REPUBLIC OF KIRIBATI

INTRODUCTION

Information on the Line and Phoenix Islands has been provided by K. Teeb'aki.

Area: Approximately 777 sq.km (published figures vary between 684 and 823 sq.km). Gilbert Islands (including Banaba), 319 sq.km; Phoenix Islands, 28 sq.km; Line Islands, 430 sq.km.

Population: 63,843 (1985 census), with all but about 3,000 living in the Gilbert Islands. In 1989, there were about 2,000 people on Kiritimati (Christmas Island) and about 500 each on Tabuaeran (Fanning) and Teraina (Washington) in the Line Group, and a handful of caretakers on Kanton (Canton) in the Phoenix Group.

The Republic of Kiribati consists of 33 low-lying coral islands in three main groups scattered over 3,550,000 square kilometres of the central Pacific Ocean. The islands stretch for about 4,000 km from east to west and span both the equator and the 180th meridian, extending from 8° North to 13°30 South, and from 168° East to 147° West. The westernmost group, the Gilbert Islands, comprise 17 inhabited islands including the capital island, Tarawa. The Phoenix Islands, 1,500 km to the east, comprise eight tiny atolls, only one of which (Kanton) is inhabited. The Line Islands, 1,800 km further east, comprise three inhabited islands (Teraina, Tabuaeran and Kiritimati) and eight uninhabited islands. The three northernmost islands in this group, Palmyra, Kingman and Jarvis, are unincorporated possessions of the U.S.A., outside Kiribati territory. (Two small uninhabited coral islands to the north of the Phoenix Islands, Howland and Baker, are also unincorporated U.S. possessions). The Line and Phoenix Groups are amongst the remotest islands in the world, the nearest continental landmass being California, nearly three thousand miles away.

All of the Kiribati islands except Banaba are low-lying coral atolls usually rising no more than 4 or 5 metres above sea level. In most of the atolls, a reef encloses a lagoon, on the east side of which are long narrow stretches of land seldom more than 100 m wide. Banaba (Ocean Island), about 450 km to the west of the main Gilbert Group, is a raised coral island, 6.5 sq.km in area and with a maximum elevation of 87 m. Most of the surface of this island has been mined for phosphates. Kiritimati (Christmas Island) in the Line Islands is the world's largest atoll. With an area of 327 sq.km, this atoll comprises almost half the total land area of Kiribati.

The southern Gilbert Islands, Phoenix Islands and Banaba have a rather dry maritime equatorial climate, whereas those islands situated further north have a more humid tropical climate. Temperatures range between 24° and 30°C, with little variation between the islands. The annual rainfall, by contrast, is extremely variable, not only between islands bat also from year to year. The average annual rainfall in the Gilbert Islands ranges from 1,000 mm in the vicinity of the equator to over 3,100 mm in the northern islands. In the Phoenix Islands, most islands receive an annual rainfall in the range 750-1,300 mm, while in the Line Islands, the annual rainfall ranges between 690 mm on Malden to 2,900 mm on Teraina. Kiritimati, situated on the border between the wet and dry belts north of the equator, is relatively dry in most years. The main rainy season extends from November to April, with rain falling in sharp irregular squalls. Banaba, the southern Gilberts and the Phoenix Islands are subject to periodic droughts when as little as 200 mm of rain may fall in one year. The predominant winds are the east to southeast trades which blow for most of the year; the stormy season (November to February) is characterized by westerlies.

Formerly part of a British protectorate and colony (the Gilbert and Ellice Islands), Kiribati attained self-government in January 1977 and became an independent sovereign and democratic republic in July 1979. The people of Kiribati are predominantly of Micronesian stock. The great majority of the population (95%) live in the Gilbert Islands, and all 17 islands in this group are inhabited. Tarawa, the capital

island, supports over 33% of the population, and is one of the most densely populated islands in the world. Except for a handful of caretakers on Kanton, the Phoenix Islands are uninhabited, although they have been used for plantations, phosphate mining and military installations in the past. In the Line Islands, only Kiritimati (Christmas Island), Tabuaeran (Fanning) and Teraina (Washington) in the northern group are presently inhabited by I-Kiribati. Virtually all land in the Gilbert Islands is under private ownership in small hereditary holdings, whereas in the Line and Phoenix Islands, all land is owned by the State Government. Following independence in 1979, the State Government has looked towards the Line and Phoenix Islands for further development, and Kiritimati, the administrative centre for these two groups, has now become a commercial centre.

The first major economic use of the islands was as a source of phosphate in the second half of the 19th century, when most of the Central Pacific islands were bonded and exploited under the American Guano Act of 1856. Guano deposits were exhausted by the turn of the century, and attention was then transferred to the coconut (copra) industry. This was successful in the Gilbert Islands, on the northern Line islands and on two of the Phoenix islands, but widely fluctuating world prices of copra prevented a profitable industry. Although the three Northern Line islands of Kiritimati, Tabuaeran and Teraina are still worked regularly, the problems with unfavourable world prices and the high shipping expenses continue to threaten the industry. In recent years, other opportunities for economic development have been investigated, notably commercial fishing, salt production and tourism. Current and proposed developments are discussed by Garnett (1983) and Douglas (1969). There is very little permanent agriculture in Kiribati because of the poor quality of the soil which is composed largely of coral sand and rock fragments.

Dahl (1980, 1986) has given a brief account of the natural ecosystems of the islands, and has reviewed their importance for nature conservation. Garnett (1983) has described the terrestrial flora and fauna of the Line and Phoenix Islands in some detail. Generally, the terrestrial plant communities on the Gilbert Islands have been completely replaced by urban areas, villages, coconut plantations or agriculture, or are seriously degraded. Even in the sparsely populated Line and Phoenix Islands, the flora and fauna of most islands have been radically altered by the introduction of exotic species of plants and animals and large-scale clearance for coconut plantations. Only a few small atolls, notably Birnie in the Phoenix Islands and Vostok in the southern Line Islands, remain in a relatively undisturbed condition.

All of the islands have extensive coral formations, generally as fringing and lagoon reefs. UNEP/IUCN (1988) provide a general account of the coral reef systems and the reef resources, and also give detailed information on three of the atolls (Tarawa and Onotoa in the Gilbert Islands and Kiritimati in the Line Islands).

Summary of Wetland Situation

The most extensive wetlands in the Republic of Kiribati are brackish to supersaline lagoons which are present in the interior of islands in all three groups. Mangrove vegetation occurs only in the Gilbert Islands, and most of the freshwater wetlands are very small, although a large lake and swamp on Teraina (Washington) is a notable exception.

Landlocked lagoons of varying sizes with brackish to supersaline water are found on Nikunau in the Gilbert Group, McKean, Birnie, Phoenix and Manra (Sydney) in the Phoenix Group, and on Kiritimati, Malden, Starbuck and Flint in the Line Islands. Small islets and salt pans are often present. Some of the lagoons, notably those on Birnie and Starbuck, occasionally dry out completely. The saline lagoon on Manra has been partly modified for aquaculture, while that on Flint has been re-opened to the sea by a boat channel which has been blasted through the island, recreating old atoll conditions. The largest system of lagoons, that on Kiritimati, covers an area almost equal to the land area of 321 sq.km.

Most other atolls have deep marine lagoons with many passages to the open sea, but on some islands, such as Tabuaeran (Fanning) in the Line Islands and Orona (Hull) and Nikumaroro (Gardner) in the Phoenix Islands, the lagoon is shallow and almost enclosed, with extensive intertidal mudflats and brackish marshes creating estuarine-like conditions.

Mangroves, consisting of four species, *Bruguiera gymnorrhiza, Lumnitzera racemosa, Rhizophora mucronata* and *Sonneratia alba,* occur only in the Gilbert Islands, where there are small stands on Tarawa, Abemana and Aranuka atolls (Fosberg, 1975).

Freshwater wetlands are scarce; most are either tiny freshwater lens pools behind the beach or areas of wet soil used for the cultivation of taro. Such wetlands are found on many of the wet atolls in the northern Gilbert Islands. Most of the Phoenix Islands are very arid and lack freshwater wetlands, although there are reported to be some small freshwater pools on Phoenix Island (Dahl, 1980). Similarly, most of the Line Islands are relatively arid and lack freshwater wetlands. However, there is a large freshwater lake on Teraina (Washington) with surrounding freshwater marsh and some swamp forest. There is also reported to be a small area of bog on Flint Island (Dahl, 1980), and Vostok is covered in a layer of peaty soils up to one metre thick.

There no streams on any of the islands. Significant underground sources of fresh water are generally limited to the larger islands, where lenses of fresh water, floating on salt water, have developed. Generally, freshwater lenses exist on those parts of the islands where coral sands form a sufficiently wide central ridge. Lens thicknesses range from two metres to over 30 metres (Anon., 1984).

The isolated stands of mangroves in the Gilbert Islands and the distinctive saline and brackish lagoons in the Line and Phoenix Islands are of conservation interest, as are the freshwater habitats of Teraina (Washington). Most of the interesting saline lagoons in the Line and Phoenix Islands are located within existing protected areas, but the unique freshwater wetlands of Teraina, the extensive "estuarine" wetlands of Tabuaeran and the mangroves of the Gilbert Islands are unprotected.

The protected areas system comprises seven Wildlife Sanctuaries and seven Closed Areas, all in the Line and Phoenix Islands. The islands of Kiritimati, Malden, Starbuck, Phoenix, McKean, Vostok and Birnie are wildlife sanctuaries, and two of these (Malden and Starbuck) are also Closed Areas. The other five Closed Areas are within the Kiritimati Wildlife Sanctuary. All seven sanctuaries contain some wetland habitat and are described in the site accounts. There are no protected areas in the Gilbert Islands, although sanctuary status has been proposed for Butaritari, Nonouti and Abaiang atolls.

Many of the atolls in Kiribati, and especially some of those in the Line and Phoenix Islands, are internationally important for their huge concentrations of breeding seabirds. Twenty-three species breed in the islands, in several cases in larger numbers than anywhere else in the world. There are important breeding colonies on all eight atolls in the Line Group (notably Kiritimati, Malden, Starbuck and Caroline), on at least five atolls in the Phoenix Group (Enderbury, Phoenix, Birnie, McKean and Hull), and on Butaritari and Nonouti atolls in the Gilbert Group (Garnett, 1984; Perry, 1980). Many of these islands are also important for nesting Green Turtles *(Chelonia mydas).*

Only one true waterbird is resident in the islands, the Pacific Reef Egret *(Egretta sacra).* This occurs in all three island groups, but is scarce in the Line Islands, occurring regularly only at Caroline Atoll where it evidently breeds. Two former residents are now extinct, Coue's Gadwall *(Anas strepera couesi)* and Tuamotu Sandpiper *(Prosobonia cancellatus).* Coue's Gadwall is a small, dark race of the Gadwall known only from two specimens collected on Teraina (Washington) in 1874, and presumed to have become extinct during the early years of settlement. The type specimen of the Tuamotu Sandpiper was collected on Kiritimati in January 1778 during Captain Cook's third voyage, but the species has not been recorded in these islands since then, although it still occurs widely in the Tuamotu Archipelago in French Polynesia. Five species of migratory shorebirds occur regularly on passage and in winter in all three island groups: the Pacific Golden Plover *(Pluvialis fulva),* Wandering Tattler *(Heteroscelus incanus),* Bristle-thighed Curlew *(Numenius tahitiensis),* Ruddy

Turnstone *(Arenaria interpres)* and Sanderling *(Calidris alba).* One other species, Grey-tailed Tattler *(Heteroscelus brevipes)* is regular in the Gilbert Islands. A goose, four ducks, eight shorebirds and three gulls have occurred as vagrants from East Asia or North America (Pratt *et al.,* 1987).

There are very few land birds in Kiribati and only one passerine, the Christmas Island Warbler or Bokikokiko *(Acrocephalus aequinoctialis)* which is known only from Teraina, Tabuaeran and Kiritimati in the Line Islands and Baker (a U.S. possession) at the northern end of the Phoenix Group.

Of the wetland ecosystems, only the mangroves would appear to be under imminent threat from development activities and pollution. However, the prospect for global sea level rise is particularly ominous for Kiribati where there are no high or volcanic islands. Wildlife generally is threatened by introduced animals, especially cats and rats, although feral pigs and goats have caused a problem on some islands. The feral cats and introduced rats pose a particularly serious problem for breeding seabirds, and several island populations of mainly ground-nesting species have been extirpated in the Line and Phoenix Islands (Garnett, 1984). A major eradication programme commenced in 1989 with the assistance of predator control experts from New Zealand.

Wetland Research

There has been very little research relating specifically to the wetlands of Kiribati. Guinther (1971) made some observations of the ecology of the estuarine environment on Tabaueran Atoll, and has also investigated the feasibility of brine shrimp production on Kiritimati. In the 1960s, the Smithsonian Institution's Pacific Ocean Biological Survey Program visited all of the Central Pacific islands and carried out extensive research on seabirds. A considerable amount of research has been carried out on the seabirds since then, particularly on Kiritimati (e.g. Garnett, 1982; Schreiber and Schreiber, 1984 & 1989). The endemic Christmas Island Warbler *(Acrocephalus aequinoctialis)* has also been studied in some detail (Milder & Schreiber, 1982 & 1989). Wildlife conservation in the Line and Phoenix islands has been reviewed by Perry (1980) and Garnett (1983), and management plans for all the islands in these two groups have been drafted.

Wetland Area Legislation

In 1980, the Government of the Republic of Kiribati published a statement of its policy concerning nature conservation in the Line and Phoenix Islands, This recognised the need to integrate conservation with development with respect to the islands' natural resources. The role of conservation was defined in terms of providing for the present and future social and economic needs of the country (Garnett, 1983).

There is no legislation relating specifically to wetlands. The legal basis for nature conservation is the Wildlife Conservation Ordinance (1975), amended in 1979. Under this new Ordinance, the Gilbert and Ellice Islands Colony Wildlife Birds Protection Ordinance of 1938 was repealed, and the status of bird sanctuaries was changed to wildlife sanctuaries. The object of the 1975 Ordinance was "to provide for the conservation and protection of birds and other animals". It basically makes two kinds of provisions for conservation:

i) Protection of species of birds and other animals. All regularly occurring species of birds, their eggs and nests are fully protected throughout Kiribati. Thirty-one species are listed, including 19 species of seabirds, Pacific Reef Egret, Northern Pintail, four regularly occurring migratory shorebirds and the resident land-birds. The Ordinance also provides full protection for Green Turtles, their eggs and nests in most of the Line and Phoenix Islands with Tabuaeran, Teraina, Kanton and Enderbury being excluded.

ii) Protection of areas of conservation importance. Two types of protected areas may be established: Wildlife Sanctuaries and Closed Areas. Wildlife Sanctuaries are areas where no person shall hunt, kill or capture any bird or other animal (other than a fish) or search for, take or wilfully destroy, break or damage the eggs or nests of any kind of bird or other animal. Closed Areas must be enclosed within Wildlife

Sanctuaries. The protection status is similar except that no person shall enter or be in a Closed Area without a valid written license.

This current legislation is weak because measures for the protection of vegetation, prohibiting the introduction of animals and plants, preventing fire, removal of soil and dumping of refuse are lacking (IUCN, 1991). Furthermore, there is no environmental impact legislation.

At international level, the Republic of Kiribati is not yet a party to any of the international conventions or programmes that directly promote the conservation of natural areas and their wildlife (IUCN, 1991). Although it is a member of the South Pacific Regional Environment Programme (SPREP), it has not ratified the Convention for the Protection of the Natural Resources and Environment of the South Pacific (SPREP Convention). All of the wildlife sanctuaries except Kiritimati and all of the Closed Areas except Northwest Point Reserve have been proposed for designation under the Convention on Wetlands of International Importance especially as Waterfowl Habitat (the Ramsar Convention), but Kiribati has yet to ratify that Convention.

Wetland Area Administration

The Wildlife Conservation Ordinance of 1975 paved the way for the creation of a Wildlife Conservation Unit on Kiritimati in 1977. This Unit was established under the then Ministry of Local Government and Rural Development, and later became an integral part of the Ministry of the Line and Phoenix Groups (now the Ministry of Line and Phoenix Development). The major aims of the Unit were to survey and monitor seabirds populations on Kiritimati, enforce strict wildlife conservation legislation, control feral cats and pigs, and provide a conservation education programme. This work was subsequently extended to the other Line and Phoenix Islands, and the Unit was given responsibility for administering and managing all of the wildlife sanctuaries and closed areas. In practice, the three-man unit only manages the wildlife sanctuary and closed areas on Kiritimati on a regular basis, the other sanctuaries being uninhabited and seldom, if ever, visited. Wider duties of the Unit have been to advise on conservation matters throughout Kiribati, and to oversee the teaching of wildlife and conservation biology in schools.

Organizations involved with Wetlands

The Wildlife Conservation Unit in the Ministry of Line and Phoenix Development is the only government body which has direct responsibility for the conservation of nature, although the Ministry of Home Affairs and Decentralisation and the Ministry of Natural Resources Development in Central Government have some responsibilities which relate to the conservation of natural resources.

WETLANDS

Site descriptions based on a report prepared by Aobure Teataata and K. Teeb'aki of the Wildlife Conservation Unit, Ministry of the Line and Phoenix Group, and the literature, particularly Garnett (1983) and IUCN (1991).

Wetland Name: Mangroves of Tarawa Atoll
Country: Republic of Kiribati
Coordinates: 1°30'N, 173°00'E
Location: in the Gilbert Islands.
Area: Area of mangroves unknown; land area of atoll 21 sq.km, lagoon area 375 sq.km.
Altitude: Sea level.
Overview: Patches of mangrove and intertidal mudflats on the shores of an atoll lagoon; one of the few areas of mangroves in Kiribati.

Physical features: Tarawa is an L-shaped atoll with over 35 small islets (motu) on the south and northeast sides and a sunken reef in the northwest. Rural North Tarawa comprises 12 major islets with a land area of 14.7 sq.km; urban South Tarawa comprises five elongated islets (mostly linked by causeways) with an area of 7.2 sq.km. The lagoon is shallow and fairly turbid, with an average depth of 10-15 m, and has many sand shoals and numerous coral patch reefs. The mean tidal range is 1.5 m. Mangroves occur in patches along part of the coast. The climate is oceanic-equatorial, with an average annual rainfall of 1,729 mm and a mean annual temperature of 27°C (mean maximum 32°C, mean minimum 26°C. From March to October, light east to southeast trade winds prevail. Ecological features: Stands of mangrove dominated by *Rhizophora mucronata,* with some *Bruguiera gymnorrhiza, Lumnitzera racemosa* and *Sonneratia alba.*

Land tenure: Mostly native land, in small hereditary holdings.

Conservation measures taken: None.

Conservation measures proposed: The Tourism Council of the South Pacific has recommended that all mangrove areas be fully protected because of their value in preventing coastal erosion (TCSP, 1990).

Land use: The I-Kiribati are traditionally subsistence fishermen. Tarawa is the capital and administrative centre of Kiribati. The population of South Tarawa numbers nearly 20,000, making this one of the most densely populated islands in the world.

Disturbances and threats: The acute shortage of land has led to extensive reclamation of the lagoon foreshore and loss of some mangrove. Construction of solid-fill causeways between islets has disturbed circulation patterns in the lagoon, and this may have had an effect on the mangroves. Dumping of rubbish on the lagoon shore and disposal of sewage have caused some pollution, and this was responsible for an outbreak of cholera in 1977. There is extensive exploitation of the lagoon resources, and giant clams in particular have suffered from over-harvesting (UNEP/IUCN, 1988).

Hydrological and biophysical values: The value of mangroves in preventing coastal erosion is especially high in view of the fragile physical nature of the atoll islands.

Social and cultural values: No information.

Noteworthy fauna: No information is available on the mangrove fauna. The intertidal lagoon fauna is described by Bolton (1982); the coral reefs are described by UNEP/IUCN (1988).

Noteworthy flora: The stands of mangroves on Tarawa (and also Abemana and Aranuka atolls) are noteworthy for their isolation, occurring here at the extreme edge of their distribution in the Central Pacific.

Scientific research and facilities: The Atoll Research Unit is based on Tarawa and is supported by the University of the South Pacific Institute of Marine Resources. It carries out research on the marine environment, particularly environmental problems affecting Tarawa (UNEP/IUCN, 1988).

Management authority and jurisdiction: No information.

References: Bolton (1982); Dahl (1986); UNEP/IUCN (1988).

Reasons for inclusion: ld, 2b. One of the few areas of mangroves in Kiribati, at the limit of mangrove distribution in the Central Pacific.

Source: See references.

Wetland Name: McKean Island Wildlife Sanctuary

Country: Republic of Kiribati

Coordinates: 3°35'S, 174°02'W

Location: the most westerly of the Phoenix Islands, about 280 km west-southwest of Kanton Island and 125 km north-northwest of Nikumaroro.

Area: 57 ha.

Altitude: Sea level to 5 m on the northern beach crest.

Overview: A low coral island with a central landlocked supersaline lagoon, of considerable interest for its diverse and relatively undisturbed plant communities and large breeding colonies of seabirds.

Physical features: McKean Island is a flat, sand and coral island approximately circular in shape, with a diameter of some 800 m. The beach is largely composed of reef rock and coral rubble, and rises sharply to a circumferential crest within which the land is concave. The interior basin has been further depressed by extensive phosphate workings during the 19th century. There is no standing surface fresh water on the island, nor any evidence of a freshwater lens. A small, shallow, landlocked and highly saline lagoon occupies the centre of

the island, and fills the area of the former phosphate workings. The depth of the lagoon fluctuates with the tide, reaching a maximum depth of 60 cm at high water. The island is surrounded by a fringing reef, 100-200 m wide. The inferred mean annual rainfall is 800 mm. The prevailing winds are easterly trades.

Ecological features: The vegetation comprises stunted *Sida fallax* scrub with low herbs and grasses. Seven species have been recorded in five main vegetation types. The western part of the island is covered by an extensive mat of *Tribulus cistoides,* while inland saline flats support *Sesuvium portulacastrum.* Most of the remainder of the island supports a mixture of *Portulaca lutea* and *Boerhavia albiflora.* The highest ground is covered by *Digitaria pacifica* grass with scattered mats of *Boerhavia* and *Tribulus* on a coarse rubble substrate. *Lepturus pilgerianus* is located mostly on the west coast of the island, mixed with *Tribulus cistoides* (Garnett, 1983).

Land tenure: State owned.

Conservation measures taken: McKean Island was declared a bird sanctuary in June 1938 under the Gilbert and Ellice Island Colony Wild Birds Protection Ordinance of 1938. The island was designated a Wildlife Sanctuary in 1975 under the 1975 Wildlife Conservation Ordinance (IUCN, 1991).

Conservation measures proposed: Dahl (1980) proposed the establishment of a national or international reserve in the Phoenix Islands, including McKean, Birnie, Phoenix, Enderbury, Orona (Hull) and possibly also Manra (Sydney), with Kanton Island as the communications link and surveillance centre. Garnett (1983) has made a number of general recommendations for management of the Phoenix Islands, including erection of multi-lingual notice boards advising visitors, such as long-distance yachtsmen and fishermen from Japanese, Taiwanese and Korean fleets, of the importance of the islands for science and nature conservation. Garnett (1983) also recommended that the Wildlife Sanctuary at McKean Island be upgraded to Closed Area.

Land use: Uninhabited. The island was bonded under the 1856 American Guano Act in March 1859, and was mined for phosphate between 1839 and 1870, by which time all reserves were exhausted. A scheme to introduce coconuts was prevented by the outbreak of World War II. The island has seldom been visited, although there is a reasonably good anchorage off the west coast.

Disturbances and threats: None known.

Hydrological and biophysical values: None known.

Social and cultural values: None known. The presence of Polynesian Rats suggests that McKean was visited by Polynesians in pre-historic times, but there is no evidence that the island was ever settled.

Noteworthy fauna: McKean is a very important breeding site for seabirds. Twenty-nine species have been recorded on the island, and 17 are known to breed. At least six of the breeding populations are considered to be of international significance. These are: 5,000 Audubon's Shearwaters *(Puffinus rherminieri),* 1,000 White-throated Storm Petrels *(Nesofregatta (fuliginosa) albigularis),* 40,000 Lesser Frigatebirds *(Fregata alien,* 23,400 Grey-backed Terns *(Sterna lunata),* 20,000 Brown Noddies *(Anous stolidus)* and 15,000 Blue-grey Noddies *(Procelsterna cerulea).* The colonies of White-throated Storm Petrel and Lesser Frigatebird are the largest known colonies of these species in the world. The Polynesian Rat *(Rattus exulans)* is the only mammal, and the Mourning Gecko *(LepidodacOilus lugubris)* is the only reptile. Invertebrates include the hermit crab *Coenobita perlata,* the land crab *Geograpsus grayii* and at least 15 insects (Garnett, 1983).

Noteworthy flora: The relatively diverse and undisturbed terrestrial vegetation is considered to be of international conservation importance (Garnett, 1983).

Scientific research and facilities: The island was visited by the Smithsonian Institution's Pacific Ocean Biological Survey Program in the 1960s, and has been visited by several ornithologists in recent years.

Management authority and jurisdiction: Wildlife Conservation Unit, Ministry of Line and Phoenix Development.

References: Dahl (1980, 1986); Garnett (1983); IUCN (1991); TCSP (1990).

Reasons for inclusion: la, 2c. The island is valued for the variety and naturalness of its terrestrial habitats and large breeding populations of seabirds, several of which are of outstanding international importance.

Source: See references.

Wetland Name: Birnie Island Wildlife Sanctuary

Country: Republic of Kiribati

Coordinates: 3°35'S, 171°33'W

Location: 90 km east of Phoenix (Rawaki) in the Phoenix Islands.
Area: 20 ha.
Altitude: Sea level to 4 m on the eastern beach crest.
Overview: A small coral island with interesting vegetation cover, a landlocked supersaline lagoon and large breeding colonies of seabirds. The island has never been inhabited and is the least disturbed of the Phoenix Group.
Physical features: Birnie Island, the smallest of the Phoenix Islands, is a low coral sandstone island measuring only 1.2 km by 0.5 km. A shallow, landlocked supersaline lagoon occupies a depression in the southeast. Despite being stream-fed, the lagoon often dries out completely. The northern half of the island is flat and covered in uniform vegetation. The east coast is rocky and consists of coral sandstone and coral fragments, while the west coast is low and sandy. Birnie is one of the drier Phoenix Islands, with an inferred mean annual rainfall of 600-800 mm or less. The prevailing winds are easterly trades.
Ecological features: The vegetation is extremely simple. Most of the island is covered by low herbs dominated by *Portulaca lutea* and some *Boerhavia albiflora.* These occur in pure stands or in varying co-dominant mosaics. The beach, beach crest and lagoon flats have either sparse or no vegetation cover, while the lagoon shoreline has an interrupted strip of uniform *Sesuvium portulacastrum.* This also occurs in a number of shallow depressions. Scattered dwarf *Sida fallax* scrub and bunch grass, probably *Lepturus* sp., have been recorded, but have since become locally extinct (Garnett, 1983).
Land tenure: State owned.
Conservation measures taken: Birnie Island was declared a bird sanctuary in June 1938 under the Gilbert and Ellice Island Colony Wild Birds Protection Ordinance of 1938. The island was designated a Wildlife Sanctuary in 1975 under the 1975 Wildlife Conservation Ordinance.
Conservation measures proposed: Birnie was selected by the International Biological Programme as one of the "Pacific Ocean Islands Recommended for Designation as Islands for Science" (Elliott, 1973). Dahl (1980) proposed the establishment of a national or international reserve in the Phoenix Islands, including Birnie, McKean, Phoenix, Enderbury, Orona (Hull) and possibly also Marra (Sydney), with Kanton Island as the communications link and surveillance centre. Garnett (1983) has made a number of general recommendations for management of the Phoenix Islands, including erection of multi-lingual notice boards advising visitors, such as long-distance yachtsmen and fishermen from Japanese, Taiwanese and Korean fleets, of the importance of the islands for science and nature conservation. Garnett (1983) has also recommended that the Wildlife Sanctuary be upgraded to Closed Area.
Land use: Uninhabited. The island was bonded under the 1856 American Guano Act in February 1860, and was formally placed under British protection in July 1889. The rights to exploit the island passed through a number of commercial concerns in the 19th and early 20th centuries, but no activities were undertaken. Colonization was considered in 1937, but not implemented, and an unsuccessful attempt was made to establish coconut plantations in 1939. Since then, the island has remained uninhabited, unused and seldom visited.
Disturbances and threats: None known.
Hydrological and biophysical values: None known.
Social and cultural values: None known. The presence of Polynesian Rats suggests that Birnie was visited by Polynesians in pre-historic times, but there is no evidence that the island was ever settled.
Noteworthy fauna: Birnie is an important breeding site for seabirds; 22 species have been recorded and six are known to breed. Populations of 100 Brown Boobies *(Sula leucogaster)* and 100 Blue-grey Noddies *(Procelsterna cerulea)* are considered to be nationally important, whilst 350-800 Masked Boobies *(Sula dactylatra)* may be internationally important. Polynesian Rats *(Rattus exulans)* are common on the island, and Green Turtles *(Chelonia mydas)* nest on the beaches. Invertebrates are poorly known, but include a mite and two parasitic flies (Garnett, 1983).
Noteworthy flora: The undisturbed atoll vegetation is considered to be of international significance (Garnett, 1983).
Scientific research and facilities: Few people have ever visited the island and only limited research has been undertaken.
Management authority and jurisdiction: Wildlife Conservation Unit, Ministry of Line and Phoenix Development.
References: Dahl (1980, 1986); Elliott (1973); Garnett (1983); IUCN (1991); TCSP (1990).

Reasons for inclusion: la, 2c. The least disturbed (most natural) of the Phoenix Islands, valued for its vegetation, supersaline lagoon, seabird colonies and turtle population.
Source: See references.

Wetland Name: Phoenix (Rawaki) Island Wildlife Sanctuary
Country: Republic of Kiribati
Coordinates: 3°42'S, 170°43'W
Location: the most easterly of the Phoenix Islands, about 180 km southeast of Kanton and 90 km east of Birnie.
Area: 65 ha.
Altitude: Sea level to 6 m on the beach crest.

Overview: A small coral island with large breeding colonies of seabirds, a landlocked supersaline lagoon and some small freshwater pools. The latter are the only freshwater wetlands in the Phoenix Islands.
Physical features: Phoenix (Rawaki) Island is a low coral island measuring 1.2 km (northwest to southeast) by 0.8 km, with a circumferential beach crest. Inland areas slope gently downwards to a 20 ha, landlocked, shallow supersaline lagoon which occupies much of the centre. There are also some small, permanent freshwater pools, the only freshwater wetlands in the Phoenix Group. The steep beach is fringed by a narrow platform reef, 30-100 m wide, and on the east coast there are storm ridges of broken coral. Phoenix is one of the drier islands in the Phoenix Group, with an inferred mean annual rainfall of 800 mm. The prevailing winds are easterly trades.

Ecological features: The vegetation is simple, comprising low herbs, grasses and stunted *Sida fallax.* These mainly form single species stands, although mixtures of *Lepturus pilgerianus* and *Sesuvium portulacastrum,* and *Boerhavia* sp. and *Portulaca lutea,* also occur. A broad belt of *Sesuvium* is found along the lagoon shore, and there are two large patches of *Sida* scrub near the north end of the lagoon. An endemic shrub, *Triumfetta procumbens,* has become extinct during this century. Further details of the vegetation are provided by Garnett (1983). No introduced plants are known to occur on the island.

Land tenure: State owned.

Conservation measures taken: Phoenix Island was declared a bird sanctuary under the Gilbert and Ellice Island Colony Wild Birds Protection Ordinance of 1938, and designated a Wildlife Sanctuary in 1975 under the 1975 Wildlife Conservation Ordinance. Conservation measures proposed: Phoenix Island was selected by the International Biological Program as one of the "Pacific Ocean Islands Recommended for Designation as Islands for Science" (Elliott, 1973). Dahl (1980) proposed the establishment of a national or international reserve in the Phoenix Islands, including Phoenix, McKean, Bimie, Enderbury, Orona (Hull) and possibly also Manra (Sydney), with Kanton Island as the communications link and surveillance centre. Garnett (1983) has made a number of general recommendations for management of the Phoenix Islands, including erection of multi-lingual notice boards advising visitors, such as long-distance yachtsmen and fishermen from Japanese, Taiwanese and Korean fleets, of the importance of the islands for science and nature conservation. Garnett (1983) has also recommended that the Wildlife Sanctuary be upgraded to Closed Area.

Land use: Uninhabited. Phoenix was bonded under the 1856 American Guano Act in 1859 and 1860, and was mined for phosphate between 1862 and 1871, by which time all reserves were exhausted. Some 20,000 to 40,000 tonnes were exported during this period. In June 1889, Phoenix was annexed to Great Britain and until 1938 various commercial concerns were licensed to develop the island, although no activities were undertaken. A survey in 1937 concluded that the island was unsuitable for colonization. An unsuccessful attempt was made to establish coconut plantations in 1939 (Garnett, 1983). Since then, the island has been uninhabited and unused, except as a Wildlife Sanctuary. There is no safe anchorage, and the island is seldom visited.

Disturbances and threats: European Rabbits *(Oryctolagus cuniculus)* were introduced in the 1860s, and currently number between 100 and 1,000 individuals.
Hydrological and biophysical values: None known.
Social and cultural values: None known. There is no evidence to suggest that the island was ever visited in pre-historic times.
Noteworthy fauna: Phoenix is a very important breeding site for seabirds, supporting some of the largest populations in the Central Pacific. Twenty-six species have been recorded and 18 are known to breed.

Noteworthy populations include 10,000 Wedge-tailed Shearwaters *(Puffinus pacificus),* 3,000 Christmas Island Shearwaters *(P. nativitatis),* 12,000 Audubon's Shearwaters *(P. l'herminieri),* 500 Bulwer's Petrels *(Bulweria bulwerii),* 400 White-throated Storm Petrels *(Nesofregatta (uliginosa) albigularis),* 850 Masked Boobies *(Sula dactylatra),* 16,000-45,000 Lesser Frigatebirds *(Fregata arid)* and 250,000 Sooty Terns *(Sterna fuscata)* (Garnett, 1983). There are no mammals other than the introduced rabbits. Small numbers of Green Turtles *(Chelonia mydas)* nest on the beaches. Insects are abundant, but exhibit low species diversity (Garnett, 1983).

Noteworthy flora: An endemic species of shrub, *Triumfetta procumbens,* apparently now extinct.
Scientific research and facilities: The island was visited by the Smithsonian Institution's Pacific Ocean Biological Survey Program in the 1960s, by the Line Islands Expedition in 1974, and by the joint Royal Society/Smithsonian Institution expeditions in 1973 and 1975.

Management authority and jurisdiction: Wildlife Conservation Unit, Ministry of Line and Phoenix Development.

References: Dahl (1980, 1986); Elliott (1973); Garnett (1983); IUCN (1991); TCSP (1990).

Reasons for inclusion: la, 2c. The island is valued for its outstanding breeding colonies of seabirds and naturalness of its various habitats. The small freshwater pools are unique in the Phoenix Islands.

Source: See references.

Wetland Name: Teraina (Washington) Island
Country: Republic of Kiribati
Coordinates: 4°43'N, 160°25'W
Location: in the northern Line Islands.
Area: Total land area 1,420 ha; lake 200 ha; bogs 100 ha.
Altitude: 0-5 m.
Overview: A raised wet atoll with a very interesting closed freshwater lagoon, extensive peat bogs and some swamp forest.

Physical features: Teraina is a raised, wet coral limestone island with an average annual rainfall of 2,970 mm. A freshwater lake of 200 ha occupies the position of its former lagoon. This borders on swampy woodland rich in epiphytes and ferns and two unique peat bogs covering 100 ha. Canals have been cut through the bogs.

Ecological features: Peat bogs with *Scirpus riparius* and *Cyrtosperma chamissonis;* swampy forest of *Pandanus* and *Cocos nucifera* with a dense fern undergrowth of *Polypodium scolopendria* and *Asplenium pacificum.* Also *Pisonia* atoll forest and atoll scrub. Thirty-five species of flowering plants are known from the island.

Land tenure: Largely state owned. Some of the copra plantations are freehold.

Conservation measures taken: None.
Conservation measures proposed: Dahl (1980) recommended that the bogs and perhaps the lake, including adequate areas of habitat for the Christmas Island Warbler, should be protected, as should the main seabird breeding areas.

Land use: Coconut plantations, subsistence agriculture and fishing. Modern settlement dates from about 1860, the resident population numbering 416 in 1978. There was some limited exploitation of guano and phosphate during the second half of the 19th century.

Disturbances and threats: Feral dogs, cats and pigs pose a threat to breeding seabirds. Feral cats have doubtless contributed to the decline in numbers of terns, noddies and ground-nesting boobies, and the island has suffered in the past from the depredations of feral pigs.

Hydrological and biophysical values: No information.
Social and cultural values: No information.

Noteworthy fauna: The wetlands of Teraina are the only known locality for Coue's Gadwall *(Anas strepera couesi).* The two type specimens of this small, dark race of the Gadwall were collected on Teraina in 1874. The duck has not been found again, and is presumed to have become extinct during the early years of settlement. The island supports the largest surviving population of the Christmas Island Warbler or Bokikokiko *(Acrocephalus aequinoctialis),* which is known only from this island, Tabuaeran, Kiritimati and Baker. There is also a population of the Scarlet-breasted or Kuhl's Lorikeet *(Vini kuhlii)*

numbering several hundred pairs. This species is believed to have been introduced by early Polynesian colonists. Teraina is an important seabird rookery, with about 10 breeding species, the most abundant being Red-footed Booby *(Sula sula)* and White Tern *(Gygis alba).* Polynesian Rats *(Rattus exulans)* occur on the island, and a few Green Turtles *(Chelonia mydas)* nest on the beaches.

Noteworthy flora: The peat bogs and swamp forest are unique in Kiribati.

Management authority and jurisdiction: Ministry of Line and Phoenix Development. References: Dahl (1980, 1986); Garnett (1983); Perry (1980).

Reasons for inclusion: ld, 2b. The only large freshwater lake and swamp forest in Kiribati, and much the largest area of peat bog.

Source: See references.

Wetland Name: Tabuaeran (Fanning)Island
Country: Republic of Kiribati
Coordinates: 3°52'N, 159°20'W
Location: in the northern Line Islands.
Area: Land area 3,370 ha; area of lagoon unknown.
Altitude: 0-4 m.
Overview: A tidal lagoon with brackish marshes and unusual "estuarine" conditions on a "wet" atoll.
Physical features: Tabuaeran is a low-lying atoll with a narrow fringing reef and three principal islets almost encircling a marine lagoon. The lagoon is tidal, and the surrounding brackish marshes and extensive intertidal mudflats create estuarine-like conditions. There are several small islets in the lagoon and some areas of salt pans. Tabuaeran is a wet atoll, with an average annual rainfall of about 2,000 mm.

Ecological features: Guinther (1971) has described the vegetation of the lagoon. Terrestrial vegetation includes atoll scrub and atoll forest with *Pisonia grandis* and *Messerschmidia argentea* (St. John, 1974). About half the land area has been planted to coconuts.

Land tenure: Largely state owned. Some of the copra plantations are freehold.

Conservation measures taken: None.

Land use: Coconut plantations, subsistence agriculture, salt production and fishing. Modern settlement dates from 1848, the resident population numbering 434 in 1978. There was some exploitation of guano and phosphate during the second half of the 19th century. Disturbances and threats: Feral cats and introduced Black Rats have doubtless contributed to the decline in numbers of terns, noddies and ground-nesting boobies, and the island has suffered in the past from the depredations of feral pigs. As long ago as 1925, it was noted that the disturbance to the native vegetation had been extensive enough to result in a considerable loss of traditional nesting sites for seabirds. Some breeding seabirds (e.g. Masked Booby *Sula dactylatra)* had already disappeared from the island by 1963.

Hydrological and biophysical values: No information.
Social and cultural values: No information.
Noteworthy fauna: Tabuaeran was formerly an important seabird rookery with 12 breeding species, but populations are now much reduced and only about six species still breed regularly: White-tailed Tropicbird *(Phaethon lepturus),* Red-footed Booby *(Sula sula),* Great Frigatebird *(Fregata minor),* Brown Noddy *(Anous stolidus),* Black Noddy (*A. minutus)* and White Tern *(Gygis alba).* There is small population of the Scarlet-breasted or Kuhl's Lorikeet *(Vini kuhlii)* on the northwestern islet. This species is believed to have been introduced by early Polynesian colonists. Tabuaeran is one of only four islands on which the Christmas Island Warbler or Bokikokiko *(Acrocephalus aequinoctialis)* is known to have occurred, but according to Perry (1980), the species has disappeared from this island since 1924. There are five species of lizards on the island. Noteworthy flora: The 22 native plant species include two endemics.
Scientific research and facilities: Guinther (1971) has studied the ecology of the estuarine environments in the lagoon.
Management authority and jurisdiction: Ministry of Line and Phoenix Development.
References: Dahl (1980, 1986); Guinther (1971); Perry (1980); St. John (1974).
Reasons for inclusion: ld. A tidal lagoon with unusual estuarine conditions.
Source: See references.

Wetland Name: Kiritimati (Christmas) Island Wildlife Sanctuary
Country: Republic of Kiribati
Coordinates: 2°00'N, 157°20'W
Location: in the northern Line Islands, 285 km southwest of Tabuaeran, 2,500 km south of Honolulu in Hawaii and 2,700 km north of Tahiti in French Polynesia.

Area: Island 32,137 ha; main lagoon 16,000 ha; subsidiary lagoons 16,800 ha.

Altitude: Sea level to 13 m.

Overview: Kiritimati is the world's largest coral atoll with a total land area of 321 sq.km and an approximately equal area of lagoons. With its multi-complex system of subsidiary land-locked lagoons, the island and its several hundred islets harbour some of the world's largest concentrations of seabirds, and are of global significance both in terms of diversity and abundance. The entire island is a Wildlife Sanctuary within which there are five closed areas.

Physical features: Kiritimati has the largest land area of any coral atoll in the world, with an approximately equal area of saltwater and supersaline lagoons. The single, large, flat island consists of coral formations 30-120 m in depth overlying volcanic rocks, and has a large tidal lagoon covering 16,000 ha and opening to the northwest. At the eastern end of this lagoon, there are several hundred smaller landlocked lagoons occupying 16,800 ha and delimited by causeways and larger tracts of land. Salinities vary widely, and many of the lagoons are supersaline. These tidal and landlocked lagoons contain hundreds of islets, the three principal ones being Cook Island, Motu Tabu and Motu Upoa. There are considerable variations in water level, and extensive intertidal mudflats are present. Freshwater lenses occur, with salinities varying between 0 and 3.5 p.p.t., and with a water table generally at a depth of between 0 and 2 m. Thirteen different physical units have been described by Garnett (1983), namely: seaward reef, seaward beach, beach crest, coastal dunes, boulder ramparts, coastal plain, central ridge, inland dunes, lagoon scarp, lagoon dunes, lagoon flats, lagoon beach and lagoon reef. The island rises to 13 m in height at the top of the dunes along the north coast of the Southeast Peninsula. Soil development is poor due to the limited supply of organic matter. A reef platform extends 30-120 m from the shoreline around the whole island, being widest along the north coast. Further details are provided by Garnett (1983), UNEP/IUCN (1988) and IUCN (1991). Kiritimati lies within the equatorial dry zone. The mean annual rainfall is 873 mm, varying widely between a minimum of 177 mm and a maximum of 2,621 mm. Rainfall is usually heaviest in March and April, and lightest in October and November. The temperature is constant, ranging diurnally between 24°C and 30°C, with little seasonal variation. The prevailing winds are easterly trades.

Ecological features: The native vegetation comprises forest, scrub, dwarf scrub, grassland and herb communities. Indigenous forest is restricted to three small groves of *Pisonia grandis* attaining a height of 10 m, at Southeast Point, Motu Tabu and near Northwest Point. The dominant scrub over most of the island is *Scaevola taccada,* in either pure stands or with *Messerschmidia argentea* and *Suriana maritima.* Lower lagoon flats are dominated by *Suriana,* growing to a maximum height of 2 m. *Messerschmidia* is found most commonly on the beach ridge, coastal plain and lagoon shores. *Sida fallax,* reaching 2 m in height, is abundant on the coastal plain to the south and on sandy soils elsewhere. *Heliotropium anomalum* forms a dwarf scrub on beach ridges and boulder ramparts, mixed with *Portulaca lutea* and *P. oleracea.* Extensive *Sida* dwarf scrub, mixed with *Heliotropium, Boerhavia repens, Portulaca, Cassytha filifonnis* and *Lepturus repens,* is found in the Southeast Peninsula and southern coastal plains. Elsewhere, *Lepturus*dominated grasslands cover large areas of coastal plain. The principal herbaceous community is dense *Sesuvium portulacastrum mat* which frequently covers the low-lying, waterlogged lagoon shore. Approximately 5,200 ha in the west have been planted with coconut palms *(Cocos nucifera),* and about 50 other introduced species occur, mainly around villages, abandoned military installations and other disturbed sites. Most alien species are believed to have arrived during the present century. Further details are provided by Gamett (1983) and IUCN (1991).

Land tenure: Largely state owned.

Conservation measures taken: Kiritimati was gazetted as a bird sanctuary in December 1960, under the Gilbert and Ellice Island Colony Wild Birds Protection Ordinance of 1938. The three principal lagoon islets (Cook Island, Motu Tabu and Motu Upua) were declared reserves with restricted access. Under the 1975 Wildlife Conservation Ordinance, the entire island was re-gazetted as a Wildlife Sanctuary in May 1975, with five areas being designated as Closed Areas: Cook Island (19 ha), a long, narrow islet at the entrance to the main lagoon; Motu Tabu (3.5 ha), a small islet with planted *Pisona* woodland in the main lagoon; Motu Upua (19 ha), a larger islet with

Messerschmidia, Heliotropium, Suriana and *Scaevola* scrub and scattered *Cocos nucifera;* Ngaontetaake (2.7 ha), an islet in the east of the central lagoon; and Northwest Point, a traditional nesting area for Sooty Terns north of the main settlement. All are important nesting areas for sea birds, Motu Upua holding the largest extant colonies of Phoenix Petrel and Christmas Island Shearwater. Entry into the Closed Areas is prohibited except under written permit.

A Wildlife Conservation Unit was established on Kiritimati in 1977 to survey and monitor seabirds populations, enforce strict wildlife conservation legislation, control feral cats and pigs, and provide a conservation education programme. The Unit is represented on the Kiritimati Development Committee and the Local Land Planning Board. Garnett (1983) proposed a five-year management plan (1983-87) involving law enforcement, education and public awareness, surveys and research, advice to government, control of introduced species and appropriate development of tourism. Many of the activities proposed in this management plan have subsequently been carried out by the Wildlife Conservation Unit. A grant has been made available by New Zealand to fund programmes for the eradication of feral cats and pigs.

Conservation measures proposed: Garnett (1983) has recommended that the island as a whole loses its wildlife sanctuary status and that a number of specific areas be gazetted as wildlife sanctuaries, namely all the islets, the central lagoons, Northwest Point, Paris Peninsula and Southeast Peninsula. Within these proposed sanctuaries, it is recommended that the following areas be declared closed areas: Cook Island, Motu Tabu, Motu Ubua, Ngaontetaake, Frigatebird Island and all Sooty Tern colonies.

Land use: Kiritimati was bonded under the 1856 American Guano Act in June 1858, after which it was sporadically exploited for phosphate. The island has been occupied more or less continuously since 1882. By 1886, some 18,000-20,000 coconut palms had been planted, and 200 tons of pearl-shell exploited. A number of commercial concerns were licensed to exploit the island in the late 19th century, and some 70,000 coconut palms were planted at the turn of the century, although only 25% survived due to severe drought. The island was uninhabited from 1905 to 1912, but then followed large-scale development of coconut plantations by Central Pacific Coconut Plantation Ltd. The island was occupied by Allied forces during World War II, and an airstrip was constructed. From 1956 to 1958, atmospheric nuclear bomb tests were conducted by the U.K. some 50 km south of the island, and up to 4,000 servicemen were present. Further bomb tests were carried out by the U.S.A. in 1962. Military interests ceased in 1969, and many of the installations were dismantled. The surviving infrastructure of roads, wharfs and airport facilities have established Kiritimati as the administrative centre for the Line Islands. The principal economic activity is copra production, the Government copra plantation covering some 5,170 ha. The population in 1989 was estimated at 2,000, the great majority of whom live in London, Banana and Poland villages in the west. Recent developments include small-scale vegetable production and the export of live crayfish and chilled reef and ocean fish. A 1971 University of Hawaii expedition investigated the possibilities for production of brine shrimp *(Artemia salina),* and brine shrimp were introduced into the lagoon, but commercial implementation of the project was abandoned in 1978. A pilot project to determine the potential for salt production has been undertaken. In recent years, there has been some tourism to the island. Further details are given in Garnett (1983) and IUCN (1991).

Disturbances and threats: Coconut plantations have replaced the natural vegetation over about a third of the land area. The indigenous Tree Heliotrope *(Messerschmidia argentea)* and other shrubs have been needlessly destroyed on several occasions in the name of agricultural projects that have turned out to be ill-conceived (Perry, 1980). Substantial changes have occurred in the ecology of the island as a result of the introduction of *alien* plants. The introduced Sourbush *(Pluchea odorata)* became widely dispersed during World War II, and forms thickets eliminating open habitats in some parts of the island. The low-growing vine *Tribulus cistoides* now dominates extensive open areas, but is to some extent beneficial in that it provides increased cover for some nesting seabirds (Perry, 1980). By 1978, there were over 50 species of exotic plants on the island (Perry, 1980). It is not known if the island was adversely affected by atmospheric nuclear bomb test programmes during 1956-58 and 1962. The El Nino-Southern Oscillation of 1982-83 had a devastating effect on seabird populations, leading to 90% mortality and no reproductive success in a number of species. Both numbers of birds and reproductive activity increased in 1983, but recovery was set back by the El Nino-Southern Oscillation of 1986-87.

Feral cats have been present on the island since the 19th century and pose the most serious threat to bird life. The feral cats feed almost entirely on seabirds, and their distribution is closely correlated with that of nesting seabirds. The total number of cats on the island, although showing considerable fluctuations, may at times exceed 2,000. As a result of predation by cats, 11 of the 18 breeding seabirds now nest only on lagoon islets that are free of cats. An exceptionally dry period during the latter part of 1978 resulted in the lowering of water levels in a number of shallow lagoons, enabling cats to move across to former islets where they extirpated several previously secure colonies of Grey-

backed Terns (Perry, 1980). A cat eradication programme employing night-shooting has met with only limited success. However, the recruitment of stray domestic cats into the feral population has been countered by programmes of trapping in the villages since 1981, and by a local bye-law which makes it illegal to possess a female cat until it has been neutered.

Feral pigs formerly posed a serious threat to ground-nesting terns in particular, but intensive hunting has drastically reduced the numbers of pigs on the island in recent years. The Black Rat *(Rattus rattus) has* been recorded in the past, but apparently no longer persists. Tilapia *(Oreochromis* sp.) and brine shrimp *(Artemis salina)* have been introduced into the lagoons.

Direct exploitation of seabirds for food posed a serious threat to populations of Sooty Terns, Red-tailed Tropicbirds and boobies until 1977, when the wildlife conservation laws were enforced for the first time. The large-scale collection of Sooty Tern eggs for food occasionally resulted in complete nesting failure in some colonies. Tropicbirds were frequently killed for the sake of their tail streamers and other plumage feathers which were used in making fish lures and for decorating artifacts (Perry, 1980). Poaching remains a problem. An increase in fishing activity, better roads, cheaper and improved cross-country motor-cycles and the wider availability of outboard motors have all contributed to greater accessibility to previously remote parts of the island, with consequent increased disturbance and poaching at the seabird colonies. Red-tailed Tropicbirds, Red-footed Boobies and Masked Boobies, in particular, have suffered from the increased levels of poaching. There seems to be little prospect of these populations recovering to their pre-1982/83 levels, as long as feral cats and poaching are prevalent.

Hydrological and biophysical values: No information.

Social and cultural values: Archaeological research indicates that Kiritimati was visited by early Polynesians but not settled for prolonged periods. Remains include two sites which may have been villages, and a number of stone structures.

Noteworthy fauna: Thirty-seven species of birds have been recorded on the island, and 20 of these are known to breed. Kiritimati has the greatest variety and some of the largest populations of tropical seabirds anywhere in the world. Eighteen species of seabirds breed on the island. Population estimates prior to the 1982/83 El Nino included 12,000 pairs of Phoenix Petrels *(Pterodroma alba),* 500,000 pairs of Wedge-tailed Shearwaters *(Puffinus pacificus),* 6,000 pairs of Christmas Island Shearwaters *(P. nativitatis),* 500 pairs of White-throated Storm Petrel *(Nesofregetta (fuliginosa) albigularis),* 4,000 pairs of Red-tailed Tropicbird *(Phaethon nthricauda),* 1,500 pairs of Masked Booby *(Sula dactylatra),* 6,000 pairs of Red-footed Booby *(S. sula),* 6,000 pairs of Great Frigatebird *(Fregata minor),* 4,500 pairs of Lesser Frigatebird *(F ariel),* 3 million to 4 million pairs of Sooty Terns *(Sterna fuscata),* 3,000 pairs of Grey-backed Tern *(S. lunata),* 2,000 pairs of Blue-grey Noddy *(Procelsterna cerulea),* 10,000 pairs of Black Noddy *(Anous minutus)* and 4,000 pairs of White Tern *(Gygis alba)* (Schreiber & Schreiber, 1984). The population of Sooty Terns, estimated at 15 million birds in the 1960s, remains the largest known population in the world despite the decline in recent years. The terns nest on five principal islets, two of which are in Closed Areas. The population of Phoenix Petrels is also the largest in the world, as is probably that of Wedge-tailed Shearwaters. Other internationally significant populations include those of the White-throated Storm Petrel, Red-tailed Tropicbird, Masked Booby, Great Frigatebird, Lesser Frigatebird, Grey-backed Tern and Blue-grey Noddy. Populations of all species declined to a greater or lesser extent following the devastating El Nino-Southern Oscillation of 1982 and 1983, and in most cases have remained below 1981 levels since then (Schreiber & Schreiber, 1984, 1989). There is only one indigenous land-bird, the Christmas Island Warbler *(Acrocephalus aequinoctialis),* which is fairly common except in the vicinity of settlements, favouring semi-open areas of native *Lepturus* grass with scattered *Messerschmidia* and *Scaevola* shrubs. The total population has been estimated at about 1,000 individuals (Garnett, 1983). The Scarlet-breasted or Kuhl's Lorikeet *(Vini kuhlii)* has been introduced to the island but remains scarce and local. Common migrants include the Pacific Golden Plover *(Pluvialis fulva),* Wandering Tattler *(Heteroscelus incanus),* Bristle-thighed Curlew *(Numenius tahitiensis)* and Ruddy Turnstone *(Arenaria interpres).* The type specimen of the Tuamotu Sandpiper *(Prosobonia cancellatus)* was collected on the island in January 1778, but the species has not been found there since.

The only mammal on the island, other than feral animals, is the Polynesian Rat *(Rattus exulans),* which is widespread and abundant. This was presumably introduced by early Polynesians. Green Turtles *(Chelonia mydas)* regularly come ashore in small numbers to nest. Mourning Geckoes *(Lepidodactylus lugubris)* and

Snake-eyed Skinks *(Ablepharus boutonii)* are common, and the Stump-toed Gecko *(Gehyra mutilata)* has been recorded. Noteworthy invertebrates include Coconut Crabs *(Birgus latro),* ghost crabs *(Ocypode* spp.), land crabs *(Cardisoma carnifex* and *Geograpsus grayii)* and land hermit crabs *(Coenobita perlata).* Further details of the fauna are provided by Garnett (1983).

Noteworthy flora: The island has one endemic plant species, *Cuscuta campestris.*

Scientific research and facilities: Kiritimati has been the subject of numerous studies and surveys. A considerable amount of research has been undertaken on the breeding seabirds (e.g. Schreiber & Ashmole, 1970; Garnett, 1982, 1983, 1984; Schreiber & Schreiber, 1984, 1989), while Milder and Schreiber (1982, 1989) have described the nesting behaviour and vocalizations of the Christmas Island Warbler. The University of Hawaii has several projects in the Line Islands and uses Kiritimati as a base. A meteorological observatory and projects on sea level rise and water temperature are based on the island. A bibliography of studies on the flora, fauna and past and present human use is given by Garnett (1983).

Conservation education: The Wildlife Conservation Unit has developed an education and public awareness programme on the island.

Recreation and tourism: An hotel and improved air connections with Honolulu have enabled the development of small-scale tourism for sport fishing and naturalists. Specialist wildlife tours consist of six-day guided visits to reserves, reefs and the Southeast Peninsula (Garnett, 1983).

Management authority and jurisdiction: Wildlife Conservation Unit, Ministry of the Line and Phoenix Groups.

References: Anon. (1985); Chock & Hamilton (1962); Dahl (1980, 1986); Garnett (1982, 1983, 1984); IUCN (1991); Milder & Schreiber (1982, 1989); Perry (1980); Schreiber & Ashmole (1970); Schreiber & Schreiber (1984, 1989); TCSP (1990); UNEP/IUCN (1988); Wildlife Conservation Unit (1985).

Reasons for inclusion: la, ld, 2a, 2b, 2c. The island is recognized as having considerable scientific and conservation importance for wildlife in the Central Pacific. It is particularly valued for the diversity and abundance of its seabird populations, with internationally significant breeding populations of 10-12 species. The large and complex system of partially and completely landlocked lagoons with hundreds of islets is unique in the Central Pacific.

Source: See references.

Wetland Name: Malden Island Wildlife Sanctuary and Reserve
Country: Republic of Kiribati
Coordinates: 4°03'S, 155°01'W
Location: in the southern Line Islands, 676 km south-southeast of Kiritimati.

Area: 3,930 ha.

Altitude: Sea level to 8 m at the beach crest.

Overview: A dry, low-lying coral island with sparse scrub and a shallow, enclosed lagoon connected to the sea by underground fissures. Malden Island is a Wildlife Sanctuary and a Closed Area with significant populations of several species of seabirds. The island was extensively mined for phosphates between 1860 and 1927.

Physical features: Malden Island is a low, flat, coral limestone island roughly triangular in shape with a fringing reef. The island measures about 8 km from east to west and 6 km from north to south. A series of wave-like ridges of sand and coral boulders forms a circumferential beach crest. The island contains an enclosed and highly saline lagoon covering approximately 1,300 ha and occupying about one third of the total land area. The lagoon is connected to the sea by underground channels, and has numerous small islets comprised of coral rocks and slabs. The floor of the lagoon is covered in brown mud, and there are some mudflats along the shore. The soil is composed of coarse coral gravel around the margin of the island, but is finer in the interior, with more sand and mud. There is no standing fresh water on the island, but there may be a freshwater lens. The fringing reef is about 100 m wide and extends 300-400 m at its northwestern and southeastern points. Malden is an arid island, with a mean annual rainfall of 726 mm. The annual rainfall is, however, very variable, ranging from as little as 100 mm to 2,400 mm. The mean annual temperature is 29.3°C (minimum 23.8°C, maximum 37.2°C). The prevailing winds are easterly trades, and severe storms are extremely rare.

Ecological features: The general aspect of the island is that of moorland, being sparsely vegetated with stunted *Sida fallax* scrub, low herbs and grasses. *Pisonia grandis* forest formerly covered much of the

island, but this was greatly reduced by indiscriminate felling and grazing during the 19th century, and only one or two clumps of *Pisonia* survive near the northeast corner of the island. Introduced weeds are particularly common around the old settlement areas. The introduced low-growing woody vine *Tribulus cistoides* now dominates extensive open areas where it provides increased cover for young Sooty Terns. Parts of the lagoon flat are completely devoid of vegetation. Sixteen species of vascular plants have been recorded, nine of which are indigenous (Garnett, 1983).

Land tenure: State owned (Government of the Republic of Kiribati).
Conservation measures taken: Malden Island was gazetted as a Wildlife Sanctuary and Closed Area in May 1975 under the 1975 Wildlife Conservation Ordinance. Practical enforcement of the regulations is, however, difficult as the Wardens are stationed on Kiritimati, some 670 km away.

Conservation measures proposed: Malden Island was selected by the International Biological Program as one of the "Pacific Ocean Islands Recommended for Designation as Islands for Science" (Elliott, 1973).

Land use: Early Polynesian settlements were abandoned when the island was discovered by Europeans in 1825. Malden was bonded in 1860 under the 1856 American Guano Act, and heavily exploited for guano and phosphate deposits from 1860 until 1927. This was the most commercially successful of the Central Pacific guano islands. The island was occupied between 1956 and 1959 by British servicemen to monitor the Christmas Island atmospheric nuclear bomb test programme, and was itself used as a target for some of the larger detonations (Garnett, 1983). An airstrip was constructed in 1958 and was in regular use until July 1979. Since then, the island has been uninhabited and unused except as a Wildlife Sanctuary. There is no anchorage, and landing is difficult and dangerous.

Possible change in land use: The U.S. mineral exploration company GEOMAREX surveyed the island in 1980, and found substantial gypsum deposits which might be worth exploiting commercially in the future (Garnett, 1983).
Disturbances and threats: Extensive exploitation of guano and phosphate deposits between 1860 and 1927 resulted in the disappearance of the Phoenix Petrel *(Pterodroma alba),* at least two other procellarids and Red-tailed Tropicbird *(Phaethon rubricauda)* as nesting species, although the tropicbird has since returned (Perry, 1980). Potholes and trenches dating back to the phosphate mining days still mar the interior of the island. Cats, pigs, goats and House Mice were introduced by the phosphate company. The last small herd of five feral pigs was eradicated by the Smithsonian Institution's Pacific Ocean Biological Survey Program in 1964, and the goats have also disappeared. Feral cats and House Mice are still present on the island. However, in 1978, the cats appeared to be present in very low numbers and were having little impact on the seabird colonies (Perry, 1980). The original vegetation cover was severely damaged by the phosphate workings, indiscriminate felling and feral pigs and goats. Most of the *Pisonia grandis* forest was destroyed, and this led to the extirpation of the Black Noddy *(Anous minutus)* as a breeding species and disappearance of many of the nesting White Terns (Perry, 1980). Fires are a potential hazard; a fire in 1977 threatened breeding seabirds (Perry, 1980). Malden Island is occasionally visited by foreign yachtsmen and fishermen, and these visits cannot be monitored from Kiritimati.

Hydrological and biophysical values: None known.
Social and cultural value: Malden Island is of considerable historical importance. Twenty-one archaeological sites with a total of over 70 ruined buildings and other stoneworks have been found, indicating that the island was settled by early Polynesian for several generations.
Noteworthy fauna: Malden is a very important breeding site for seabirds. Nineteen species have been recorded and 11 or 12 have been found breeding in recent years. Populations have been estimated as follows: 40 Red-tailed Tropicbirds *(Phaethon rubricauda),* 3,000 Masked Boobies *(Sula dactylatra),* 2,000 Brown Boobies *(S. leucogaster),* 5,000 Red-footed Boobies *(S. sula),* 3,000 Great Frigatebirds *(Fregata minor),* 7,000 Lesser Frigatebirds *(F. arid),* 10,000 Sooty Terns *(Sterna fuscata),* 2,500 Grey-backed Terns (S. *lunata),* 200 Blue-grey Noddies *(Procelsterna cerulea),* 500 Brown Noddies *(Anous stolidus)* and 50 White Terns *(Gygis alba)* (Perry, 1980). The island supports the largest concentrations of Lesser Frigatebirds, Grey-backed Terns and probably also Masked and Brown Boobies in the Line Islands. Tidal mudflats bordering the lagoon are frequented seasonally by large numbers of Pacific Golden Plovers *(Pluvialis fulva),* Bristle-thighed Curlews *(Numenius tahitiensis)* and Wandering Tattlers *(Heteroscelus incanus).* The only mammals still present on the island are feral cats and House Mice *(Mus musculus).* Polynesian Rats *(Rattus exulans)* are known to have occurred in the past, but are now locally extinct. Small numbers of Green Turtles *(Chelonia mydas)* nest on the beaches. Two species of

lizard, the Mourning Gecko *(LepidodacOus lugubris)* and Snake-eyed Skink *(Ablepharus boutonii)* have been recorded. Invertebrates include hermit crabs *(Ceonobita* spp.) and a brown libellulid dragonfly (Garnett, 1983).

Noteworthy flora: None known.

Scientific research and facility: The island was visited by the Smithsonian Institution's Pacific Ocean Biological Survey Program on several occasions in the 1960s, and by the Line Islands Expedition in 1974. In recent years, staff of the Wildlife Conservation Unit have visited the island almost annually. No detailed research has, however, been undertaken, and there are no research facilities on the island.

Management authority and jurisdiction: Wildlife Conservation Unit, Ministry of Line and Phoenix Development.

References: Dahl (1980, 1986); Elliott (1973); Garnett (1983, 1984); IUCN (1991); Perry (1980); TCSP (1990).

Reasons for inclusion: la, 2c. Malden is valued for its large breeding populations of seabirds and interesting saline lagoon.

Source: Mr Aobure Teataata.

Wetland Name: Starbuck Island Wildlife Sanctuary
Country: Republic of Kiribati
Coordinates: 5°37'S, 155°56'W
Location: in the southern Line Islands, 830 km south-southeast of Kiritimati.
Area: Land area 1,620 ha.
Altitude: Sea level to 6-8 m on a steep bank behind the reef.
Overview: A small coral island with several interesting saline lagoons, a very large breeding colony of Sooty Terns and breeding populations of at least four other seabirds. The island is protected as a Wildlife Sanctuary and is remote and seldom visited. The presence of feral cats poses a threat to the breeding seabirds.

Physical features: Starbuck is a low, dry, coral limestone island with fringing and offshore reefs. The island extends for 8.9 km from east to west and up to 3.5 km from north to south. The beach is steep and backed by a 6-8 m high bank composed of large coral fragments. This rampart drops 2.5 m to the flat interior, which is largely composed of broken, black coral pieces. There are several small, shallow and highly saline lagoons in the southeast which occasionally dry out completely. There is no free-standing fresh water on the island, although a freshwater lens may form. Soils appear to be mainly coral sand interspersed among larger areas of coral rag and broken reef rock (IUCN, 1991). Starbuck is one of the drier Line Islands with an inferred mean annual rainfall of about 800 mm. The prevailing winds are easterly trades.

Ecological features: The island is covered with an impoverished atoll scrub vegetation. With the exception of a limited number of *Cordia subcordata* bushes, the vegetation consists entirely of stunted *Sida fallax* scrub with low herbs and grasses. Five other species have been tentatively identified: a bunch grass, probably *Lepturus repens, Bidens pilosa, Portulaca lutea, Tribulus cistoides* and *Ipomoea* sp. *Bidens , Ipomoea* and *Tribulus* are all likely to have been introduced, while the other species are probably indigenous (Garnett, 1983).

Land tenure: State owned.
Conservation measures taken: Starbuck was established as a Wildlife Sanctuary and Closed Area in 1975 under the 1975 Wildlife Conservation Ordinance.

Conservation measures proposed: The elimination of feral cats would considerably enhance the nature conservation value of the island (Garnett, 1983).

Land use: The island is uninhabited. Starbuck was bonded under the 1856 American Guano Act and mined for phosphate between 1870 and 1893. The rights to exploit the island passed through a number of companies until 1920, since when no action has been taken to develop or use the island in any way. The island has seldom been visited in recent years, and there is no safe anchorage.

Disturbances and threats: Feral cats are present on the island (three were sighted in 1974), and these have probably caused a decline in the numbers of breeding terns, noddies and ground-nesting boobies (Garnett, 1983).
Hydrological and biophysical values: None known.

Social and cultural values: None known. The presence of Polynesian Rats suggests that the island may have

been visited by Polynesians in pre-historic times, but there is no evidence that the island was ever inhabited.
Noteworthy fauna: Starbuck is a very important breeding site for seabirds. Fifteen species have been recorded around the island, and as many as 11 species may breed. The island is particularly important for its large colony of Sooty Terns *(Sterna fuscata),* estimated at about 1.5 million pairs (Perry, 1980; Garnett, 1983). Polynesian Rats *(Rattus exulans)* occur on the island, and Green Turtles *(Chelonia mydas)* have been recorded, although it is not known if they nest.

Noteworthy flora: None known.

Scientific research and facilities: The Line Islands Expedition visited Starbuck in 1974.

Management authority and jurisdiction: Wildlife Conservation Unit, Ministry of Line and Phoenix Development.

References: Dahl (1980, 1986); Garnett (1983); IUCN (1991); Perry (1980).
Reasons for inclusion: la, 2c. The island is a special value for its colony of Sooty Terns which is thought to be of international importance.
Source: See references.

Wetland Name: Vostok Island Wildlife Sanctuary
Country: Republic of Kiribati
Coordinates: 10°06'S, 152°23'W
Location: in the southern Line Islands; 158 km north-northwest of Flint, 230 km west of Caroline, 709 km south southeast of Malden and 1,490 km northwest of Rarotonga in the Cook Islands.

Area: 24 ha.
Altitude: 0-5 m.
Overview: Vostok Island is one of four Wildlife Sanctuaries in the Line Islands and the least disturbed island in this group. It harbours eight breeding species of seabirds, and supports a dense stand of *Pisonia* forest on deep peat deposits. The island is too small, remote and inhospitable to support any commercial undertaking.

Physical features: Vostok is a small, triangular-shaped sand and coral island with a fringing reef but no lagoon. There is no standing fresh water on the island and no evidence of a freshwater lens. However, the interior of the island is covered in peat soils up to one metre thick over phosphatic hardpan, and these peats are moist at a depth of 30 cm. In the south and west, the beaches are about 50 m wide and rise abruptly to a crest at the edge of the forested interior. In the east, the beaches are 25-35 m wide and border on a raised flat area of coral sand and rubble.

Ecological features: The vegetation is extremely simple. The central portion of the island (about 10-15 ha) is occupied by a pure stand of *Pisonia grandis* forest which reaches its maximum density and a height of 30 m at the edge of the western beach.

Boerhavia repens forms a herb mat on the sandy edges of clearings in the forest and also occurs in a belt 3-10 m wide extending from the north to the southeast end of the island. The succulent herb *Sesuvium portulacastrum* may be present (Clapp & Sibley, 1971b). Elsewhere, there are open areas of sand, and sand with coral rubble.
Land tenure: Vostok Island is wholly owned by the Government of the Republic of Kiribati. In recent years, the island was leased to a Captain Omer of Moorea, French Polynesia, but the lease terminated in 1989.
Conservation measures taken: The island was gazetted as a Wildlife Sanctuary in June 1979 under the 1975 Wildlife Conservation Ordinance. The killing of all resident and regularly occurring birds and the Green Turtle is prohibited. The island is also protected by its remoteness and inhospitable nature.
Conservation measures proposed: Vostok Island was selected by the International Biological Program as one of the "Pacific Ocean Islands Recommended for Designation as Islands for Science" (Elliott, 1973). Garnett (1983) recommended that the Wildlife Sanctuary be upgraded to Closed Area status.
Land use: The island was bonded under the 1856 American Guano Act in 1860, and a British claim was made in 1873, but it is unlikely that the phosphate deposits were ever worked. An unsuccessful attempt was made in 1922 to establish a coconut plantation (Garnett, 1983). Until 1989, this island together with Caroline and Flint were leased to a Captain Omer Darr of French Polynesia. The leaseholder did not, however, develop Vostok. Its small size and various other factors have rendered Vostok unsuitable for any form of commercial undertaking, and this has ensured that the island has remained intact since Darr's leasehold. At present, the island is uninhabited, and no use is made of it other than as a Wildlife Sanctuary.
Possible changes in land use: None is anticipated at present.

Disturbances and threats: Vostok is the least disturbed of the Line Islands, and the only island in this group not affected by introduction of alien mammals. An attempt to plant coconut seedlings in 1922 failed. Fire poses the principal threat, and could be especially hazardous on this island where the terrain is capped by a deep layer of peat. Fortunately, a fire in 1974 caused only limited damage to breeding seabirds. Yachts occasionally cruise past the island and anchor offshore, but the level and types of disturbance which these visits cause are unknown.
Hydrological and biophysical values: None known.
Social and cultural values: There are no known archaeological sites on the island, although the presence of rats suggests that Polynesians may have visited the island in prehistoric times (Garnett, 1983).
Noteworthy fauna: Vostok Island is a very important breeding site for seabirds, especially five tree-nesting species, the Red-footed Booby *(Sula sula),* Great Frigatebird *(Fregata minor),* Lesser Frigatebird *(F. arkl),* Black Noddy *(Anous minutes)* and White Tern *(Gygis alba)* which nest in the *Pisonia* forest. Three other species breed on the island in smaller numbers, the Masked Booby *(Sula dacOatra),* Brown Booby *(S. leucogaster)* and Brown Noddy *(Anous stolidus).* The populations of Masked Booby (400), Red-footed Booby (3,000) and Great Frigatebird (4,500) are considered to be of national importance (Garnett, 1983). Several migratory shorebirds from the northern hemisphere have been recorded including the Pacific Golden Plover *(Pluvialis fulva),* Bristle-thighed Curlew *(Numenius tahitiensis)* and Wandering Tattler *(Heteroscelus incanus).* The only mammal known to occur on Vostok is the Polynesian Rat *(Rattus exulans),* which is abundant. This is a vegetarian feeding on stems and leaves of both *Pisonia* and *Boeharvia,* and does not pose a threat to nesting seabirds. One species of skink, the Azure-tailed Skink *(Emoia cyanura),* occurs on the island, and Green Turtles *(Chelonia mydas)* have been seen offshore, although there is no record of nesting. The large population of Coconut Crabs *(Birgus latro)* is nationally important.
Noteworthy flora: The undisturbed *Pisonia* forest is an excellent example of a type of atoll forest which would once have covered many atoll and coral islands in the Central Pacific before clearance by man.
Scientific research and facilities: Recent scientific visits to the island have included visits by the Pacific Ocean Biological Survey Program in June 1965, the Line Islands Expedition in September 1974, and staff of the Wildlife Conservation Unit in November 1977 and May 1991.
Management authority and jurisdiction: Wildlife Conservation Unit, Ministry of the Line and Phoenix Development.
References: Clapp & Sibley (1971b); Dahl (1980, 1986); Elliott (1973); Garnett (1983); IUCN (1991); Perry (1980); TCSP (1990).
Reasons for inclusion: ld, 2c. Vostok is the least disturbed of the Line Islands. The excellent stand of *Pisonia* forest and the deep peat deposits are of special interest.
Source: K. Teeb'aki.

Wetland Name: Caroline Atoll
Country: Republic of Kiribati
Coordinates: 10°00'S, 150°14'W
Location: in the southern Line Islands, 830 km west of Tahiti in French Polynesia.
Area: 227 ha.
Altitude: 0-6 m.
Overview: Caroline Atoll is one of the most unspoiled of the Line Islands. It combines features of physical and biological interest with natural scenic beauty. The atoll harbours impressive breeding populations of seabirds, while its pristine lagoon supports a rich and varied marine life with very large populations of *Tridacna* clams. Many of these features are of national and international conservation significance. The island has been a focus of potential development by foreign entrepreneurs, but its remoteness from administrative centres creates various problems for development, and it has been recommended that much of the atoll be reserved for nature conservation.

Physical features: Caroline island is a low-lying, densely vegetated crescent-shaped atoll, 9.2 km long by 1.6 km wide. It consists of 38 small wooded islets surrounding a narrow tidal lagoon. Channels between the islets vary in width from as little as 5 m to as much as 200 m. The northernmost and southernmost islets are the largest in the group. There is no standing fresh water on the atoll. However, the vegetation is lush and dense throughout, and the accumulation of decayed plant material contributes significantly to the moist-retaining process in the soil. Freshwater lenses are said to exist on South Island and on Nake Islet in the north. In 1974, the freshwater lens on South Island was about 1.5 m below ground level. The lagoon is

partly enclosed and is about 500 m wide at its widest. It is shallow and clear, about 6-10 m deep, and contains living corals. Some of the coral reefs form continuous barriers across the lagoon, and many are partly exposed at low tide. Ecological features: The main plant formations are forests of *Pisonia grandis* and *Calophyllum* sp., forest/scrub dominated by the Beach Heliotrope *Messerschmidia argentea, Suriana* scrub, and dwarf scrub with *Morinda citnfolia* and *Heliotropium* sp.

Fifteen of the 35 species of vascular plants recorded from the island are native. Coconut plantations exist on South Island and to a lesser extent also on Long Islet and Nake Islet in the north. Groves of coconut palms or individual palms can be found here and there on some of the other islets, but most islets are still free of this introduced species.

Land tenure: The entire atoll is owned by the Government of the Republic of Kiribati.

Conservation measures taken: None, other than the general protection afforded to seabirds and Green Turtles under the Wildlife Conservation Ordinance of 1975.

Conservation measures proposed: Various recommendations have been made with respect to the importance of Caroline Atoll and the possibility of implementing appropriate conservation measures. Dahl (1980) considered the atoll to be a candidate for reserve status, especially if existing introduced predators could be controlled. It has been suggested that the atoll should be designated as a Biosphere Reserve under the Unesco Man and the Biosphere Programme and/or as a World Heritage Site under the World Heritage Convention. Following the Kiribati Government Expedition to the atoll in 1991, personnel of the Wildlife Conservation Unit and officials of the Ministry of Line and Phoenix Development agreed that all islets in Caroline Atoll except South Island, Long Islet and Nake Islet should be made into Wildlife Sanctuaries.

Land use: There was some exploitation of guano and phosphate in the second half of the 19th century, and a small stock-raising and copra community inhabited the atoll from 1846 to the late 1930s. In recent decades, the atoll has been uninhabited, although South Island, Long Islet and Nake Islet are visited from time to time by Polynesian copra gatherers under an agreement with the Government in Tarawa, The atoll has recently been leased to a Mr Urima Felix of Moorea, French Polynesia. The lessee has proposed to develop the island for the extraction of copra, exploitation of fish, and tourism, and envisages the eventual development of a hotel complex. Nothing has yet been finalized by the developer, and the future of the leasehold is uncertain.

Possible changes in land use: It is possible that there will be some development on the three main islets, South, Long and Nake, in the future, but this remains uncertain because of the remoteness of the atoll and the various logistic problems which development would entail.

Disturbances and threats: A solid coconut plantation occupies the whole of South Island. This introduced species has taken over all of the interior of the island to the edge of the beach. Smaller plantations exist on Long and Nake islets, but these have spread only to a limited extent. Coconut palms are highly competitive, their high, dense canopies blocking out the light and inhibiting the growth of native species. An introduced parasitic vine, *Ipomoea tuba,* has successfully colonized both open and shaded areas. The recent leasing of Caroline Atoll to a French Polynesian entrepreneur has led to some poaching of Green Turtles. The leaseholder has established a homestead on Motu Ana-Ana, and has brought domestic dogs and cats with him. These now pose a serious threat to seabirds, which had already ceased to breed on Motu Ana-Ana by 1990. Caroline Atoll is regularly visited by yachts, and these presumably cause some disturbance to wildlife.

Hydrological and biophysical values: No information.

Social and cultural values: The social and cultural values of Caroline Atoll lie mainly in its conservation significance which, it is believed, could be enhanced through the development of nature-oriented tourism.

Noteworthy fauna: Caroline is a very important atoll for seabirds, with nine breeding species: Masked Booby *(Sula dactylatra),* Brown Booby *(S. leucogaster),* Red-footed Booby *(S. sula),* Great Frigatebird *(Fregata minor),* Lesser Frigatebird *(F. ariel),* Sooty Tern *(Sterna fuscata),* Brown Noddy *(Anous stolidus),* Black Noddy *(A. minutus)* and White Tern *(Gygis alba).* The most abundant species are the Great Frigatebird, estimated at 10,000 birds, and Sooty Tern, estimated at 500,000 birds (Perry, 1980). The Reef Heron *(Egretta sacra)* occurs on the island and evidently breeds, while several species of migratory shorebirds, such *as* the Pacific Golden Plover *(Pluvialis fulva),* Bristle-thighed Curlew *(Numenius tahitiensis)* and Wandering Tattler *(Heteroscelus incanus),* are winter visitors. The Long-tailed Cuckoo *(Eudynamis taitensis)* occurs as a regular non-breeding visitor from New Zealand. Green Turtles

(Chelonia mydas) nest on the beaches, and there are three native species of lizards. *Tridacna clams* are abundant throughout the lagoon. Other conspicuous invertebrates include Coconut Crabs *(Birgus latro),* land crabs and hermit crabs.

Noteworthy flora: There are excellent undisturbed stands of *Pisonia* forest on many of the islets, and these provide nesting habitat for a large proportion of the breeding seabirds.

Scientific research and facilities: Several scientific visits have been made to the atoll including visits by staff of the Wildlife Conservation Unit in 1988 and 1991. Earlier visits included those by the Pacific Ocean Biological Survey Program in 1965 and Line Island Expedition in 1974.

Management authority and jurisdiction: Ministry of Line and Phoenix Development. References: Clapp & Sibley (1971a); Dahl (1980, 1986); Garnett (1983); Perry (1980).

Reasons for inclusion: la, 2b, 2c. Caroline Atoll combines a variety of features of conservation importance. Virtually all of the islets except the inhabited Motu Ana-Ana support populations of seabirds. Caroline continues to support large populations of the Coconut Crab which is now rare on most inhabited atolls. The *Pisonia* forests are amongst the oldest stands of this species in the Line and Phoenix Islands, and provide habitat of exceptional importance to the wildlife. The pristine lagoon, with its rich marine life and large populations of *Tridacna* clams, is of great national and international conservation importance.

Source: Aobure Teataata.

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