

A Directory of Wetlands in Oceania

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WESTERN SAMOA

INTRODUCTION

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Area: 2,935 sq.km.

Population: 170,000.

Western Samoa is an independent state in the South Pacific situated between latitudes 13° and 14°30' South and longitudes 171° and 173° West, approximately 1,000 km northeast of Fiji. The state comprises two main inhabited islands, Savai'i (1,820 sq.km) and Upolu (1,105 sq.km), and seven islets, two of which are inhabited.

Western Samoa is an oceanic volcanic archipelago that originated in the Pliocene. The islands were formed in a westerly direction with the oldest eruption, the Fagaloa volcanics, on the eastern side. The islands are still volcanically active, with the last two eruptions being in 1760 and 1905-11 respectively. Much of the country is mountainous, with Mount Silisili (1,858 m) on Savai'i being the highest point.

Western Samoa has a wet tropical climate with temperatures ranging between 17°C and 34°C and an average temperature of 26.5°C. The temperature difference between the rainy season (November to March) and the dry season (May to October) is only 2°C. Rainfall is heavy, with a minimum of 2,000 mm in all places. The islands are strongly influenced by the trade winds, with the Southeast Trades blowing 82% of the time from April to October and 54% of the time from May to November. The closeness of Western Samoa to the cyclone belt means that it is frequently affected by cyclones, with the two worst cyclones in recorded history occurring in 1990 and 1991.

Western Samoa has been independent since 1962. The majority of the population, which is Polynesian in origin, live on the island of Upolu. The most densely populated area is the capital city of Apia, where the population density is approximately 75 persons per sq.km. By contrast, Savai'i and rural Upolu are sparsely populated. Agriculture, mainly subsistence agriculture using traditional farming methods, forms the basis of the economy, with the principal subsistence crops being taro, bananas, breadfruit and pawpaws. The four principal cash crops, and main exports, are coconuts, taro, cocoa and bananas. Tourism has grown rapidly in importance in recent years.

The natural vegetation consists primarily of lowland and montane rain forest with additional small areas of cloud, riverine, swamp, mangrove and beach forest. Extensive deforestation has occurred as a result of commercial timber operations and the clearance of land for agriculture. Most of the lowland forest on Savai'i and Upolu has now been cleared or highly modified, but the montane forests are less disturbed and still contain a rich endemic flora and fauna. The terrestrial ecosystems have recently been described by Pearsall and Whistler (1991), while UNEP/IUCN (1988) provide a general account of the coral reef systems and reef resources.

A major survey of potential protected areas was carried out in 1975 by the United Nations Development Advisory Team for the South Pacific (Holloway and Floyd, 1975). This recommended the creation of six national parks, 24 nature reserves, 13 historical/legendary sites and seven archaeological sites, but only one of the national parks (O Le Pupu Pu'e) and one of the nature reserves (Palolo Deep) were subsequently declared, in 1978 and 1979 respectively. A number of studies of the ecosystems and wildlife of Western Samoa have been carried out since then (Dahl, 1980; KRTA Limited, 1988; TCSP, 1990; Pearsall and Whistler, 1991) and these have generally endorsed the proposals of Holloway and Floyd, but no new protected areas have been established, primarily because most of the land proposed for protection is under customary ownership.

Summary of Wetland Situation

There are six main wetland communities in Western Samoa, distinguished from each other by floristic, physiognomic and geographical differences. Three of these communities, coastal marsh, montane marsh and montane bog, are dominated by herbaceous species; the other three, mangrove scrub, mangrove forest and swamp forest, are dominated by woody trees. Of the two main islands of Western Samoa, Upolu is the older and possesses the most wetland areas, especially herbaceous marshes in low-lying coastal basins which are separated from the sea by a sand barrier and lack a stream outlet. This absence of a stream outlet restricts the growth of mangroves in these areas.

The characteristic species of herbaceous marshes and bogs are *Acrostichum aureum*, *Carex graeffeana*, *Cyclosorus interruptus*, *Eleocharis dulcis*, *Paspalum orbiculare* and *Rhynchospora corymbosa*. The separation of coastal marsh from montane marsh is somewhat artificial, since both are dominated by the same species, *Eleocharis dulcis*. However, two species found in coastal marsh (*Acrostichum* and *Cyclosorus*) are rare or absent in montane

marsh. Montane bog, dominated by species of *Carex* and *Paspalum*, is known only from elevations of over 1,500 metres on Savai'i.

Of the wetlands with woody vegetation, swamp forest occurs in sites where the soil is saturated with fresh water, typically inland and even in montane areas. Characteristic species include *Barringtonia samoensis*, *Erythrina fusca*, *Hibiscus tiliaceus*, *Inocarpus fagifer*, *Kleinbovia hospita*, *Palaquium steblinii*, *Pandanus turritus* and *Terminalia richii*. *Pandanus turritus* is generally the dominant species in the swamp forest in montane craters. In eastern Upolu, there is an unusual type of mixed upland swamp forest in which lowland rain forest species and swamp forest species grow side by side.

Mangroves are confined to the two large islands, generally occurring in small stands along tidal inlets, at river mouths or as a narrow fringe along muddy and sandy shores where there is some offshore protection from extreme wave action. Two main communities are recognized; mangrove forest consisting of almost pure stands of *Bruguiera gymnorhiza*, and mangrove scrub (rarely more than 5 m high) consisting of a mixture of both *Rhizophora (mangle) samoensis* and *Bruguiera*. There is also a single small stand (less than 1 ha) of *Xylocarpus moluccensis* on white sand substrate at a stream mouth near Sala'ilua on Savai'i.

Almost all of the wetlands in Western Samoa have been disturbed to some extent either directly by human activities or through the introduction of pests, the only exceptions being some of the higher altitude montane marshes and the montane bog on Savai'i. The cutting and in-filling of mangroves has been largely uncontrolled (Bell, 1985), and much of Western Samoa's mangrove vegetation is now badly degraded. The severe cyclones of 1990 and 1991 affected many of the wetland areas, especially herbaceous marshes along northern and eastern shores which were damaged by salt water incursions.

In their survey of the terrestrial ecosystems of Western Samoa, Pearsall and Whistler (1991) recognized a total of eight wetland ecosystems as follows: *Bruguiera* mangrove; *Rhizophora* mangrove; *Xylocarpus* mangrove; freshwater lake; herbaceous marsh; mixed lowland species swamp forest; mixed upland species swamp forest; and *Pandanus turritus* swamp forest. All eight were considered to be high priorities for conservation based on rarity and threats in Western Samoa, and four (herbaceous marsh, mixed lowland species swamp forest, mixed upland species swamp forest and *Pandanus turritus* swamp forest) were considered to be of global importance because of their rarity, endangered status or presence of endemic species.

The principal wetlands of Western Samoa are as follows:

Coastal Marsh

* Falealili Marsh, Upolu

A series of small herbaceous marshes on the south coast of Upolu, degraded by human impact. The small marsh at Malaemalu was identified as a priority site for conservation by Pearsall and Whistler (1991), but this site is now very degraded and is no longer considered to be a priority.

* Apolimafofou Marsh, Upolu

A small herbaceous marsh at the west end of Upolu, the least disturbed of any coastal marsh in Western Samoa. (See Site Accounts).

* Pu'apu'a Marsh, Savai'i

A small marsh near the east end of Savai'i, degraded by human settlement and not considered to be a priority area for protection.

* Faga Marsh, Savai'i

A small marsh near the east end of Savai'i, degraded by human settlement and not considered to be a priority area for protection.

* Falealupo Marshes (Cape Mulinu'u), Savai'i

Two areas of coastal marsh at the extreme western end of Savai'i, degraded by past exploitation and human settlement, and severely damaged by Hurricane Ofa in 1990. The preservation of the village forest under a covenant agreement has in the last few years increased awareness of the conservation importance of this area. The southern marsh (Tofutafoe) was recommended for designation as a Nature Reserve by Holloway and Floyd (1975), and identified as a priority site for conservation by Pearsall and Whistler (1991).

* Satoalepai Marsh, Savai'i

A large degraded marsh near Matautu Bay at the northern tip of Savai'i. The cyclones of 1990 and 1991 opened up an outlet to the sea, and sea water now flows freely into the marsh.

Montane Marsh

* Lakes and marshes of the Aleipata Uplands, Upolu

A series of small lakes and herbaceous marshes in a chain of volcanic craters in the Aleipata Uplands of eastern Upolu. (See Site Accounts).

* Mount Le Pu'e Lake and Marsh, Upolu

A small lake and marsh in a volcanic crater, protected in the O Le Pupu Pu'e National Park (2,857 ha; established 1978).

* Lake Lanoto'o, Lake Lanoata'ata and Lake Lanoanea, Upolu

Three small lakes with fringing marshes in volcanic craters in the central highlands of Upolu. Lake Lanoto'o is the largest freshwater lake in Western Samoa. (See Site Accounts).

* Olo Manu Uta Marsh (Maugaloa Marsh), Savai'i

A large herbaceous marsh in the eastern highlands of Savai'i. (See Site Accounts).

* Lake Mafane and Lake Mautalano, Savai'i

Two small lakes with fringing marshes in volcanic craters in the eastern highlands of Savai'i. (See Site Accounts).

Montane Bog

* Mount Silisili Bog, Savai'i

A small montane bog near the summit of Mount Silisili (1,858 m); the only significant montane bog in Western Samoa. (See Site Accounts).

Mangrove Scrub

* Vaovai Mangroves, Upolu

A small area of mangrove scrub along a tidal channel near Nu'usafe'e on the south coast of Upolu. Identified as a priority site for conservation by Pearsall and Whistler (1991), but now degraded and no longer considered to be a priority.

* Vaie'e Mangroves (Fusi/Tafitoala), Upolu

An area of mangrove scrub lining a creek on the east side of Safata Bay. The mangrove remains in a fairly healthy state, but is threatened by increasing encroachment from nearby villages. Recommended for designation as a Nature Reserve by Holloway and Floyd (1975).

* Apia Mangroves, Upolu

A narrow strip of mangrove scrub along the north coast of Upolu, west of Apia harbour. The largest area of mangroves in Western Samoa, but degraded because of its location in the main urban area. The site is still of some importance, and is being considered for rehabilitation by the Division of Environment and Conservation.

* Moata'a Mangroves, Upolu

A small patch of mangrove scrub just east of Apia harbour, now largely reclaimed for settlement and developments such as a sports park and hotel.

* Aleipata Mangroves, Upolu

A small patch of mangrove scrub at the east end of Upolu, degraded by human settlement.

* Lano Mangroves, Savai'i

A tiny patch of mangrove scrub near the east end of Savai'i, degraded by human settlement.

* Lalomalava Mangroves, Savai'i

A small patch of mangrove scrub at the east end of Savai'i, degraded by human settlement.

Mangrove Forest

* Sa'anapu-Sataoa Mangrove Forest, Upolu

A large stand of mangrove forest on the west side of Safata Bay; the least disturbed stand of mangrove forest in Western Samoa. (See Site Accounts).

* Falelatai Mangroves (Pata), Upolu

A small patch of mangrove forest on a scenic tidal inlet on the southwest coast of Upolu, degraded by human activities. Recommended for designation as a

Nature Reserve by Holloway and Floyd (1975) and identified as a priority site for conservation by Pearsall and Whistler (1991).

* Fasitootai Mangroves, Upolu

A tiny patch of mangrove forest on the northwest coast of Upolu, degraded by human activities.

Swamp Forest

* Lalomauga Swamp Forest, Upolu

A small patch of degraded swamp forest near the northeast coast of Upolu. Most of the original swamp is covered with village plantations, and there is an electricity power plant in the swamp which supplies the eastern coast of the island.

* Vaipu Swamp Forest (Fusiluaga), Upolu

A large area of swamp forest in the uplands of eastern Upolu, with an unusual mixture of lowland rain forest and swamp forest species. (See Site Accounts).

No conservation areas have as yet been established specifically to protect wetlands, although the O Le Pupu Pu'e National Park (2,857 ha) contains a small crater lake and marsh (Mount Le Pu'e Lake) and a small area of coastal marsh. Parks (1992) identified the most pristine mangrove area in Western Samoa (Sa'anapu-Sataoa) as a Grade 1 Site for conservation, and this mangrove forest has recently been proposed as a Conservation Area to be established with Global Environment Facility funding under the guidance of the South Pacific Regional Environment Programme (SPREP). In addition, several water catchment areas are currently being proposed under the new Water Catchment Protection Regulation proposal to Government.

Of the 21 terrestrial ecosystems described by Pearsall and Whistler (1991), "Mixed Upland Species Swamp Forest" was identified as the highest priority for conservation in Western Samoa. Only three examples of this forest type were known, and the conservation of the largest and least disturbed of these (Punataemo'o Swamp Forest near Afulilo Falls on Upolu) was considered to be the top priority. Unfortunately, this swamp forest has since been cleared for a hydro-electric dam. The second largest example of mixed upland species swamp forest (Vaipu Swamp Forest) is safe for the moment, but could be affected in the future by an expansion of the hydro-electric project.

Very little information is available on the wetland fauna of Western Samoa. Rather few species of waterbirds occur in the islands, and only six species are resident, the Pacific Reef Heron (*Egretta sacra*), Pacific Black

Duck (*Anas superciliosa*), Banded Rail (*Rallus philippensis*), White-browed Crake (*Porzana cinerea*), Spotless Crake (*Porzana tabuensis*) and Purple Swamphen (*Porphyrio porphyrio*). Eight species of shorebirds have been recorded on migration and during the austral summer, but only four, the Pacific Golden Plover (*Pluvialis fulva*), Wandering Tattler (*Heteroscelus incanus*), Bristle-thighed Curlew (*Numenius tahitiensis*) and Ruddy Turnstone (*Arenaria interpres*) are regular (Mayr, 1945; Pratt *et al.*, 1987; Watling and Talbot-Kelly, 1982). The apparently flightless Samoan Woodhen (*Gallinula (Pareudiastes) pacifica*) is known only from the forests of Savai'i and may have frequented the montane wetlands on this island. Although there is no conclusive evidence of its having been found since 1873, there have been unconfirmed reports this century from wetlands in Aleipata District.

Wetland Research

No research relating specifically to wetlands has been carried out in Western Samoa, and most of the information that is available has been derived from general surveys of the terrestrial ecosystems (*e.g.* Ollier *et al.*, 1979; Dahl, 1980; KRTA Limited, 1988; Pearsall and Whistler, 1991; Parks, 1992) and marine ecosystems (*e.g.* Bell, 1985; Andrews and Holthus, 1989; Zann, 1991). Whistler (1992) and Parks (1992) provide the most comprehensive accounts of the flora of Western Samoa's wetlands, while Vodonaivalu (1982) and Sua (1988) summarize information on the mangrove communities. Scientists from ORSTOM are currently conducting a study of fisheries in mangrove areas.

Wetland Area Legislation

There is no specific legislation concerning wetland conservation in Western Samoa, although areas with potential for conservation come under the auspices of the Lands and Environment Act (1989) and National Parks and Reserves Act (1974). Policy and legislation relating to the establishment and administration of protected areas have recently been summarized by IUCN (1991).

The Forestry Act (1967) controls the conservation of water catchment areas under the Regulation on Water Catchment Protection (1992). The exploitation of marine resources is regulated through the Fisheries Protection Act (1972) and the Exclusive Economic Zone Act (1977). The Fish Dynamiting Act (1972) prohibits all use of dynamite for fishing.

The Protection of Wild Birds Regulation, imposed in 1981 under the Animal Ordinance of 1910 and amended in 1989, gives total protection to 15 species of birds and partial protection to three types of pigeon for which there are open seasons. Three resident waterbirds are covered by the schedule, namely the Pacific Black Duck (*Anas superciliosa*), White-browed Crake (*Porzana cinerea*) and Spotless Crake (*Porzana tabuensis*).

At international level, Western Samoa has ratified the Convention on the Conservation of Nature in the South Pacific (Apia Convention) and the Convention for the Protection of the Natural Resources and

Environment of the South Pacific (SPREP Convention), and has also signed but not yet ratified the Convention on Biological Diversity. However, it is not yet a party to the World Heritage Convention, Unesco Man and the Biosphere Programme or Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention).

Wetland Area Administration

With over 75% of Western Samoa's land under customary ownership, the majority of wetlands are administered by village councils and individuals. The Lands and Environment Act (1989) gives the right to the Government to take customary land for conservation purposes if there is a need to protect specific sites, but this right has not yet been used for wetland conservation. The two small wetlands in O Le Pupu Pu'e National Park are administered by the Division of Environment and Conservation, Department of Lands and Environment.

A new system for the protection of biodiversity is being developed whereby villages manage and monitor the conservation of their customary land with Government assistance instead of setting up National Parks. Four villages are already involved in this new method of conservation.

Organizations involved with Wetlands

(a) Western Samoan Government

Department of Lands and Environment

- Division of Environment and Conservation

Responsible for administration of the Lands and Environment Act (1989), National Parks and Reserves Act (1974) and all matters concerning the protection and conservation of the environment.

(b) Non-governmental Organizations

O Le Siosiomaga Society

South Pacific Regional Environment Programme (SPREP)

WETLANDS

Site descriptions based on a report prepared by Cedric Schuster of the Division of Environment and Conservation, Department of Lands and Environment.

Lakes and Marshes of the Aleipata Uplands (1)

Location: 14°00'S, 171°27'-171°33'W; in the eastern highlands of Upolu.

Area: Unknown.

Altitude: 210-550 m.

Overview: A series of small lakes and herbaceous marshes in a chain of volcanic craters in the Aleipata Uplands of eastern Upolu, mostly protected from human impact because of their high altitude.

Physical features: The Aleipata uplands of eastern Upolu comprise a long broad ridge covered with lowland rain forest. There are ten small volcanic craters along the ridge crest, at least seven of which contain interesting wetlands. Olomaga, Lanoto and Savai'i craters contain freshwater lakes with a narrow fringe of herbaceous marsh and patches of *Pandanus turritus* swamp forest; Seuga, Tiatala and Olomauga craters contain patches of *Pandanus turritus* swamp forest; and Latalua crater contains a small herbaceous marsh.

Ecological features: Herbaceous marsh with *Eleocharis dulcis*; swamp forest dominated by *Pandanus turritus*.

Land tenure: Customary ownership.

Conservation measures taken: None.

Conservation measures proposed: The central and eastern portions of the Aleipata Uplands were recommended for designation as a national park by Holloway and Floyd (1975), Dahl (1980), Anon (1985) and KRTA Limited (1988), and were identified as a priority site for conservation by Pearsall and Whistler (1991). The proposed national park (Lake Olomaga National Park) covers 1,300 ha and includes all the main wetlands.

Land use: None at the wetlands.

Disturbances and threats: There is little if any disturbance at the wetlands. The lowland rain forest in this area was severely damaged by Hurricane Ofa in 1990 and again by Hurricane Val in 1991, and the vegetation now consists mainly of weeds and secondary growth.

Hydrological and biophysical values: No information.

Social and cultural values: No information.

Noteworthy fauna: No information is available on the wetland fauna. The surrounding forests are reputed to support a particularly rich and varied bird life.

Noteworthy flora: *Pandanus turritus* swamp forest.

Management authority and jurisdiction: No information.

References: Anon (1985); Dahl (1980); Holloway & Floyd (1975); KRTA Limited (1988); Pearsall & Whistler (1991).

Reasons for inclusion: 1a, 1d, 2b. The site contains several good examples of montane marsh and important stands of *Pandanus turritus* swamp forest.

Source: Cedric Schuster.

Vaipu Swamp Forest (2)

Location: 13°58'S, 171°36'W; in the northern uplands of eastern Upolu, 24 km southeast of Apia.

Area: Approximately 520 ha.

Altitude: 240 m.

Overview: An area of mixed upland species swamp forest in a water-logged basin in the hills of eastern Upolu; the last significant wetland of this type in Samoa.

Physical features: A large patch of swamp forest in a poorly drained basin on one of the main tributaries of the Salani River. The swamp is fed by Afulilo Falls and stream, and lies below the site of the former Punataemo'o swamp forest which was recently submerged by a hydro-electric scheme. The basic alluvium and basic colluvium soils in the central part of the basin are saturated with fresh water, and there is some open water in the northeast.

Ecological features: The forest comprises a mixture of typical swamp forest species and lowland rain forest species, with *Barringtonia samoensis*, *Calophyllum neo-ebudicum*, *Cananga odorata*, *C. harveyi*, *Canthium merrillii*,

Clidemia hirta, *Cyathea* spp., *Dysoxylum samoense*, *Elaeocarpus tonganus*, *Fagraea berteriana*, *Ficus tinctoria*, *Hernandia moerenhoutiana*, *Hibiscus tiliaceus*, *Macaranga stipulosa*, *Myristica fatua*, *M. hypargyrea*, *Neonauclea forsteri*, *Pisonia* sp., *Planchonella torricellensis*, *Pometia pinnata*, *Rhus taitensis*, *Scirpodendron ghaeri*, *Syzygium samarangense* and *Terminalia richii* (Pearsall & Whistler, 1991). The screwpine *Pandanus turritus* and various endemic woody trees such as *Aglaiia samoense*, *Clintostigma samoense* and *Sterculia fanaibo* have also been recorded. The swamp forest lies adjacent to disturbed lowland rain forest and secondary forest.

Land tenure: The wetland and surrounding areas are entirely under customary ownership.

Conservation measures taken: None.

Conservation measures proposed: Holloway and Floyd (1975) recommended that the site be protected as a nature reserve, and this was supported by Dahl (1980). The site has been recognized as one of the highest priorities for conservation in Western Samoa, and was listed as the third highest priority by Pearsall and Whistler (1991) in their "Terrestrial Ecosystem Mapping for Western Samoa". The wetland has recently been proposed as a National Conservation Area.

Land use: None at the wetland. A hydro-electric power scheme has recently been developed in the catchment area.

Disturbances and threats: The wetland is threatened by development of plantations and expansion of the road network in the area. Pigeon hunting causes some disturbance, and there may be a small amount of logging. The cyclones of 1990 and 1991 caused only limited damage to the forest. Development of the Afulilo Hydro-electric Power Project in the water catchment area resulted in the destruction of the neighbouring Punataemo'o Swamp Forest; any further expansion of this project could have a detrimental effect on Vaipu Swamp Forest.

Hydrological and biophysical values: The swamp forest is a very important water catchment area for the Salani river system.

Social and cultural values: The area is of some archaeological significance, with old Samoan settlements at both ends of the wetland. These are believed to have been occupied by the Paramount Chiefs for generations.

Noteworthy fauna: Wildlife recorded at the site includes Pacific Boa (*Candoia bibroni*), two species of flying fox (*Pteropus* sp.), Pacific Black Duck (*Anas superciliosa*), Mao (*Gymnomyza samoensis*) and possibly Spotless Crake (*Porzana tabuensis*). The endangered Tooth-billed Pigeon (*Didunculus strigirostris*) is known to occur in the area.

Noteworthy flora: The site contains a rare type of swamp forest (mixed upland species swamp forest) with a number of endemic tree species.

Scientific research and facilities: The area has never been properly surveyed and is in urgent need of detailed study.

Recreation and tourism: The area has great potential for eco-tourism, although at present it is seldom visited except by pigeon hunters.

Management authority and jurisdiction: The Division of Environment and Conservation has responsibility for management; jurisdiction lies with the Department of Lands and Environment.

References: Anon (1985); Dahl (1980); Holloway & Floyd (1975); Parks (1992); Parks *et al.* (1992); Pearsall & Whistler (1991); Whistler (1992).

Reasons for inclusion: 1d, 2b, 2d. The last example of this type of mixed swamp forest surviving in Western Samoa and reportedly also in the entire South Pacific. Vaipu Swamp Forest may be the only Samoan wetland free of introduced exotic freshwater species. There is a high degree of endemism in the flora and fauna, and the wetland remains in almost pristine condition apart from some recent cyclone damage.

Source: Cedric Schuster.

Lanoto'o, Lanoata'ata and Lanoanea Lakes (3)

Location: 13°54'S, 171°50'W; in the central highlands of Upolu, about 6 km south of Apia.

Area: Lake Lanoto'o 60 ha; area of other lakes unknown.

Altitude: Lake Lanoto'o at 762 m.

Overview: A group of three small crater lakes with fringing herbaceous marsh and *Pandanus turritus* swamp forest, in the central highlands of Upolu.

Physical features: Lake Lanoto'o, Lake Lanoata'ata and Lake Lanoanea are small freshwater lakes inside steep-sided volcanic craters. The open water areas are surrounded by a narrow fringe of herbaceous swamp and *Pandanus* swamp forest. Lake Lanoto'o is the largest lake in Western Samoa.

Ecological features: Herbaceous swamp dominated by *Eleocharis dulcis*, and upland swamp forest dominated by *Pandanus turritus*. Montane rain forest around the lakes includes species such as *Dysoxylum huntii*, *Cyathea* spp., *Hibiscus tiliaceus*, *Pometia pinnata* and *Syzygium* spp.

Land tenure: Half of Lake Lanoto'o is Government Land and half is Customary Land. Surrounding areas are partly Government Land, partly Customary Land and partly private (freehold).

Conservation measures taken: None.

Conservation measures proposed: Holloway and Floyd (1975) proposed the establishment of a national park of about 1,050 ha to protect all three lakes and the surrounding forests, and this was supported by Dahl (1980) and KRTA Limited (1988). Pearsall and Whistler (1991) also identified the three lakes and their surrounding forests as a priority site for conservation. The Department of Lands and Environment has requested the Land Board to set aside Lake Lanoto'o and its environs as a Conservation Area. The Government has been urged to declare its half of the lake as a Conservation Area as soon as possible, and to start negotiating with the customary owners for the remainder.

Land use: None at the wetlands.

Disturbances and threats: Goldfish (*Carassius auratus*) were introduced into Lake Lanoto'o in about 1900 and are thriving. The surrounding forests are being cleared for shifting agriculture and plantations, particularly in the northwest around Lake Lanoata'ata and Lake Lanoanea, and the entire area was badly affected by Hurricane Ofa in 1990 and Hurricane Val in 1991.

Hydrological and biophysical values: The region is an important water catchment area, and includes the headwaters of the Fulu-asou river system which flows north to Apia.

Social and cultural values: Eco-tourism and outdoor recreation activities, if controlled, could generate income for the local people and help to maintain the ecosystem in its natural condition.

Noteworthy fauna: An important area for the Pacific Black Duck (*Anas superciliosa*) and Spotless Crake (*Porzana tabuensis*). The forests contain most of Western Samoa's endemic bird species, notably the endangered Tooth-billed Pigeon (*Didunculus strigirostris*), Samoan Triller (*Lalage sharpei*) and Mao (*Gymnomyza samoensis*).

Noteworthy flora: Swamp forest dominated by the screwpine *Pandanus turritus*.

Conservation education: School field-trips occasionally visit the lakes, and boy-scouts and girl-guides sometimes camp in the area.

Recreation and tourism: The lakes are occasionally visited by tourists (mainly naturalists), and have good potential for tourism. KRTA Limited (1988) has made various recommendations concerning tourist development in the area, including the provision of nature trails.

Management authority and jurisdiction: The Division of Environment and Conservation has responsibility

for management; jurisdiction lies with the Department of Lands and Environment.

References: Anon (1976); Anon (1985); Dahl (1980); Eaton (1985); Holloway & Floyd (1975); KRTA Limited (1988); Parks (1992); Parks *et al.* (1992); Pearsall & Whistler (1991).

Reasons for inclusion: 1a, 2b. Although now very disturbed by encroaching agriculture, the area remains important for wildlife. The site includes the largest lake in Western Samoa.

Source: Cedric Schuster.

Sa'anapu-Sataoa Mangrove Forest (4)

Location: 13°59'S, 171°52'W; on the west side of Safata Bay on the south coast of Upolu.

Area: 90 ha.

Altitude: Sea level.

Overview: An area of estuarine mangrove forest, important as a nursery ground for mullet. The village that owns the site is eager to preserve it in its natural state.

Physical features: A large stand of mangrove forest bordering the tidal estuary of the Leaf River. In 1990, Hurricane Ofa deposited a fair amount of sand in the estuary mouth, but otherwise the ecosystem remains in good condition. One of Western Samoa's finest stands of coastal forest is found across the estuary from the mangrove forest.

Ecological features: Mangrove forest dominated by *Bruguiera gymnorrhiza* with some *Rhizophora (mangle) samoensis*. Other species present include the ferns *Acrostichum aureum* and *Humata heterophylla*, and *Barringtonia asiatica*. The nearby coastal forest is dominated by *Diospyros elliptica*, *D. samoensis* and *Syzygium* spp.

Land tenure: The wetland and surrounding areas are entirely under customary ownership.

Conservation measures taken: The inhabitants of Sa'anapu village, in collaboration with the Division of Environment and Conservation, have banned dynamiting and fish poisoning in the wetland, and have established quota for crab catchers. Fishermen from neighbouring villages are prohibited from fishing in the mangroves.

Conservation measures proposed: Holloway and Floyd (1975) recommended that the site be protected as a nature reserve, and this was supported by Dahl (1980). Pearsall and Whistler (1991) listed the Sa'anapu-Sataoa Mangrove Forest along with nearby coastal rain forest in their top ten priority sites for conservation in Western Samoa, and Parks (1992) identified the mangrove forest as a Grade 1 Site for conservation. The forest has recently been proposed as a Conservation Area to be established with funding from the Global Environment Facility under the guidance of the South Pacific Regional Environment Programme (SPREP).

Land use: Fishing; harvesting of crabs. Villages and plantations in surrounding areas.

Disturbances and threats: The site is threatened by forest clearance and landfill for human settlement, and pollution. Feral pigs cause some damage to the mangroves.

Hydrological and biophysical values: The mangrove forest is an important nursery ground for a wide variety of fish species including mullet (*Mugil* spp.).

Social and cultural values: No information.

Noteworthy fauna: Birds recorded at the site include Pacific Reef Heron (*Egretta sacra*), Pacific Black Duck (*Anas superciliosa*), Pacific Golden Plover (*Pluvialis fulva*), Purple-capped Fruit-Dove (*Ptilinopus porphyraceus*), Samoan Whistler (*Lalage sharpei*), Samoan Broadbill (*Myiagra albiventris*) and Cardinal Honeyeater (*Myzomela cardinalis*). Flying foxes (*Pteropus* sp.) also occur in the mangroves. Common invertebrates include the mangrove crab *Scylla paramamosian* and crabs of the genus *Uca*.

Noteworthy flora: *Trichomanes* spp. are endemic to the forest, and the high density of epiphytes is of special interest.

Scientific research and facilities: The Division of Environment and Conservation is currently investigating the possibilities for sustainable utilization of the mangrove forest as a way of promoting its conservation.

Conservation education: Conservation of mangroves has become an important environmental issue in Western Samoa. Because of its relatively undisturbed condition, the Sa'anapu-Sataoa Mangrove Forest will be used as an example of how a healthy mangrove forest should be.

Recreation and tourism: There is some potential for eco-tourism along the river into the mangrove forest.

Management authority and jurisdiction: The Division of Environment and Conservation has responsibility for management; jurisdiction lies with the Department of Lands and Environment.

References: Dahl (1980); Holloway & Floyd (1975); Parks (1992); Parks *et al.* (1992); Pearsall & Whistler (1991); Sua (1988); Zann (1991).

Reasons for inclusion: 1a, 2b, 2c. The largest and least disturbed stand of mangrove forest in Western

Samoa; an important fish breeding area.

Source: Cedric Schuster.

Apolimafou Marsh (5)

Location: 13°52'S, 172°04'W; near the extreme western tip of Upolu.

Area: Approximately 50 ha.

Altitude: Near sea level.

Overview: An area of herbaceous marsh at the west end of Upolu; the least disturbed of any coastal marsh in Western Samoa.

Physical features: A small area of freshwater marsh on the coastal lowlands at the west end of Upolu. The site lies adjacent to coconut plantations.

Ecological features: Herbaceous marsh with *Eleocharis dulcis* and *Cyclosorus interruptus*. *Erythrina fusca* and *Pandanus tectorius* are found in isolated clumps along the edges of the marsh. *Ludwigia octovalvis* dominates in areas of disturbed vegetation along the roads bordering and crossing the wetland.

Land tenure: Customary ownership.

Conservation measures taken: None.

Conservation measures proposed: Recommended for designation as a nature reserve by Holloway and Floyd (1975), and identified as a priority site for conservation by Dahl (1980) and Pearsall and Whistler (1991). Parks (1992) identified the marsh as a Grade 2 site.

Land use: No information.

Disturbances and threats: The marsh is situated directly behind a village and is threatened by further expansion of the village. Some reduction in water supply may have occurred as a result of agricultural activities in the surrounding area. There has been some disturbance to the marsh vegetation along a road which crosses the marsh.

Hydrological and biophysical values: No information.

Social and cultural values: No information.

Noteworthy fauna: The Pacific Black Duck (*Anas superciliosa*) and Purple Swamphen (*Porphyrio porphyrio*) occur in the marsh.

Noteworthy flora: An excellent example of a lowland herbaceous marsh.

Management authority and jurisdiction: No information.

References: Anon (1985); Dahl (1980); Holloway & Floyd (1975); Parks (1992); Pearsall & Whistler (1991).

Reasons for inclusion: 1a. Probably the best remaining example of lowland herbaceous swamp in Western Samoa, still in relatively good condition.

Source: Cedric Schuster.

Lake Mafane, Lake Mautalano and Olo Manu Uta Marsh (6)

Location: 13°39'S, 172°20'W; in the eastern highlands of Savai'i.

Area: Unknown.

Altitude: 600-1,000 m.

Overview: Two crater lakes with fringing marshes and a large area of herbaceous marsh in the eastern highlands of Savai'i, still in a healthy, relatively undisturbed condition and well protected from human disturbance because of their isolated location.

Physical features: Lake Mafane (approximately 50 ha) and Lake Mautalano (a few ha) are small freshwater lakes with fringing herbaceous marshes, situated in steep-sided volcanic craters about 4 km apart. The crater rims rise to peaks at 1,000 and 716 m respectively. Olo Manu Uta Marsh (Maugalao Marsh) is a large herbaceous marsh situated at 625 m above sea level on the southwestern slopes of Mount Olo Manu Uta, east of Mount Maugalao. Other small volcanic craters further west along the crest of Savai'i contain smaller and as yet unmapped wetlands.

Ecological features: Herbaceous marsh with *Eleocharis dulcis* and *Rhynchospora corymbosa*. The surrounding highlands are covered in montane rain forest and cloud forest.

Land tenure: Lake Mafane and Lake Mautalano are partly on public land and partly under customary ownership; Olo Manu Uta Marsh is situated entirely on public land.

Conservation measures taken: None.

Conservation measures proposed: Lake Mafane and Olo Manu Uta Marsh were recommended for designation as nature reserves by Holloway and Floyd (1975), while Lake Mautalano was recommended for designation as a strict nature reserve, closed to the general public. All three sites were identified as priority areas for conservation by Dahl (1980). KRTA Limited (1988) recommended extending the boundaries of the proposed Mount Silisili National Park to include the three wetlands. It was suggested that the wetlands be grouped within a buffer zone and incorporated into the National Park, together with a corridor about 2,000 m in width linking them to the Silisili highlands. Pearsall and Whistler (1991) also recommended that the wetlands be included with the Silisili highlands in a single large protected area.

Land use: None. The surrounding forests are scarcely if ever used by their customary owners.

Disturbances and threats: None known at the wetlands. The upland forests on northern exposures were severely damaged by Hurricane Ofa in 1990 and Hurricane Val in 1991.

Hydrological and biophysical values: No information.

Social and cultural values: No information.

Noteworthy fauna: No information.

Noteworthy flora: No information.

Management authority and jurisdiction: No information.

References: Anon (1985); Dahl (1980); Holloway & Floyd (1975); KRTA Limited (1988); Pearsall & Whistler (1991).

Reasons for inclusion: 1a. Excellent examples of upland lakes and marshes, still in a pristine condition and surrounded by almost undisturbed primary rain forest.

Source: Cedric Schuster.

Mount Silisili Bog (7)

Location: 13°37'S, 172°29'W; in the central highlands of Savai'i.

Area: Unknown.

Altitude: Over 1,500 m.

Overview: A montane bog dominated by species of *Carex*; the only bog of this type in Western Samoa.

Physical features: A small montane bog surrounded by cloud forest near the summit of Mount Silisili (1,858 m).

Ecological features: The bog vegetation is dominated by species of *Carex*.

Land tenure: The wetland and surrounding areas are almost entirely under customary ownership.

Conservation measures taken: None.

Conservation measures proposed: The central highlands of Savai'i have frequently been recommended for reserve status, but no action has been taken because the majority of the land is under customary ownership. Holloway and Floyd (1975) recommended the establishment of a large national park (8,900 ha) and this was supported by Dahl (1980) and Hay (1985). KRTA Limited (1988) endorsed the view that the establishment of the proposed Silisili National Park was of the highest priority, and proposed extending the boundaries to include Lake Mafane, Lake Mautalano and Olo Manu Uta Marsh to the east. Pearsall and Whistler (1991) similarly recommend the establishment of a large reserve encompassing all of the central highlands of Savai'i as well as a corridor of forest extending almost down to the south coast.

Land use: None. There is no human habitation in the area.

Disturbances and threats: None known.

Hydrological and biophysical values: No information.

Social and cultural values: No information.

Noteworthy fauna: The White-browed Crake (*Porzana cinerea*) and Spotless Crake (*Porzana tabuensis*) are known to occur in the area. There is a slight possibility that the endemic Samoan Woodhen (*Gallinula (Pareudiastes) pacifica*) could still survive in the moist montane forests and bogs of central Savai'i, although

there are no confirmed reports since 1873. The montane forests of Savai'i (above 900 m) are also home to the endemic Samoan White-eye (*Zosterops samoensis*), known only from this island. Other interesting birds of the cloud forest include the endangered Tooth-billed Pigeon (*Didunculus strigirostris*), the Friendly Ground-Dove (*Gallicolumba stairii*), the Island Thrush (*Turdus poliocephalus*), the rare Mao (*Gymnomyza samoensis*) and an endemic subspecies of the Red-headed Parrot-finch (*Erythrura cyaneovirens gaughrani*).

Noteworthy flora: A unique wetland plant community in Western Samoa. The surrounding cloud forests are very rich in endemic species, with approximately 53% of species endemic compared to 25-33% for the islands as a whole.

Management authority and jurisdiction: No information.

References: Anon (1985); Dahl (1980); Hay (1985); Holloway & Floyd (1975); KRTA Limited (1988); Parks *et al.* (1992); Pearsall & Whistler (1991); Whistler (1992).

Reasons for inclusion: 1d, 2b, 2d. The only significant montane bog in Western Samoa.

Source: Cedric Schuster.

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