size of the Susupe wetlands, (b) a decrease in the depth and therefore the amount of open water at Lake Susupe due to encroachment by emergent aquatic plants, and (c) the seasonal persistence of flooding throughout the marsh. This has been a problem on Tinian, where wells adjacent to Makpo Swamp have been pumping water since the 1930s. Makpo is described in historical literature as open water with a variety of waterfowl, but it is now a shallow swamp (Barran, 1988; Northern Islands Company, 1989). An additional threat is the potential use of wetlands for aquaculture, which would render portions of the wetlands unsuitable for the Mariana Moorhen.

Wetland Research

There is currently little wetland research being conducted, with the exception of an ecological study of the Mariana Moorhen and an attempt to create artificial wetland as mitigation for loss of wetland habitat as a result of filling (Dames and Moore, 1990). Past research has involved descriptive inventories and engineering studies for flood control proposals (Tenorio and Associates, 1979; Moore *et al.*, 1977; Best and Davidson, 1981; ERC, 1990). The most intensive research activity occurred for the environmental impact analysis for two flood control project proposals (U.S. Army Corps of Engineers, 1986a & 1986b). These projects seem to be on hold because of marginal cost/benefit analyses and lack of local funding, but will probably be revived in the event of future flood damage. These projects could probably be designed to improve habitat conditions for Mariana Moorhens, and may provide the funding and impetus for much needed but costly habitat improvement activities. These needs include an increase in open water habitat and the eradication of tilapia, if feasible.

Wetland Area Legislation

(a) Federal Laws

- Rivers and Harbors Act of 1899 - Authorizes the Army Corps of Engineers to regulate dredging of 'navigable' waters.
- Fish and Wildlife Coordination Act of 1958 - Includes a requirement that other federal agencies consult with the U.S. Fish and Wildlife Service about proposals that have an impact on wetlands.
- Land and Water Conservation Fund Act of 1965 - Authorizes a fund from which money can be used for acquisition of land for conservation purposes.
- Coastal Zone Management Act of 1972 - Requires that all federal actions be consistent with an approved management programme, and provides a framework for providing funding to state

coastal resource management programmes, including the CNMI Coastal Resources Management Office.

- Endangered Species Act of 1973 - Section 2 directs federal agencies to cooperate with state and local agencies to resolve water resource issues in concert with the conservation of endangered species. Section 7 directs federal agencies to consult with the U.S. Fish and Wildlife Service about any action, including issuance of permits, that will impact endangered species.
- Clean Water Act of 1977 - in addition to water quality provisions in this law, Section 404 authorizes the Army Corps of Engineers to regulate the discharge of fill into wetlands through a permit system.
- Emergency Wetlands Resources Act of 1986 - Authorizes the use of money from the Land and Water Conservation Fund for the acquisition of important wetland habitat. The Act directs the Department of the Interior to develop a plan for identifying priority sites for acquisition. National and Regional Wetlands Priority

Conservation Plans have been prepared by the U.S. Fish and Wildlife Service (U.S. Fish & Wildlife Service, 1989a & 1990).

(b) Commonwealth Laws

- Coastal Resources Management Act (PL 3-47) - Established the Coastal Resources Management Office (CRMO) and contains regulations and standards for activities permitted in 'Wetland and Shoreline Areas of Particular Concern' (APCs). The established policy for impacts to APCs is sequential consideration of avoidance, minimization and mitigation. Regulations affecting APCs include the prohibition of adverse impacts on drainage patterns, destruction of important habitat, discharge of toxic substances and degrading of water quality and flow. Regulations also protect mangroves and critical wetland habitat of rare and endangered species and maintenance of public landholdings within and adjacent to wetland and mangrove APCs. One limitation encountered has been that these regulations are locked into APCs as outlined on maps that fail to delineate the wetlands adequately. This has limited the ability of CRMO to protect wetlands not so identified. This problem is currently being corrected.
- Fish, Game and Endangered Species Act (PL 2-51) - Authorizes the designation of endangered species and critical habitat. The Act established the Division of Fish and Wildlife, and contains fish and wildlife regulations. One shortcoming is the lack of specific powers and protections in the critical habitat designation. Environmental Protection Act (PL 3-23) - Established the Division of Environmental Quality, and includes regulations for water quality certification, waste water discharge and earth-moving permit systems.
- Public Land Exchange Act (PL 5-33) - Includes the framework for acquisition of land for public purposes, including wetland protection, through exchange for public land. The Act makes no provision for prioritizing wetland acquisitions.

Wetland Area Administration

One wetland on Saipan (not otherwise described in this Directory) is part of American Memorial Park, a U.S. National Park administered by the National Park Service. This wetland is primarily swamp and was impacted by filling and waste oil in the past. Most of the mangroves on Saipan are found in the Park, either in this wetland or adjacent to the Puerto Rico mudflats. The mudflats are not part of the National Park, and are therefore not adequately protected. The Park wetland is used by a small number of Mariana Moorhens. No other wetlands are formally protected. However, privately owned wetlands are being acquired through exchange for other public land to protect wetlands and relieve private individuals of land which cannot be filled for development. The supply of public land available for exchange may, however, be exhausted before all wetlands are acquired. The Mariana Public Land Corporation that administers public lands has verbally expressed the willingness to turn management of the acquired wetlands over to the CNMI Department of Natural Resources.

Organizations involved with Wetlands

a) CNMI Government

- Mariana Public Land Corporation (MPLC)
 - Leases public land for development, homesteads, agriculture and grazing, and administers land acquisition through land exchanges.
- Coastal Resources Management Office (CRMO)
 - The primary permitting agency for physical development, including activities within the coastal and wetland 'Areas of Particular Concern'.
- Division of Environmental Quality (DEQ)
 - Regulates water quality and contaminants. The DEQ is the permitting agency for pollution control, sewage disposal and earth-moving activities. It monitors water quality and administers most of the federal clean water laws.
- Department of Natural Resources (DNR)
 - Responsible for the management and disposition of submerged lands. The Director is authorized to designate 'Critical Habitat' for endangered species.
- Division of Fish and Wildlife (DFW)
 - Conducts research on native fauna including the Moorhen. The DFW reviews land use proposals and makes recommendations to CRMO, DEQ, DNR and federal agencies concerning permit issuance and conditions.

b) U.S. Government

- U.S. Army Corps of Engineers (ACOE)
Mandated by Section 404 of the Clean Water Act to regulate the discharge of fill into wetlands through a permit system. The ACOE also regulates dredging of navigable waters through the Rivers and Harbors Act.
- U.S. Fish and Wildlife Service (USFWS)
Mandated to ensure the survival of Endangered Species. This includes review of project proposals that will affect Endangered Species including Section 404 permit applications to ACOE for the discharge of fill into wetlands. The USFWS consults with other federal agencies regarding permit applications and proposals. The USFWS Refuge Section may become involved in formal protection of important CNMI wetlands by the establishment of a wildlife refuge, and is authorized to expedite protection through easements or acquisition when necessary.
- Environmental Protection Agency (EPA)
Evaluates permit applications to ACOE under EPA's 404 (b) (1) 'Guidelines for impacts that can be avoided and may require public participation and a detailed alternative analysis'.

WETLANDS

Site descriptions compiled by Derek W. Stinson of the Division of Fish and Wildlife, CNMI Government.

Wetland Name: Pagan Lakes

Country: Northern Marianas

Coordinates: Inner (Sanhalom) Lake 18°09'52"N, 145°46'39"E; Lagona Lake 18°08'19"N, 145°46'03"E

Location: on the island of Pagan, 375 km north of Saipan. Both lakes are on the main northern part of the island. Lagona Lake is near the west coast and Inner Lake is at the western foot of Mount Pagan.

Area: Lagona Lake 17 ha; Inner Lake 15 ha.

Altitude: Lagona Lake 0.15 m; Inner Lake 1.3 m.

Overview: The two Pagan lakes are the only significant wetlands on the islands north of Saipan. Both lakes are geologically rather young and have not developed marshes. The emergent vegetation that was present was recently destroyed by both feral ungulates and a volcanic eruption that deposited large amounts of cinders on the lake shores.

Physical features: Pagan is a volcanic island of 46 sq.km. The most recent major eruption was in

1981. According to Corwin *et al.* (1957), Inner Lake has a nearly flat muddy bottom with a maximum depth of 23 m. Recent accumulation of cinders may have decreased the size and depth somewhat. Warm springs emptied into the lake near the southeast shore, but these may also have been affected by the eruption in 1981. The lake waters are oligosaline, with an average chloride content of 2.5 p.p.t.

Lagona Lake has, or had, a maximum depth of 20 m (Corwin *et al.*, 1957). The bottom of fine grained alluvium is covered by organic debris. A cinder beach 10 m in height and a minimum of 85 m in width separates the western shore of the lake from the ocean. The beach isolates the lake sufficiently to make tidal influence of the lake very small. During storms, waves sometimes wash over the beach and raise the level of the lake. The lake water is mesosaline, with an average chloride content of 7 p.p.t.

The climate of Pagan is similar to that of Saipan but with slightly less annual rainfall (approximately 1,730 mm) and slightly cooler temperatures (average 27-29°C).

Ecological features: The lakes have been heavily impacted by man and volcanic activity. Earlier this century, the lakes supported a fringe of water fern (*Acrostichum aureum*) which was used by Mariana Common Moorhens (*Gallinula chloropus guami*) and an endemic form of the Nightingale Reed-warbler (*Acrocephalus lusciniya yamashinae*). However, much of this vegetation was destroyed by feral animals in the 1960s and 1970s. In 1981, Mount Pagan erupted and buried any remaining emergent vegetation under ash deposits. Another factor that has had a serious impact on the ecology of the lakes has been the introduction of tilapia (*Sarotherodon mossambicus*) in the 1950s (Stinson *et al.*, 1991b). Although Inner Lake had a thick layer of cinders floating on its surface for months after the recent eruptions, the tilapia survived, and both lakes are heavily infested with this pest species.

The vegetation surrounding Lagona Lake is primarily trees, particularly *Cocos nucifera*, *Casuarina equisetifolia* and *Hibiscus tiliaceus*. Small patches of sedges (*Cyperus* spp.) and grasses have colonized the northern shore. Inner Lake has had much of the surrounding vegetation buried by ash deposits, but the west shore has a stand of *Casuarina* and there are a few *Cocos* palms.

Land tenure: Public/Commonwealth.

Conservation measures taken: In an effort to allow emergent aquatic plants to become re-established on the shore of Lagona Lake, a solar electric fence has been erected by the Division of Fish and Wildlife and Soil Conservation Service to exclude feral ungulates.

Conservation measures proposed: If emergent vegetation becomes re-established and if tilapia could be eradicated, Mariana Common Moorhens might be re-introduced.

Land use: None; the island is uninhabited.

Possible changes in land use: None expected in the immediate future because of sporadic volcanic activity. However, if the volcano becomes quiescent, the island may be re-inhabited and receive consideration for development. Pagan is the largest Mariana island north of Saipan, and has the safest anchorage and most extensive beaches.

Disturbances and threats: Lagona Lake was formerly the site of a village, and during World War II, the island's population reached 8,000. However, the most obvious disturbances have been due to thick deposits of volcanic ash and cinders. The introduction of tilapia and mosquito fish (*Gambusia* spp.) has also had a serious impact on the aquatic ecosystem. There seems to be no additional threats to these lakes at present, unless resort developments are proposed. Intense grazing by domestic animals destroyed much of the wetland vegetation and apparently caused the extinction of the endemic subspecies of Nightingale Reed-warbler in the 1960s (Reichel *et al.*, 1992).

Hydrological and biophysical values: The lakes retain large quantities of silt that would otherwise have an impact on the fringing reef.

Social and cultural values: Pagan is no longer inhabited, but the lakes were used for fishing and recreation when the island was inhabited. Lagona Lake was the site of a village during the Japanese administration (1914-1944).

Noteworthy fauna: The wetland vegetation formerly supported a population of about 75 Mariana Common Moorhens (*Gallinula chloropus guami*) and an endemic subspecies of the endangered Nightingale Reed-warbler (*Acrocephalus lusciniya yamashinae*). No Reed-warblers could be found in 1979, and this subspecies is now believed to be extinct (Tenorio and Associates, 1979). The Moorhen is also now extinct on Pagan,

although it survives elsewhere in the Mariana Islands (Stinson *et al.*, 1991b). The introduction of tilapia in the 1950s may have affected the Moorhen and led to its decline prior to the volcanic eruption of 1981 which finally eradicated this population (Stinson *et al.*, 1991b). The lakes are often used by migrant and vagrant waterbirds. Species reported include: *Phalacrocorax carbo*, *P. melanoleucos*, *Nycticorax nycticorax*, *N. caledonicus*, *Bubukus ibis*, *Egretta sacra*, *E. garzetta*, *Anas penelope*, *A. crecca*, *A. platyrhynchos*, *Pandion haliaetus*, *Tringa nebularia*, *T. glareola*, *Xenus cinereus*, *Actitis hypoleucos*, *Heteroscelus brevipes* and *H. incanus*.

Noteworthy flora: None.

Recreation and tourism: The lakes provide recreational swimming and are an interesting place to explore for visiting scientists and transient sailing boats.

Management authority and jurisdiction: Coastal Resources Management (Susupe, Saipan) and U.S. Army Corps of Engineers (Agana, Guam).

References: Corwin *et al.* (1957); Glass *et al.* (1990); Reichel *et al.* (1992); Stinson *et al.* (1991a, 1991b); Tenorio and Associates (1979).

Reasons for inclusion: 1d, 2b; formerly 2a, 2d. These lakes are the only significant wetlands in the archipelago north of Saipan, and are two of only four lakes in the CNMI. They formerly supported a population of the endangered Mariana Common Moorhen (*Gallinula chloropus guami*) and an endemic subspecies of the endangered Nightingale Reed-warbler (*Acrocephalus lusciniya yamashinae*). Moorhens may be re-introduced in the future if the habitat can be rehabilitated.

Source: Derek W. Stinson.

Wetland Name: Puerto Rico Mudflats

Country: Northern Marianas

Coordinates: 15°13'03"N, 145°43'33"E

Location: 1.5 km north of Garapan, Saipan.

Area: 17 ha.

Altitude: Sea level.

Overview: Tidal mudflats bounded by a narrow strip of national park and a landfill. The site has a broken fringe of mangroves. It is the only intertidal mud-bottomed area in the CNMI, and is an important feeding area for migratory waterbirds.

Physical features: A mudflat that is irregularly exposed at low tide. The mudflats contain several rusting hulks of pontoons, remnants from the American invasion of 1944. The site is bounded on the northeast by a landfill built up on coral fill. A narrow fringe of mangrove and strand vegetation along the southeast shoreline is backed by a busy primary road. The southwest is bounded by an artificial breakwater protecting a boat basin.

Ecological features: The southeast boundary comprises a broken fringe of mangroves (*Bruguiera gymnorrhiza*) and other strand trees (*Pandanus* spp. and *Thespesia populnea*). The mudflats are partly vegetated with sea-grasses (*Enhalus acoroides* and *Halodule uninervis*). This area may have been partly filled at one time during construction of the coastal road.

Land tenure: The southeast shore down to the mean high tide mark is part of American Memorial Park, administered by the U.S. National Park Service. Land below the mean high tide mark is public land.

Conservation measures taken: None.

Conservation measures proposed: Acquisition of the mudflats as part of American Memorial Park was recently considered, but was not pursued because of the political risk that this would result in or accelerate consideration of alternative development proposals.

Land use: Recreation and subsistence fishing.

Possible changes in land use: There is reportedly a proposal to close and cap the existing landfill on the northeast boundary of the site, and to use it for commercial docking facilities. This would presumably require the dredging of the northern part of the mudflats to accommodate large ships.

Disturbances and threats: The mangroves may have been much more extensive at one time, but were filled during construction of the coastal road. The main island landfill at the northern boundary may be leaching poisons into the mudflats and tidal waters. No study has been carried out to evaluate or quantify this problem. An abundance of trash and garbage floats or blows onto the shore from the dump, or is deliberately dumped

there. Closure of the dump will stop this, but dump closure may be followed by dredging of a portion of the site for commercial or private port facilities.

Hydrological and biophysical values: The mangroves help to protect the shoreline from typhoon damage and perhaps saltwater intrusion.

Social and cultural values: Primarily in preserving native and migrant birds, and conserving opportunities for traditional harvest of shellfish, although possible contamination of the stocks needs to be investigated.

Noteworthy fauna: The sea-grass beds provide important habitat for juvenile fishes, while the mudflats support an abundance of fiddler crabs (*Uca* spp.) and molluscs. When exposed at low tide, the mudflats are heavily used by resident and migratory waterbirds for feeding. When the flats are not exposed, the pontoons are used as loafing sites by waterbirds. Native breeding birds often seen at the site include *Ixobrychus sinensis*, *Egretta sacra*, *Halcyon chloris* and *Myzomela rubrata*. Migrants that commonly use the area include: *Pluvialis (dominica) fulva*, *Charadrius mongolus*, *Numenius phaeopus*, *Tringa nebularia*, *Actitis hypoleucos*, *Heteroscelus brevipes*, *H. incanus* and *Arenaria interpres*. Additional species recorded at the site include: *Butorides striatus*, *Ardea cinerea*, *Pluvialis squatarola*, *Charadrius leschenaultii*, *Limosa lapponica*, *Numenius arquata*, *N. madagascat-iensis*, *Xenus cinereus*, *Calidris tenuirostris*, *C. ruficollis* and *C. temminckii*.

Noteworthy flora: Mangroves are extremely limited in extent in the CNMI, and are considered to be an endangered habitat. Three small stands on Saipan are the only mangroves in the CNMI.

Scientific research and facilities: The site is used for surveys of migratory birds. Conservation education: The site has potential for school field trips.

Recreation and tourism: The site is immediately adjacent to a National Park and shoreline bike trail. It is one of the best bird-watching localities in the Marianas, and is the site of numerous first records for the archipelago (Glass *et al.*, 1990; Stinson *et al.*, 1991a).

Management authority and jurisdiction: Coastal Resources Management (Susupe, Saipan), Department of Natural Resources (Capitol Hill, Saipan), U.S. Army Corps of Engineers (Agana, Guam) and U.S. National Park Service.

References: Duenas and Swavely, Inc. (no date); Glass *et al.* (1990); Reichel *et al.* (1992); Stinson *et al.* (1991a).

Reasons for inclusion: 1d, 2b, 3b. Perhaps the only mudflat habitat in the CNMI and an important feeding site for migratory shorebirds. The opportunities for migratory shorebirds to stop over during periods of inclement weather are limited in Oceania.

Source: Derek W. Stinson.

Wetland Name: Kagman North

Country: Northern Marianas

Coordinates: 15°10'35"N, 145°46'05"E

Location: approximately 6.6 km ESE of Garapan on the Kagman Peninsula, Saipan.

Area: Approximately 1 ha.

Altitude: 60 m.

Overview: A small, permanently flooded man-made pond and adjacent seasonally flooded field consistently used by relatively high numbers of the endangered Mariana Common Moorhen (*Gallinula chloropus guami*).

Physical features: A 0.5 ha excavated pond with a surrounding berm. A small field outside the berm is seasonally flooded. The pond has a slope of approximately 20% and a maximum depth of 7 m. It was originally excavated as part of an irrigation project in 1971, but apparently was never used. Soil at the site (Chacha Clay) typically has a dark yellowish-brown clay surface layer of approximately 17 cm. The subsoil is mottled, strong brown clay to 100 cm. The substratum is mixed strong brown, dark red and light grey clay to more than 150 cm (Young, 1989).

Ecological features: The pond is partly covered with a mat of swamp morning glory (*Ipomoea aquatica*) and has some *Lemna* spp. floating on the water surface. The surrounding vegetation is primarily tall grass (*Pennisetum purpureum*) and the small tree tangentangen (*Leucaena leucophala*). The vegetation of the adjacent seasonal wetland is typical of disturbed sites, and includes *Mimosa invisa* and *Ludwigia octovalvis*.

Land tenure: Public/Commonwealth.

Conservation measures taken: The pond is currently under the jurisdiction of the Department of Natural Resources.

Land use: The wetland is little used, except for harvest of *Ipomoea aquatica* by nearby residents. The pond also functions in flood control. The adjacent area is a homestead project, and local residents are building homes there.

Possible changes in land use: None expected.

Disturbances and threats: During 1990, much of the surrounding vegetation was mowed down, and apparently the pond was intended to be used as a ponding basin for the new surrounding homestead area. After some inter-agency correspondence, this plan was changed so that the pond will not be further physically impacted. As more homes are built in the adjacent homestead area, there may be increasing disturbance from humans and pets. An additional threat is the potential for introduction of tilapia (*Serotheradon mossambicus*), an aggressive, exotic fish that has seriously impacted the ecology of other wetlands on Saipan.

Hydrological and biophysical values: Kagman North is probably the only permanent freshwater pond on Saipan. Most other wetlands are at least slightly brackish. The pond has an important function in flood control.

Social and cultural values: Primarily preservation of an Endangered Species that was formerly abundant and commonly subject to subsistence hunting.

Noteworthy fauna: The pond supports up to 10% of the Saipan population of the endangered Mariana Common Moorhen (*Gallinula chloropus guami*), and is frequently used by migratory waterbirds including the herons *Bubukus ibis* and *Egretta intermedia* and the ducks *Anas strepera*, *A. crecca*, *A. acuta* and *A. querquedula*. The pond is noteworthy for the absence of tilapia.

Noteworthy flora: None known.

Scientific research and facilities: The wetland will probably become a primary study site for research on the Mariana Common Moorhen. It offers a contrast to other Saipan wetlands that are largely choked with reeds (*Phragmites karka*) and infested with tilapia.

Conservation education: The site has potential for use by small school groups, but access would have to be limited to avoid disturbance to nesting Moorhens.

Recreation and tourism: The wetland is visited by bird-watchers, including occasional tour groups and Audubon field trips.

Management authority and jurisdiction: Department of Natural Resources (Capitol Hill, Saipan) and U.S. Army Corps of Engineers (Agana, Guam).

References: Dames and Moore (1990); Stinson *et al.* (1991b); Young (1989).

Reasons for inclusion: 2a, 3c. The site consistently supports up to 10% of the Saipan population of the Mariana Common Moorhen and up to 5% of the world population of this endangered subspecies.

Source: Derek W. Stinson.

Wetland Name: Susupe Wetland

Country: Northern Marianas

Coordinates: 15°09'10"N, 145°42'40"E

Location: east of Susupe village, Saipan. The site includes Susupe Lake and the surrounding marsh from Chalan Kiya to Chalan Kanoa and Chalan Paio.

Area: 202 ha.

Altitude: 0.8 m.

Overview: A slightly brackish marsh containing a 17 ha lake and about 17 small ponds. This wetland is essential habitat for the endangered Mariana Common Moorhen (*Gallinula chloropus guami*), and is used by the endangered Nightingale Reed-warbler *Ocrocephalus luscini*a). The lake and marsh constitute the largest area of waterbird habitat in the CNMI.

Physical features: Susupe Wetland encompasses a major portion of the western coastal plain of Saipan between the villages of Oleai and San Antonio. The wetland was probably once a coastal lagoon, but was formed when coastal lime sand blocked off the low-lying area from the sea (U.S. Army Corps of Engineers, 1986b). The wetland receives run-off from a watershed of about 1,120 ha. During the rainy season, the entire marsh retains standing water, reaching a depth of 1.8 m in the small pothole ponds. During the dry season, much of

the standing water disappears, but most of the soil remains saturated and the potholes normally retain water. The potholes have been reported to dry up in extremely dry years (U.S. Army Corps of Engineers, 1986b). The limestone rocks and sandy soils that underlie much of the area possess a great capacity for absorption, and allow rainwater to percolate. There is very little surface flow of water in channels.

Lake Susupe is the central and lowest point within the wetland. The lake and nearby ponds may be sink holes in the underlying limestone. The lake is perennial and has no surface outlet to the sea. Lake water contains high concentrations of alkaline earths derived from the drainage through limestone. Susupe is a closed mixohaline lake with reported salinities of 0.5-11 p.p.t., and is contiguous with basal groundwater. Periodic changes in water level occur, but are not caused by tidal action. The lake shows very little stratification in temperature, salinity and pH (7.2-8.4). Surface waters are saturated with dissolved oxygen during the day. Bottom sediments consist of black, gelatinous sedimentary peat composed of decaying vegetation and plankton, terrigenous silts and clays. Organic and inorganic nitrogen levels in Lake Susupe are high, but phosphate seems to be scarce. Lake water examined in a glass appears faint yellowish-brown in colour. pH data suggest that the colour is due to suspended particulates rather than to humic acid discoloration (U.S. Army Corps of Engineers, 1986b).

The small pothole ponds to the east and south of the lake show more pronounced thermal stratification and rapid extinction of dissolved oxygen below the surface. The lack of mixing in these ponds and the high oxygen demand from decomposing vegetation create a stagnant, highly reducing environment. Salinity measurements have ranged from about 0.5 to 5.8 p.p.t. (U.S. Army Corps of Engineers, 1986b). pH measurements taken in December 1978 at the potholes ranged from 4.5 to 8.3 (U.S. Army Corps of Engineers, 1986b). The soil of the marsh, Mesei Variant muck, typically has a black muck surface layer of 20 cm. Below this to 60 cm is 'very dark grey gravelly mucky clay loam and olive grey gravelly mucky sandy loam'. The substratum is 'grey very gravelly sandy loam' (Young, 1989). Parts of the wetland, particularly on the west side, were filled with limestone gravel and debris previous to and during World War II.

The climate is warm and humid, the temperature almost always remaining between 25 and 30°C. The annual rainfall, most of which falls in the rainy season from July to December, is 2,000-2,500 mm. The CNMI is in or near an area of typhoon formation, and is subject to occasional periods of heavy rain.

Ecological features: The original plant communities in the wetland are unknown because they were cleared for extensive cultivation of rice and sugar cane during the 30 years of the Japanese mandate (1914-1944). Lake Susupe has a relatively narrow fringe of bulrush (*Scirpus littoralis* var. *thermalis*). Surrounding the bulrush is a broken band of water fern (*Acrostichum aureum*) which grows to over two metres tall and in water up to one metre in depth. Ironwoods or Australian pines (*Casuarina equisetifolia*) form a broken line around the lake and patchy stands with an understorey of *Acrostichum* in the pothole area east of the lake. Most of the marshland beyond this fringe is choked with dense, monospecific stands of reeds (*Phragmites karka*) broken only at the potholes and by a few stands of bamboo (*Bambusa vulgaris*). Floating mats of salt grass (*Paspalum distichum*) are found at most of the potholes. Around the outer boundaries of the marsh and west of the lake are dense stands of the small tree *Hibiscus tiliaceus* forming seasonally flooded swamps.

Land tenure: The wetland is part public (Commonwealth) land and part private land. Lake Susupe is publicly owned, but a small portion of the lake shore is privately owned. Conservation measures taken: No official refuges have been specifically designated, but all wetlands are regulated by local and U.S. Federal statutes. The most effective protection for local wetlands is Section 404 of the U.S. Clean Water Act. This Section requires that any discharge of fill into a wetland must have a permit issued by the U.S. Army Corps of Engineers. The listing of the Mariana Common Moorhen (*Gallinula chloropus guami*) as a U.S. Endangered Species in 1984 resulted in the additional requirement that the U.S. Army Corps of Engineers cannot issue a permit to fill Saipan wetlands without first consulting with the U.S. Fish and Wildlife Service. Privately owned portions of the wetland are being acquired through the exchange of public land when landowners express an interest in this action. The Commonwealth is thus acquiring wetland for conservation purposes. This process has been relatively free of political considerations, but public land available for exchange may be exhausted before all the wetland is acquired.

Conservation measures proposed: No official proposals to make the wetland into a refuge have been made. The U.S. Fish and Wildlife Service has tentative plans to help acquire easements and acquisition to expedite the establishment of a Commonwealth wildlife refuge. The wetland is on the list for priority acquisition for federal funds when available (U.S. Fish and Wildlife Service, 1990).

Land use: Very little of the wetland is used. There is a private home on the west shore of the lake and a small vehicle repair shop. There is also a small amount of cultivation of taro on private land on the fringes of the wetland. A very small amount of recreational fishing takes place at the lake. The villages of Susupe and Chalan Kanoa lie to the west and southwest of the wetland. These areas are densely populated suburban neighbourhoods.

Possible changes in land use: No changes in land use are anticipated, but land adjacent to the wetlands will be heavily developed for housing and small businesses. A major flood control project was proposed for the area, but was never implemented, perhaps because of lack of local financial commitment (U.S. Army Corps of Engineers, 1986b). This proposal may resurface after the next episode of severe flooding. If this project were properly designed and maintained, it might improve the wetland as Moorhen habitat. There have been proposals in the past to use the lake water for irrigation, aquaculture or public water supply, but none is being considered seriously at present.

Disturbances and threats: The wetland ecosystem has been seriously impacted by past activities. During the Japanese mandate, many dikes and irrigation canals, still visible today, were constructed throughout the marsh. The present effect on drainage is unknown. The lake was also connected to the sea by a drainage ditch, but this was blocked by road construction in 1944. Lake water was used for irrigation and for industrial wash water for a nearby sugar mill. The mill's effluent, containing soil, cane waste and perhaps pesticides, drained back into the lake through a ditch. The lake was probably also affected by fertilizers from adjacent wetland farming. These disturbances probably caused whole-scale reduction in species diversity of the aquatic plant and animal community. Also of importance was the introduction of exotic mosquito fish (*Gambusia affinis*) and tilapia (*Sarotheradon mossambicus*). *Gambusia* was probably introduced by the U.S. military during World War II for mosquito control. Tilapia were introduced in 1955 for aquaculture. Both species are hardy, tolerant omnivores, and have been implicated in the reduction and extirpation of native fishes and crustaceans elsewhere (Courtenay & Robins, 1989; Maciolek, 1984; Myers, 1965). These exotic species, coupled with the degradation of the lake environment, may have had a severe impact on aquatic food organisms and may have contributed to the extinction of the Marianas Mallard (*Anas oustaleti*) and the decline of the Mariana Common Moorhen (Stinson *et al.*, 1991b). The most recent threat to the wetland is a proposal, currently under study, to use lake water as a source of public water.

Hydrological and biophysical values: The role of Susupe wetland in groundwater recharge and flood control is extremely important. The lake and marsh hold great amounts of storm water after storms, and allow infiltration to the groundwater. The sediment trapping function of the wetland is crucial to the health of the lagoon and reef less than one km from the western edge of the wetland. Sediment load and coastal erosion would be much worse if the wetland did not stop and hold storm water during typhoons.

Social and cultural values: The wetland is one of the characteristic features of Saipan for residents and visitors alike. Recreational fishing, the hunting of waterbirds (now prohibited) and exploring the fringes of the wetland are important memories to many long-time residents. The wetland is critical habitat to endemic bird species that are unique to the Marianas, including the Mariana Common Moorhen (locally called 'Pulattat'), the Nightingale Reed-warbler ('Gaga kariso') and formerly the Marianas Mallard, now extinct. These species are part of the threatened heritage of the CNMI. The lake and marsh are not very important in fish production. Tilapia are little used, and access to the lake is very limited as the marshes are covered with impenetrable reed thickets. As more and more of Saipan's natural areas are lost to development and the proliferation of resorts and golf courses, these marshes are likely to be amongst the last fragments of wild areas and important wildlife habitat remaining on the island.

Noteworthy fauna: Susupe wetland constitutes 77% of the remaining habitat for the Mariana Common Moorhen (*Gallinula chloropus guami*) in the CNMI (excluding Guam). This endemic subspecies of Moorhen was listed as Endangered by the U.S. Fish and Wildlife Service in 1984. Only about 300-400 survive on the islands of Guam, Saipan and Tinian. Estimates of the number occupying the Susupe wetland have included 36 (Stinson *et al.*, 1991b), 90-120 (U.S. Army Corps of Engineers, 1986b) and 60-100 (Tenorio and Associates, 1979). Although the quality of the wetland is reduced, it supports a large percentage of the Moorhens remaining on Saipan and perhaps nearby Tinian. It is also a dry season refuge for Moorhens when many other smaller wetlands have dried up. The Moorhen shared habitats with the Marianas Mallard (*Anas oustaleti*), which is now extinct, partly as a result of over-hunting and partly as a result of wetland loss and degradation. The wetland is also used by the endangered Nightingale Reed-warbler (*Acrocephalus luscinioides*). This species has become extinct on Pagan, Aguijan and Guam for various

reasons. It remains relatively widespread on Saipan, but its habitat is rapidly decreasing as a result of development.

In addition to the Moorhen, Reed-warbler and common resident breeding birds such as the Yellow Bittern (*Ixobrychus sinensis*), the wetland is used by a variety of migratory and vagrant species. These have included: *Nycticorax nycticorax*, *Bubulcus ibis*, *Egretta sacra*, *E. garzetta*, *E. intermedia*, *E. alba* (*Casmerodius albus*), *Ardea cinerea*, *Anas penelope*, *A. falcata*, *A. strepera*, *A. crecca*, *A. acuta*, *A. querquedula*, *A. clypeata*, *Aythya ferina*, *A. fuligula*, *A. mania*, *Larus ridibundus*, *Chlidonias hybrida* and *Sterna bergii*.

A species of prawn has been described from Susupe Lake, but apparently is now rare or extinct (Gurney, 1939).

Noteworthy flora: The wetland includes the largest reed marsh remaining in the Marianas and a large percentage of the swamp habitat.

Scientific research and facilities: Research on the Mariana Common Moorhen is being conducted at the wetland.

Conservation education: If the lake and surrounding marsh can be secured through land exchange, easements and outright purchase, the potential exists for some interpretive development. The U.S. Fish and Wildlife Service has tentative plans to help establish a Commonwealth Wildlife Refuge at the wetland. The possibility exists for an interpretive board-walk nature trail.

Recreation and tourism: The lake is stagnant, has a very muddy bottom and is rather shallow. The potential for recreation is low except for nature trails. An interpretive nature trail and visitor centre would probably be heavily used by tourists. However, the best location for such a facility, on the western shore of the lake, is privately owned.

Management authority and jurisdiction: Commonwealth agencies: Division of Fish and Wildlife (Saipan), Coastal Resources Management (Susupe, Saipan) and Mariana Public Land Corporation (Capitol Hill, Saipan). Federal agencies: U.S. Fish and Wildlife Service (Honolulu, Hawaii) and U.S. Army Corps of Engineers (Agana, Guam and Fort Shafter, Hawaii).

References: Courtenay & Robins (1989); Gurney (1939); Maciolek (1984); Myers (1965); Stinson *et al.* (1991b); Tenorio and Associates (1979); U.S. Army Corps of Engineers (1986b); U.S. Fish and Wildlife Service (1989b & 1990); Young (1989).

Reasons for inclusion: 1a, 2a, 2b, 2d, 3c. Susupe wetland supports a minimum of 10% of the world population of the Mariana Common Moorhen (*Gallinula chloropus guamt*). It should be considered critical to the survival of this endangered subspecies.

Source: Derek W. Stinson.

Wetland Name: Flores Pond

Country: Northern Marianas

Coordinates: 15°08'23"N, 145°42'50"E

Location: 2 km north of Saipan International Airport, Saipan.

Area: 1 ha.

Altitude: 40 m.

Overview: A small, seasonally flooded pond that is consistently used by relatively high numbers of Mariana Common Moorhens (*Gallinula chloropus guami*).

Physical features: Flores Pond lies in the lowest point of a depression of approximately 5 ha. The soil is primarily Inarajan Clay, a deep, somewhat poorly drained soil formed in mixed alluvium from volcanic and limestone uplands. The surface layer is dark clay about 18 cm thick over mixed very dark grey or grey-brown clay and a substratum of brown clay to 150 cm (Young, 1989). The area generally retains ponded rainwater during the rainy season, but dries up during the early dry season. The area that remains flooded for the longest period has a mud bottom, but is colonized by grasses and forbs during the dry season.

The climate is warm and humid, the temperature nearly always remaining between 25 and 30°C. The annual rainfall of approximately 2,000-2,500 mm falls primarily during the rainy season, which lasts from July to December. The month with the highest rainfall is usually September. The CNMI lies in or near an area of typhoon formation, and is subject to occasional periods of heavy rainfall and flooding.

Ecological features: The vegetation is typical of abandoned agricultural sites, and the original vegetation is unknown. The vegetation at the pond includes grasses, forbs (*Ludwigia octovalvis*) and shrubs (*Sesbania cannabina*). Areas of mud become exposed at low water levels. The surrounding vegetation is part forested (with some *Hibiscus tiliaceus*) and part pasture and agricultural fields.

Land tenure: Privately owned.

Conservation measures taken: Identified as a Priority Wetland Acquisition Site in the Regional Wetlands Concept Plan under the Emergency Wetland Resources Act (U.S. Fish & Wildlife Service, 1990).

Conservation measures proposed: Potential exists for public acquisition through land exchange.

Land use: The site receives some light grazing during the dry season. It appears to have been used for agriculture in the past.

Possible changes in land use: The drainage pattern could easily be disrupted by nearby development if this were to prevent storm water from reaching the pond.

Disturbances and threats: The area is used for some light grazing during the dry season, but this does not seem to have any negative effects. Introduced tilapia (*Sarotheradon mossambicus*) entered the wetland in storm waters in 1990, but died off when the pond dried up. Part of the wetland appears to have had some top-soil removed, and this is a potential problem in the future. Renewed agricultural activity is possible, but if this were limited in extent, it would probably not have serious impacts. Possible development of adjacent lands may reduce the available cover and affect use of the wetland by birds.

Hydrological and biophysical values: The pond retains large amounts of storm water and allows it to infiltrate or evaporate slowly. It also retains eroded soil that would otherwise impact the lagoon and offshore reefs. The pond also probably recharges groundwater to some extent.

Social and cultural values: Primarily in preserving endangered endemic bird species and functioning as a site for educational field trips.

Noteworthy fauna: Relatively large numbers (maximum 16) of the endangered Mariana Common Moorhen (*Gallinula chloropus guami*) use the wetland when it is flooded, and the endangered Nightingale Reed-warbler (*Acrocephalus luscini*) has been recorded there. Areas of shallow water and mud are heavily used by the Moorhens and also by a variety of migrant and vagrant waterbirds which have included: *Phalacrocorax melanoleucos*, *Nycticorax nycticorax*, *Bubulcus ibis*, *Egretta garzetta*, *Anas crecca*, *A. acuta*, *A. querquedula*, *A. clypeata*, *Aythya ferialis*, *Pluvialis (dominica) fulva*, *Tringa stagnatilis*, *T. nebularia*, *T. ochropus*, *T. glareola*, *Actitis hypoleucos*, *Gallinago hardwickii*, *G. gallinago*, *Calidris temminckii*, *C. acuminata*, *C. alpina*, *Philomachus pugnax* and the wagtail *Motacilla alba lugens* (Glass *et al.*, 1990; Stinson *et al.*, 1991a).

Noteworthy flora: None known.

Scientific research and facilities: The pond will probably become an important study site for the Mariana Common Moorhen.

Conservation education: The site is used by the Marianas Audubon Society during field trips, and has been used by the Soil Conservation Service during its field trips. The wetland will continue to be used for recreational and educational activities as long as the landowners are willing to allow access.

Recreation and tourism: The wetland is used by small groups of resident bird-watchers and bird tours, but as the site is small, seasonal and privately owned, the potential is limited.

Management authority and jurisdiction: Mr Donald Flores (owner) and U.S. Army Corps of Engineers (Agana, Guam).

References: Glass *et al.* (1990); Stinson *et al.* (1991a, 1991b); U.S. Fish & Wildlife Service (1990); Young (1989).

Reasons for inclusion: 1a, 2a, 3c. The site seasonally supports up to 10% of the Saipan population and 5% of the world population of the endangered Mariana Common Moorhen. It is also an important stop-over site for a variety of migrant and vagrant waterbirds.

Source: Derek W. Stinson.

Wetland Name: Lake Hagoi

Country: Northern Marianas

Coordinates: 15°04'00"N, 145°43'33"E

Location: west of North Field near the northern end of Tinian.

Area: 17 ha.

Altitude: 5 m.

Overview: Lake Hagoi is a mesohaline marshy pond with less than one ha of open water. Although Lake Hagoi dries up during droughts, it occasionally supports the highest concentrations of Mariana Common Moorhens (*Gallinula chloropus guami*) reported at any site.

Physical features: A marshy pond occupying the lowest part of a basin of 17 ha on a raised limestone terrace. There is generally less than one ha of open water, and the lake dries out completely during prolonged droughts. The wetland soil, Mesei Variant Muck, typically has a black muck surface layer of 20 cm. Below this to 60 cm there is 'very dark grey gravelly mucky clay loam and olive grey gravelly mucky sandy loam', and the substrate is a gravelly loam (Young, 1989). The soil of the surrounding area is Chinen Clay Loam, a shallow, well-drained soil of limestone plateaus.

The climate of Tinian is very similar to that of Saipan, being warm and humid, and subject to heavy rains during tropical storms.

Ecological features: The small area of open water is surrounded by about two ha of marsh vegetation dominated by *Scirpus littoralis*. There are also patches of water fern (*Acrostichum aureum*) near the open water and in the surrounding marsh. Most of the rest of the wetland is vegetated with thick stands of *Phragmites karka*. Near the perimeter of the wetland are patches of *Hibiscus tiliaceus* and bamboo (*Bambusa vulgaris*).

Land tenure: Commonwealth land under lease to the U.S. Navy.

Conservation measures taken: None.

Conservation measures proposed: Lake Hagoi is listed as a potential acquisition site (U.S. Fish & Wildlife Service, 1990). The open water is slowly silting in and becoming increasingly choked with vegetation. Some dredging may be required in the future to maintain open water and increase its permanence through the dry season.

Land use: None. The wetland was formerly used for agriculture.

Possible changes in land use: The U.S. Navy has proposed to lease land back to the local government or individuals for agriculture and grazing, but this would probably not affect the lake.

Disturbances and threats: In former times, a farm was located adjacent to the lake, and shallow wells were dug for irrigation water. Mosquito fish (*Gambusia affinis*) are reported from the lake, and are known to be notoriously destructive to native fauna. The fish was probably introduced by the U.S. military during World War II for mosquito control. Introduced monitor lizards and rats probably also have an impact on nesting birds. The possible introduction of tilapia (*Sarotheradon mossambicus*) may represent the greatest threat to the Mariana Common Moorhen at the wetland. Another potential threat is a proposal to locate a radar installation on Tinian in the direct flight path between Lake Hagoi and Lake Susupe on Saipan. The wide variation in numbers of Moorhens observed at Lake Hagoi suggests that Moorhens fly between Hagoi and wetlands on Saipan seasonally, if not regularly. The proposed radar installation could therefore pose a collision hazard for Moorhens.

Hydrological and biophysical values: Groundwater recharge, although the groundwater is not presently being exploited.

Social and cultural values: Primarily in preserving the endangered Mariana Common Moorhen.

Noteworthy fauna: The extinct Marianas Mallard (*Anas oustaleti*) was last reliably reported from Lake Hagoi in 1974 (Shallenberger, 1979). The largest concentrations of Mariana Common Moorhens (*Gallinula chloropus guami*) ever reported have been at this lake. In 1982, Engbring *et al.* (1986) observed 100 Moorhens and estimated that an additional 25 were present. The highest numbers are generally reported during the dry season, apparently because other wetlands have dried up (Stinson *et al.*, 1991b). The commonest resident bird at the lake is the Yellow Bittern (*Ixobrychus sinensis*). The lake is also frequently used by migratory waterbirds including: *Nycticorax nycticorax*, *Bubulcus ibis*, *Egretta sacra*, *E. intermedia*, *Anas penelope*, *A. strepera*, *A. crecca*, *A. acuta*, *A. querquedula*, *A. clypeata*, *Aythya fuligula* and *Fulica atra*.

Other species reported from the site include a lymnaeid snail (*Galba viridis*) and introduced mosquito fish (*Gambusia affinis*), monitor lizards (*Varanus indicus*) and rats (*Rattus* spp.) (Best & Davidson, 1981).

Noteworthy flora: None known.

Scientific research and facilities: Lake Hagoi will probably be included as a study site in future studies of the Mariana Common Moorhen.

Conservation education: Lake Hagoi is one of only two wetlands of any size on Tinian and could be used for educational field trips, although access is relatively difficult because of the dense vegetation and mud.

Recreation and tourism: The site has only limited potential for recreation and tourism, and these should not be recommended because the development required to improve access would be likely to increase the problems of feral animals and may encourage poaching.

Management authority and jurisdiction: Coastal Resources Management (Susupe, Saipan), U.S. Army Corps of Engineers (Agana, Guam) and Department of the Navy, Pacific Division (Pearl Harbor, Hawaii).

References: Best and Davidson (1981); Engbring *et al.* (1986); Glass *et al.*, (1990); Shallenberger (1979); Stinson *et al.* (1991b); Tenorio and Associates (1979); U.S. Fish & Wildlife Service (1988 & 1990); Young (1989).

Reasons for inclusion: 1a, 2a, 3c. Lake Hagoi occasionally supports higher numbers of the endangered Mariana Common Moorhen than any other site, involving 50% of the CNMI population and perhaps 30% of the entire world population.

Source: Derek W. Stinson.

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