Nooto – North Tarawa, Kiribati's first Ramsar site

Directory of Wetlands of Kiribati - 2014

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SPREP
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Ramsar

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1 Introduction

The Secretariat of the Pacific Regional Environment Programme (SPREP) is an intergovernmental organisation charged with promoting cooperation among Pacific islands countries and territories to protect and improve their environment and ensure sustainable development for present and future generations. For more information, see: www.sprep.org.

Wetlands are among the world's most productive (and threatened) ecosystems and the services that they provide to humanity are significant. In order to effectively conserve and manage wetlands, a first step is to document and understand their distribution and status through conducting detailed baseline wetland inventories. Across the Pacific region, The Directory of Wetlands in Oceania 1993 documented available information on the distribution, status and values of wetlands in Pacific Island Countries and Territories, however, much of this existing information needs updating.

A number of Pacific Island Countries are contracting parties to the Ramsar Convention on Wetlands and as such are obligated to formulate and implement national planning to promote the conservation of their Ramsar Sites and other wetlands within their jurisdiction. Such planning relies very much on the availability of comprehensive data on wetlands.

The aim of this project was to update wetland inventories for Kiribati, Palau and Vanuatu (Scott 1983) as a means of strengthening the baseline state of knowledge of wetlands in these countries. Such baseline information would be valuable for informing conservation decisions, raising awareness of the importance of wetlands, influencing public perception of wetlands, creating ongoing monitoring, revealing trends over time, identifying priority sites for conservation management (e.g. for designating Ramsar Sites or other types of Protected Areas) and as a tool for planning and implementing effective conservation interventions for wetlands, especially in light of the impacts of climate change.

This project activities to build national capacity to conduct future wetland inventory updates, as well as to be able to use information collated in the inventory process in national decision making. To facilitate this, collated data will be centralized and delivered to SPREP, which will act as the central depository and dissemination point.

Updating wetland inventories is a priority under the SPREP Regional Wetlands Action Plan 2011-2013.

Funds for the project were granted to SPREP from the Australian Government and through the Convention for the Protection of Natural Resources and the Environment of the South Pacific Region (Noumea Convention), to update wetland inventories.

SPREP contracted the team of Roger Jaensch and Doug Watkins to work with the appropriate Government agencies on the project. Roger led the updates for Palau and Vanuatu and Doug the update for Kiribati.

2 Kiribati Overview

2.1 Compilers and scope of update

The introduction and overview for Kiribati for the 1993 edition of *A Directory of Wetlands in Oceania* were compiled by Aobure Teataata and K. Teeb'aki. This updated version was prepared by Doug Watkins and Kiritian Batoromaio in 2014.

This update retains essential still-current information from the 1993 edition, introduces data that have become available subsequently and adds several new categories of information. Consequently, it has standalone status. Importantly, this update includes maps of the extent of each site.

Updated accounts for important sites that were included in the 1993 edition follow this introduction and overview; references cited in the following sections or in the accounts are listed together.

For the 2014 update of the wetland directory, the boundary of each site was defined following discussions between the consultant and the national agency responsible for wetlands. It was based on information in the original Directory (Scott 1993). For one site there has been a major change in the inventoried area. In the original Directory the "Mangroves of Tarawa Atoll" was listed. This update includes a smaller area (Nooto North Ramsar Site) of the mangroves of Tarawa atoll.

The other 12 directory sites cover complete islands and their marine waters to 6 m at low tide. The site boundary shown for these 12 sites in this update, serves to define the scope of information in the site account and has no legal status. Should the responsible National Government agency wish to taken actions that would impact on customary or other owners of the wetland sites then full consultation would be required.

2.2 Geographical summary

Area: Land, 801.8 km2; Economic Exclusion Zone, over 3.5 million km2.

The 33 coral atolls and islands of the Republic of Kiribati are situated between latitudes 4°42'N and 9°57'S and longitudes 169°31'E and 150°11'W. From east to west the country spans approximately 4 500 km.

Kiribati has three island chains; the Gilbert (17 islands including Banaba), Phoenix (8 islands) and Line Islands (8 islands). The countries adjacent to the Gilbert Islands in the west are the Marshall Islands to the north, Nauru to the west and Tuvalu to the south. The Phoenix Islands, in central Kiribati, has Tokelau to the south. The Line Islands in the East of Kiribati have French Polynesia to the south and Hawaii to the north. The United States also has several territories adjacent to Kiribati.

All of the Kiribati islands, except Banaba, are low-lying coral atolls usually rising no more than 5 metres above sea level. In most of the atolls, a reef encloses a lagoon, and on the east side, 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 km^2 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 km^2, this atoll comprises almost half the total land area of Kiribati.

2.3 Geological and geomorphic setting

Kiribati is situated on the large Pacific plate that underlies two thirds of the Pacific Ocean. During the Cretaceous, hotspots under the Pacific plate developed into volcanoes that rose up from the sea floor. As the plate moved on to the northeast the crust became colder and denser and the volcanoes started to subside (Neall and Trewick 2008). In the tropical waters the growth of coral formed a fringing reef and as the volcano continued to subside an atoll was formed.

During the Pleistocene, limestone formed from earlier coral reefs (Falkland and Woodroffe 1997). The surface morphology of atolls seen today developed in the Holocene.

2.4 Climate and natural disasters

The southern Gilbert Islands, Phoenix Islands have a 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 is extremely variable, not only between islands but 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 Island to 2 900 mm on Teeraina Island. Kiritimati Island 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.

The climate of the Kiribati is linked to its central Pacific Ocean position and that the islands are situated near the equator. There are three key process that drive the climate of Kiribati: the Inter-Tropical Convergence Zone, South Pacific Convergence Zone and the Pacific Monsoon.

The major factor for climate variability is the El Niño-Southern Oscillation. In a neutral state the air and sea temperatures vary from east to west across the Pacific, with a warm pool of air to the North-east of Papua New Guinea. The interaction between the air, surface water and subsurface water temperatures can create a “feedback loop” that results in large changes in temperature and pressure. An El Niño-Southern Oscillation event is caused when the “feedback loop” creates a significant ocean temperature differential between the Western and/or Central Pacific and the Eastern Pacific.

The South Pacific Convergence Zone is generally positioned from the Solomon Islands through Fiji, Samoa and Tonga. Rainfall is affected by the relative positions of the South Pacific Convergence Zone and the Intertropical Convergence Zone. It varies considerably from year to year and is greatly influenced by the El Nino–Southern Oscillation (Australian Bureau of Meteorology and CSIRO 2011).

2.5 Biogeographic regions

Kiribati is a nation of very small lands surrounded by the Pacific Ocean. As such the Marine Ecoregions of the World (Spalding *et al.* 2007) are used to describe the bioregions.

Kiribati is situated in four ecoregions in three provinces within the Eastern Indo-Pacific Realm (Spalding *et al.* 2007). The Gilbert Islands are within the "Gilbert/Ellis Islands Marine Ecoregion of the Marshall, Gilbert, and Ellis Islands Province". The Phoenix Islands are in the "Phoenix/Tokelau/Northern Cook Islands Marine Ecoregion of the Central Polynesia Province". The northern Line Islands are in the "Line Islands Marine Ecoregion of the Central Polynesia Province", while the southern Line Islands are in the "Tuamotus Marine Ecoregion of the Southeast Polynesia Province".

The Gilbert/Ellis Islands Marine Ecoregion and the Line Islands Marine Ecoregion are wholly within Kiribati. The Phoenix/Tokelau/Northern Cook Islands Marine Ecoregion includes islands in Kiribati, Tokelau and the Cook Islands. The Tuamotus Marine Ecoregion covers part of Kiribati and French Polynesia.

2.6 Vegetation

The islands of Kiribati have very harsh conditions for plants and this has resulted in a flora of approximately 306 species of which only 83 may be indigenous (Thaman 1992). The soils tend to be 25 cm to 1 m in depth and composed of coral sand and fragments. The soils have a high pH (up to 8.9), very low Potassium and low levels of trace elements (Thaman 1992).

The vegetation of many of the islands has been greatly impacted by thousands of years of human habitation. The vegetation of the Gilbert Islands has been described in the following seven groups (Thaman 1992): coastal strand, mangroves and coastal marsh, relict stands of inland forest, coconut palm-dominated agricultural lands, houseyard and village gardens, ruderal vegetation and Giant Swamp Taro ('Te bwabwai'- *Cyrtosperma chamissonis*) or babei pits. Imagery analysis (ALD 2013) has estimated the vegetation coverage of each of the island groups: Gilbert Islands - 75%, Phoenix Islands - 56% and Line Islands 33%. Vegetation cover is dominated by the Coconut ('Te nii' - *Cocos nucifera*) stands; Gilbert Islands - 75%, Phoenix Islands - 15% and Line Islands 25%. Coconuts are considered to have been introduced to the Pacific Islands from South-east Asia by seafaring Austronesians (Gunn *et al.* 2011).

Mangroves are limited to the Gilbert Islands where stands were documented covering 258 ha in 1995 (Metz 1995). Four species have been recorded (*Rhizophora stylosa*, *Bruguiera gymnorhiza, Sonneratia alba* and *Lumnitzera littorea)*.

2.7 Wetlands of Kiribati

All of the islands have extensive coral formations, generally as fringing and lagoon reefs. Much of these reef systems are below the shallow reef ledges that fringe the island.

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 the few freshwater wetlands are very small (<0.5 ha), although a large lake and swamp on Teeraina Island is a notable exception.

Landlocked lagoons of varying sizes with brackish to supersaline water are found on Nikunau in the Gilbert Group, McKean, Birnie, Rawaki and Manra 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. 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, which is on Kiritimati Island, covers an area almost equal to the land area of 321 km^2.

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

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 Rawaki Island (Dahl 1980). Similarly, most of the Line Islands are relatively arid and lack freshwater wetlands. However, there is a large freshwater lake on Teeraina with surrounding freshwater marsh and some swamp forest. There is also reported to be a small area of peat bog on Flint Island (Dahl 1980), and Vostok is covered in a layer of peaty soils up to one metre thick.

There are 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 saline water. 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 special conservation interest, as are the freshwater habitats of Teeraina Island. Most of the interesting saline lagoons in the Line and Phoenix Islands are located within existing protected areas, but the unique freshwater wetlands of Teeraina Island, the extensive "estuarine" wetlands of Tabuaeran Island and the mangroves of the Gilbert Islands are not in protected areas.

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, Rawaki, 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.

2.8 Wetland fauna

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 nesting seabirds. Twenty-three species breed in the islands, in several cases these have been recorded in larger numbers than anywhere else in the world (Garnett 1983; Perry 1980). Historically, internationally important nesting colonies have been recorded on all eight atolls in the Line Group (notably Kiritimati, Malden, Starbuck and Caroline), on at least five atolls in the Phoenix Group (Enderbury, Rawaki, Birnie, McKean and Hull), and on Butaritari and Nonouti atolls in the Gilbert Group (Garnett 1983; Perry 1980). The size of many of these nesting colonies has declined in the past four decades and this is now being addressed in the management of the Phoenix Islands Protected Area (PIPA 2009) and in management programs for invasive species in the Phoenix and Line Islands (ECD 2010; Pierce *et al.* 2013). 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 Teeraina Island 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 Teeraina, Tabuaeran and Kiritimati in the Line Islands.

2.9 Human population

Population: 105 000 (2014 estimate), 103 500 (2010 census), (Worldpopulationreview 2014) with 90% living in the Gilbert Islands. In 2010, there were about 5 600 people on Kiritimati (Christmas Island) and about 5 500 on Abaiang and 5 000 on Tabiteuea.

The Phoenix Islands are uninhabited - except for a handful of caretakers on Kanton Island. In the Line Islands, only Kiritimati Island, Tabuaeran Island and Teeraina Island are presently inhabited.

Following independence in 1979, the national Government has looked towards the Line and Phoenix Islands for further development, and Kiritimati Island, the administrative centre for these two groups, has become a commercial centre.

2.10 Land tenure system

Almost all land in the Gilbert Islands is under private ownership in small hereditary holdings. In contrast, in the Line and Phoenix Islands, all land is owned by the national Government.

2.11 Economy

Kiribati is one of the poorest nations in Oceania with a GDP of US$ 170 million in 2013 which represents a per capita GDP of $1 650 (World Bank 2014). Constraints on economic growth include; small land area, geographic dispersion of the islands, remoteness from markets, high vulnerability to natural forces and scarce natural resources.

Major private sector activities include fisheries, tourism, retail trade and copra, with the exports being primarily limited to fisheries and copra (IMF 2013). Over the past decade fishing licences have generated 45% of the national revenue. However, these revenues account for less than 10% of the value of fish catch in Kiribati waters (IMF 2013).

Kiribati has a sovereign wealth fund (Revenue Equalization Reserve Fund) that was financed by phosphate mining from 1956 to 1979 on Banaba Island. The fund is used to cover financial deficits. As of 2012 the Revenue Equalization Reserve Fund amounted to 3.5 times GDP (IMF 2013).

2.12 Pressures and threats to wetlands

The major threats to biodiversity identified by the Government (ECD 2013), that are relevant to wetlands, are; over-exploitation and unsustainable harvesting methods and practises, climate change, invasive alien species, habitat loss, waste and pollution, increased population, inadequate integration of customary rights in biodiversity conservation, data and information gaps, low public awareness, and insufficient community support.

Generally, the terrestrial plant communities on the Gilbert Islands have been seriously degraded or completely replaced by urban areas, villages, coconut plantations or agriculture. 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.

While there has previously been concern for the mangrove stands in the Gilbert Islands (Scott 1993) recent changes in Government policy, to increase coastal resilience to climate change, is resulting in new plantings of mangroves. In the “Climate Adaption” program, supported by GEF, 37 000 mangrove seedlings were planted in Tarawa and outer islands (World Bank 2011) and this work will continue in Phase III.

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 nesting seabirds, and several island populations of mainly ground-nesting species have been extirpated in the Line and Phoenix Islands (Garnett 1983). Since 1989 a major eradication programme commenced under a partnership with the New Zealand Government, Pacific Expeditions and the Pacific Invasives Initiative (ECD 2010). This work has focused on the Line Islands and in the Phoenix Islands Protected Area and included work on rats, cats and rabbits. It has also included the development of biosecurity guidelines for the Phoenix Islands (Conservation International Pacific Islands Program 2011).

2.13 Threatened wetland species

The status of many endemic species of Kiribati is yet to be fully understood due to capacity and financial constraints (ECD 2010). Given this qualification, the IUCN Red List (IUCN 2014) identifies the following globally threatened species known to occur in Kiribati: one mollusc (Giant Clam *Tridacna gigas),* five bird species (Bristle-thighed Curlew (*Numenius tahitiensis)*, Kiritimati Reed-warbler (*Acrocephalus aequinoctialis)*, Rimatara Lorikeet (*Vini kuhlii)*, White-throated Storm-petrel (*Nesofregetta albigularis)*, and Phoenix Petrel (*Pterodroma alba*); two turtle species - Leatherback Turtle (*Dermochelys coriacea)* and Green Turtle (*Chelonia mydas*). It also lists a range of threatened marine species: 72 species of coral, three species of shark and 16 species of fish.

2.14 Conservation measures

In the past three decades there has been a range of major actions taken by the Government of Kiribati, at the policy and program level, that are delivering better outcomes for wetlands. These range from new and revised legislation (see below), increased engagement in international Conventions, and access to international funding and national program initiatives.

Kiribati has increased its engagement in international Conventions, joining:

- Convention on Biological Diversity (1994)
- Framework Convention on Climate Change (1995)
- Convention on Combating Desertification (1998)
- World Heritage (2000), and
- Convention on Wetlands of International Importance (2013).

Several of these Conventions have been of assistance in providing frameworks and access to co-funding that have better enabled Kiribati to assess and plan how to respond to global environmental challenges. These projects have included:

- National Capacity Self-Assessment Project (Govt. Kiribati 2009) in relation to the Convention on Biological Diversity, Framework Convention on Climate Change and Convention on Combating Desertification.
- National Biodiversity Strategy and Action Pan (MELAD 2006) to address the impacts of climate change.
- Kiribati Adaptation Program – a 12 year program over three phases that is supporting measures to reduce vulnerability to the effects of climate change.

Key domestic initiates that have benefited wetlands have included:

- Development of a National Environmental Strategy (SPREP 1994) with support from SPREP and UNDP
- Ongoing updates of the National Development Plan with an increasing emphasis on the links between the natural environment and human wellbeing (Govt. Kiribati 2012).
- Development and implementation of a National Adaptation Program of Action (ECD 2007) to address climate change, with support from GEF and UNDP.
- Establishment of the Phoenix Island Protected Area, development of its Management Plan and its listing as a World Heritage Site in 2010 (PIPA 2009).
- Kiribati Biodiversity Area Report (ECD 2013a) which detailed a gap analysis of “key biodiversity areas” provided advisory support for its Protected Area network design.
- Kiribati Integrated Environment Policy (2013b) which facilitates implementation of the environment key policy areas of the Kiribati Development Plan. This was a collaboration with SPREP and Conservation International.
- Program of Work for Protected Areas (POWPA phase I and II) supported by GEF.
- Invasive Alien Species eradication and control program (Pacific Invasives Initiative 2010).

Kiribati has been successful in being granted approximately USD 1 million a year in Official Development Assistance under the sector “General Environment Protection” since 2000 (Open Aid Data 2014).

2.15 Wetland area legislation

Legislation relating to the use and management of wetlands in Kiribati is covered in natural resource and biodiversity provisions

The **Environment Act 1999 (as amended 2007)**: In 2007, the existing Environment Act was amended to include provisions for Environment Impact Assessment and to include coverage of coral reefs, mangroves and sea grasses as protected ecosystems. The Minister of the Ministry of Environment, Land and Agriculture Development (MELAD) is now able to prescribe areas and species to be protected through regulations. The amendments significantly strengthen the power of the Act to maintain the natural environment and mitigate significant impacts of development on the environment.

The **Wildlife Conservation Ordinance (revised 1997)**: This legislation replaced a 1938 Ordinance to protect wild birds. It has elements; (i) to protect birds and other animals and (ii) to protect areas of conservation importance. The "species" provision protects 32 species of seabirds, five species of shorebirds, two species of waterbirds and the Green Turtle (*Chelonia mydas*). The "protected area" provisions have been used to establish of terrestrial sanctuaries the Line Islands for wild animals (excluding fish), and closed areas within these sanctuaries (Malden Island Wildlife Sanctuary, Starbuck Island Wildlife Sanctuary and parts of Kiritimati Island). This provision has also be used to declare all animals fully protected on Birnie Island, Malden Island, Caroline Island, McKean Island, Kiritimati Island, Rawaki Island (Phoenix), Flint Island, Starbuck Island, Gardner Island (Nikumaroro), Manra Island (Sydney), Orona Island (Hull), Vostok Island. It is recognised that this legislation is in urgent need of updating (ECD 2010).

The **Phoenix Islands Protected Area (PIPA) Regulations 2007:** These regulations, empowered by the Environment Act 1999 (as amended 2007), provide the legal framework for the Phoenix Island Protected Area. These Regulations prescribe the following islands and their lagoons and internal waters as protected areas within the Phoenix Island Protected Area: Birnie Island, Enderbury Island, Kanton (also known as Abariringa or Canton) Island, Mama (also known as Sydney) Island, McKean Island, Nikumaroro (also known as Gardner) Island, Orona (also known as Hull) Island and Rawaki (also known as Phoenix) Island.

The Fisheries Ordinance (Cap 33) and Fisheries (Amendment) Act 1984: This Act has some provisions relating to fish and turtles.

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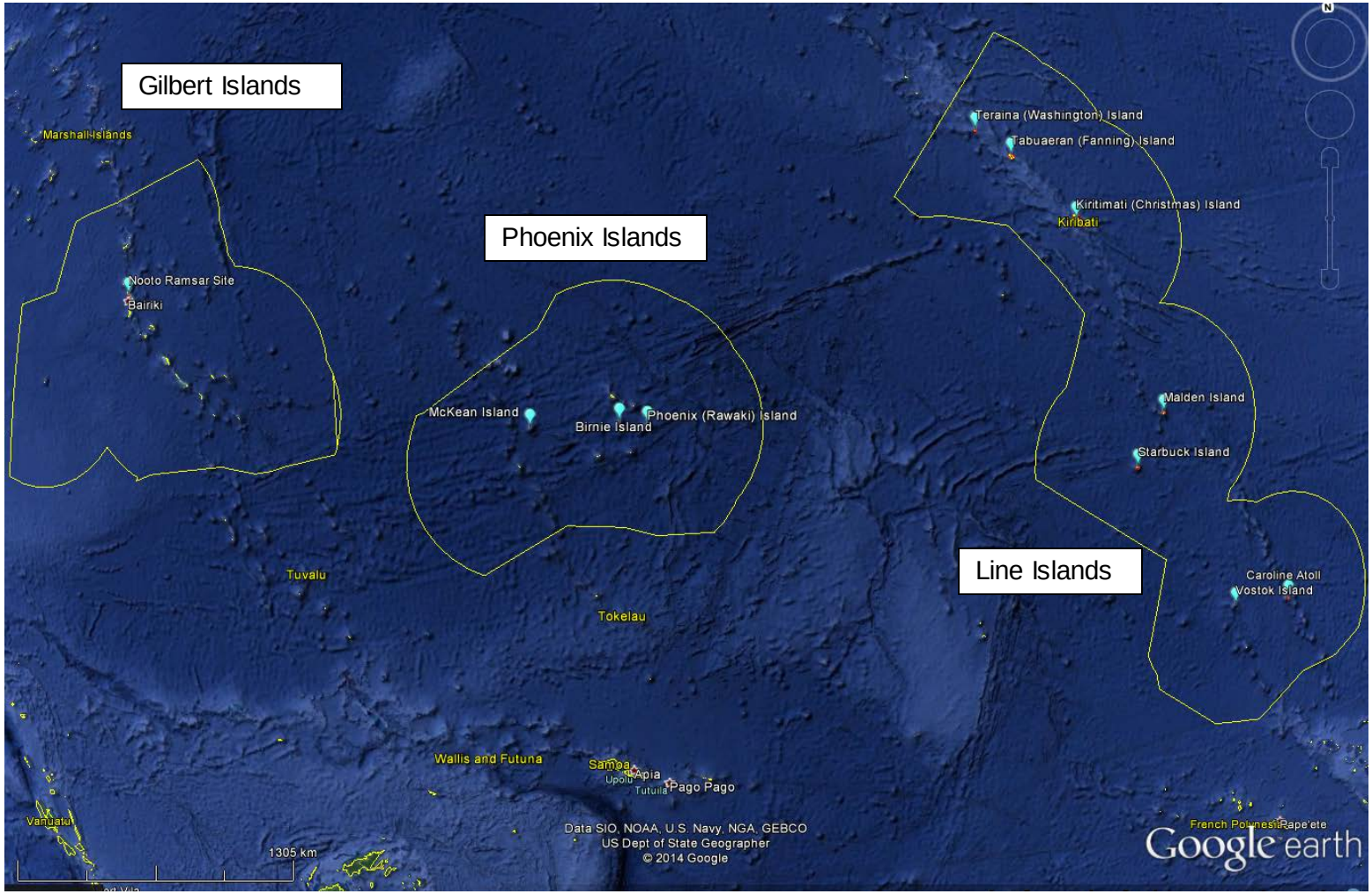
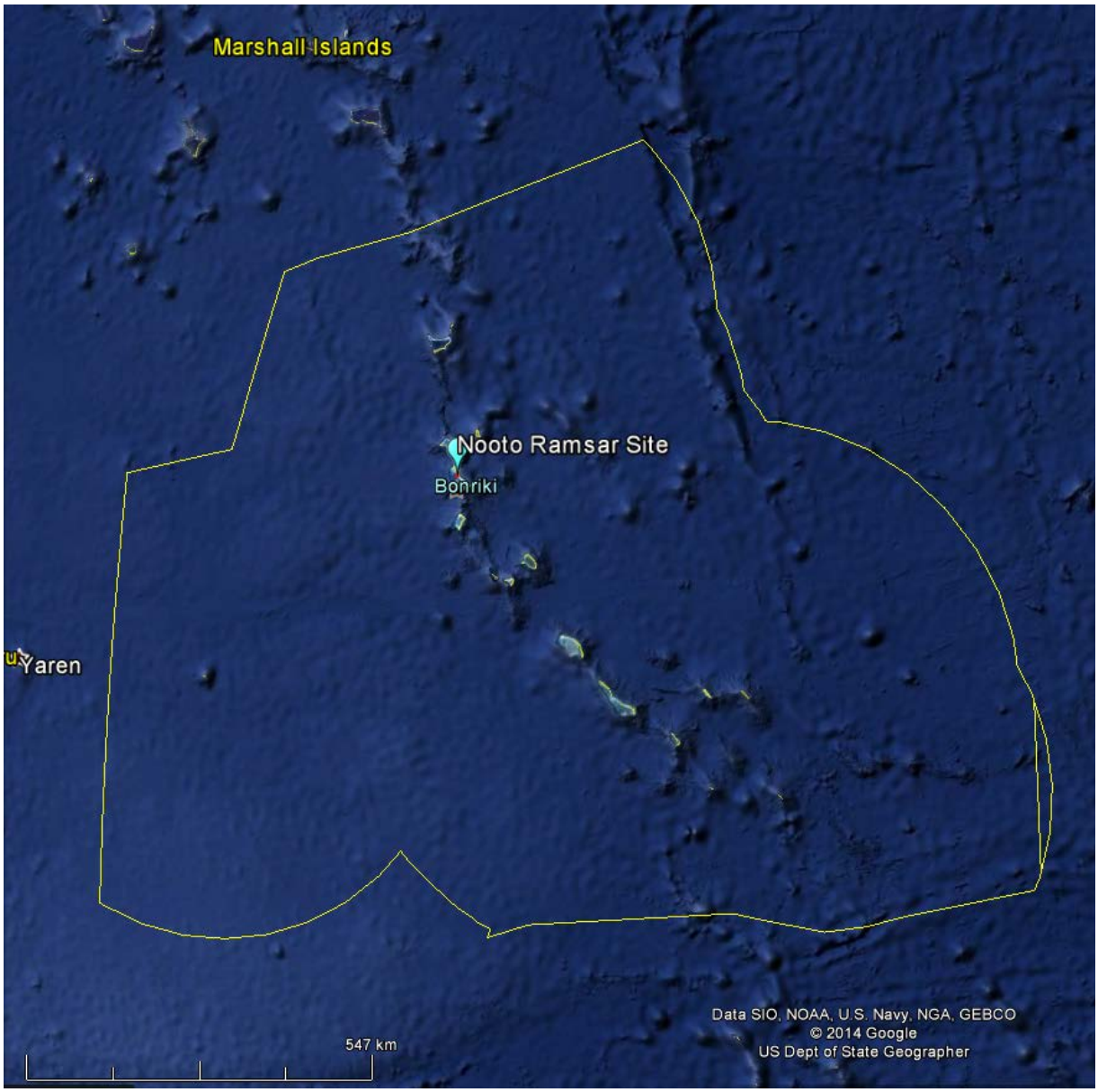
2.17 Location maps of the inventoried wetlands of Kiribati

Location of inventoried wetland sites in the context of the three Exclusive Economic Zones of Kiribati (Image from Google Earth)



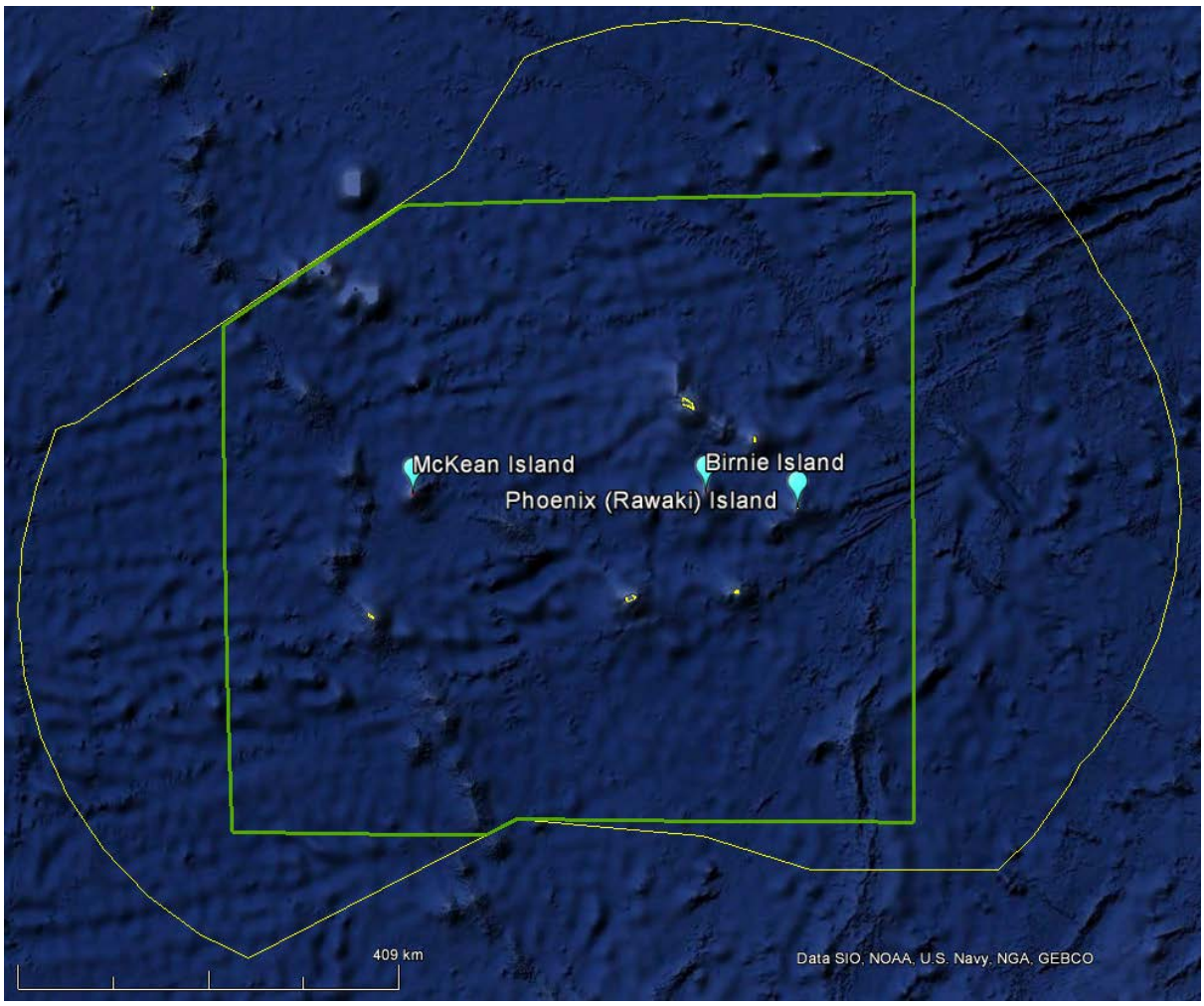
Location of inventoried wetland sites in the Gilbert Islands, Kiribati

Yellow polygon show the Kiribati Exclusive Economic Zone; Image from Google Earth



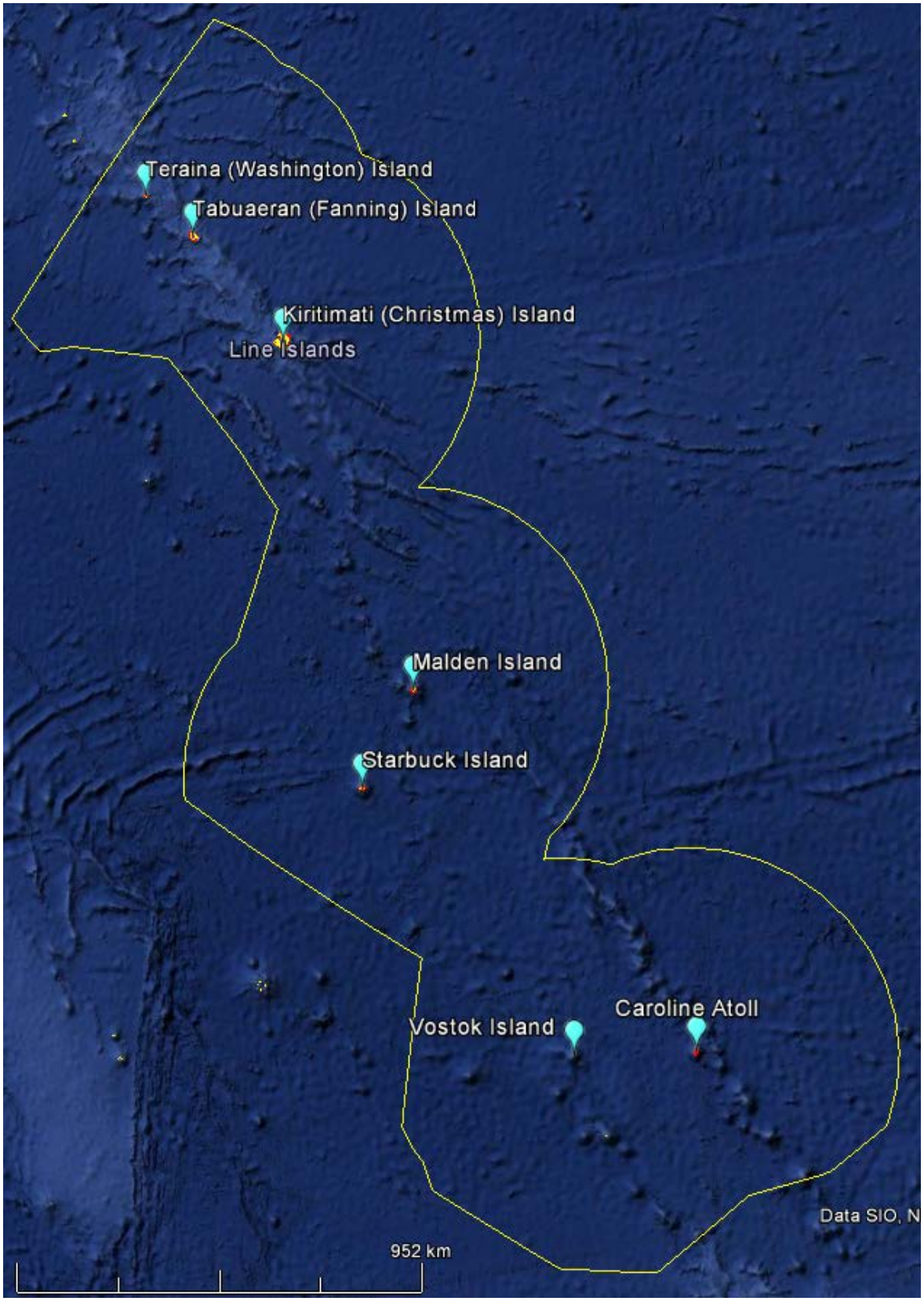
Location of inventoried wetland sites in the Phoenix Islands, Kiribati

Yellow polygon shows the Kiribati Exclusive Economic Zone (Phoenix Group);
Green polygon shows the Phoenix Islands Protected Area; Image from Google Earth



Location of inventoried wetland sites in the Line Islands, Kiribati

Yellow polygon shows the Kiribati Exclusive Economic Zone (Line Islands);
Image from Google Earth



3 Wetland Accounts

3.1 Nooto - North Tarawa Ramsar Site

A. Overview:

Patches of mangrove and intertidal mudflats on the shores of an atoll lagoon in North Tarawa; one of the few areas of mangroves in Kiribati.

B. Area and boundary:

Area: 1 033 ha (Ramsar Information Sheet)

Boundary: The boundary of the site as delineated follows the boundaries set by local government jurisdiction (through the North Tarawa Island Council).

C. Location

General statement: The site is situated in the northern part of the main atoll of Tarawa (North Tarawa). North Tarawa is considered as the rural area while the southern part of the atoll (South Tarawa) is where the capital and commercial centre of the country is located. Nooto - North Tarawa contains patches of mangrove and intertidal mudflats on the shores of an atoll lagoon. These stands of mangrove are dominated by a single species – Te Tongo or Red Mangrove (*Rhizophora stylosa*). The area contains a wide range of coastal habitats and the adjacent lagoon, coral reefs and reef patches that support high biodiversity and are resource rich – including a wide variety of finfish, turtles, crustaceans, seaweed and other plants.

Coordinates: Centre of site	1°31’ N	173°00’ E
Nooto village	1°31’ N	173°00’ E
Reef patch one	1°30’ N	172°58’ E
Reef patch two	1°30’ N	172°58’ E

Administrative region/s: North Tarawa Island Council (Gilbert Islands)

D. Site Maps: See below.

E. Ramsar Wetland Types:

Dominant types:

- J Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.
- G Intertidal mud, sand or salt flats
- A Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.
- B Marine subtidal aquatic beds; includes kelp beds, sea-grass beds, and tropical marine meadows.
- C Coral reefs.
- I Intertidal forested wetlands; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests.
- E Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks

Types also present

2 Ponds (taro) (each below 1 ha).

Location of the Nooto - North Tarawa Ramsar Site, Kiribati (Image from Google Earth)

The three areas of the Nooto - North Tarawa Ramsar Site, Kiribati
(Image from Google Earth)

F. Geomorphic setting:

Elevation: -6 m to 3 m above sea level

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 km^2; urban South Tarawa comprises five elongated islets (linked by causeways) with an area of 7.2 km^2. 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.

Tarawa Atoll is situated on top of a chain of mid-oceanic volcanoes. During the Holocene, carbonate caps developed on an earlier reef that formed around the eroded volcano (Richmond 1993). The atolls are a mix of limestone and unconsolidated conglomerate.

Three periods of atoll development have been described (Falkland and Woodroffe 1997).The first, early in the Holocene was the rapid vertical growth of the reef, followed by a period when the reef built to sea level and the reef flats formed. The third period, since 3 500 year BP, is when the islands formed.

The soils are very infertile, being young, shallow, alkaline, coarse-textured and of carbonic mineralogy. Because of their immaturity, they vary little from the original coral-limestone parent material overlaying the limestone platform. They range from 25 cm to 1

m or deeper, with some accumulation of clays and H_2S near the centre of site near the water table. Potassium levels are often extremely low, and pH values of up to 8.9 and high $CaCO_3$ levels make scarce trace elements, particularly iron, manganese, copper and zinc, unavailable to plants.

On the ocean side of the site there is an uplifted fringing limestone reef in the wave zone, and it is covered by a sandy beach. This runs up to a raised rampart or shingle ridge of wave-washed boulders and coral fragments deposited during storms. This ridge is the highest portion of the site, which is no more than 3 m above mean sea level. Inland of the rampart and extending towards the lagoon is an area of windblown sand and debris.

On the lagoon side of the site, there is a narrow to very wide intertidal or foreshore area of fine sand which is exposed at low tide. Farther from shore, the bottom drops off to the deeper parts of Tarawa Lagoon.

G. Biogeographical region:

Tarawa Island is in the center of the Gilbert/Ellis Islands Marine Ecoregion, in the Marshall, Gilbert, and Ellis Islands Province of the Eastern Indo-Pacific Realm (Spalding *et al.* 2007).

H. Climate:

Tarawa has a warm and humid climate all year round. The average temperature each month is between 28°C with average monthly highs of 30°C and average monthly lows of 26°C (Weatherbase 2014a).

Average rainfall is 1 930 mm, with the highest in January (270 mm) and lowest in September and October (80 mm). Rainfall is affected by the South Pacific Convergence Zone and the Intertropical Convergence Zone. It varies considerably from year to year and is greatly influenced by the El Nino–Southern Oscillation (Australian Bureau of Meteorology and CSIRO 2011).

I. Soil:

The soils have developed since the Holocene and are derived from coral. In general there is a layer of sand 0.5 – 2 m thick above the underlying coral rock (Mason 1960).

J. Water regime:

There are two major elements of the water regime of the site – the movement of marine waters with the tide and the shallow freshwater lens under the land area of the site. Tidal flushing is critical for all of the dominant wetland types of the site. It is essential for the health of the mangroves at the site and especially for the reproductive lifecycles of animal species that are found there. The tidal flow across the complete Tarawa atoll influences the biota and ecology of the site.

The only permanent freshwater resource of the site is groundwater in the form of a lens of freshwater (often slightly brackish). The freshwater lens hydrostatically "floats" on the higher-density saltwater beneath the island.

The long term sustainability of the groundwater lens is critical to ensure the continued provision of freshwater supply to the community. This freshwater lens is vulnerable to overuse and contamination, making its protection and management vital.

K. Water chemistry:

The chemistry of the marine waters of the atoll is important to maintaining the ecological character of the site. Issues of concern include pollution of the waters from the high human population density in South Tarawa and ocean acidification.

Research on ocean acidification in the Pacific anticipates long term, gradual declines in calcification and reef accumulations and changes in community structure (Guinotte *et al.* 2003). This decline has already been recorded in the Kiribati region.

L. Biota:

The site contains a wide range of relatively pristine and healthy ecosystems, including coral reefs, lagoons, coastal swamps, intertidal mudflats and mangroves all of which provide site-specific ecosystem services and benefits for the local community such as flood and storm surge mitigation, preventing coastal erosion, food and income from near shore marine species, maintenance of traditional practices and sources of construction materials.

The site provides a nesting habitat for the globally Endangered Green Turtle (*Chelonia mydas*) and the globally Vulnerable Giant Clam (*Tridacna gigas*). There are also coconut crabs (*Birgus latro*) and mangroves crabs (*Scylla serrata*), which contribute significantly to the local diet. Also present is the topshell, or trochus (*Trochus niloticus*), which is a marine snail that was introduced to Kiribati in 1937 from Palau. It is believed that trochus may have potential as an export commodity.

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).

Vegetation: Stands of mangrove dominated by *Rhizophora mucronata*, with some *Bruguiera gymnorrhiza*, *Lumnitzera racemosa* and *Sonneratia alba*.

The site contains 27 hectares of mangrove forest dominated by 4 species, predominantly *Rhizophora stylosa,* with some *Bruguiera gymnorrhiza*, *Lumnitzera racemosa* and *Sonneratia alba*. They are unique due to their isolation occurring here at the extreme edge of their distribution in the central pacific.

Notable plant species found at the site with multiple cultural uses are the coconut palm (*Cocos nucifera)*, beach hibiscus (*Hibiscus tiliaceus)*, screw pine (*Pandanus tectorius)*, Alexandrian laurel (*Calophyllum inophyllum)*, cordia (*Cordia subcordata)*, beach gardenia (*Guettarda speciosa)*, beach cabbage (*Scaevola sericea)*, pemphis (*Pemphis acidula)*, portia tree (*Thespesia populnea)*, *Rhizophora* spp., tree heliotrope (*Argusia argentea)*, ironwood (*Casuarina equisetifolia)*, *Premna serratifolia*, noni (*Morinda citrifolia)*, native mulberry (*Pipturus argenteus)*, tropical almond (*Terminalia catappa)*, dye fig (*Ficus tinctoria)* and pacific banyan (*Ficus prolixa)* (Thaman 1962).

M. Land use:

The site has a village with small-scale agricultural gardens and domesticated livestock breeding (pigs and chickens), small-scale coconut plantations, fishing and reef gleaning for both commercial and subsistence.

This area constitutes one of the most important fishing grounds for "reef gleaning", mainly for a wide range of shellfish. Farther from shore, the bottom drops off to the deeper parts of Tarawa Lagoon. On the ocean side of the fringing limestone reef is an intertidal fringing reef that gradually drops off into the ocean. This is also an important fishing and gleaning area, with many fisherman diving or taking their boats and canoes over the reef edge into the open ocean or to dive on the outer edge of the reef or on the reef slope.

N. Pressures and trends:

The population of North Tarawa as of 2010 census was 6 102 and that of South Tarawa was 34 427 (National Statistics Office 2012).

The following factors have been identified as adversely affecting the ecological character of the sites (RIS 2013): Limited enforcement of the Environment Act 1999 (as amended) in North Tarawa;

- Coastal soil erosion and saltwater incursion
- Overexploitation of inshore fisheries resources, including turtles, giant clam (*Tridacna gigas*), beche-de-mer, ark shell (bun), bonefish (ikarii), goat fish (maebo), baitfish (tarabuti), large demersal species, some sharks and other commercially-important target species, especially by commercial fishermen from South Tarawa, who employ unsustainable fishing methods.
- Poor sanitation
- Water shortages and poor water quality
- Poor soils and limited agricultural potential
- Increased generation of non-biodegradable wastes
- Limited awareness and public knowledge on Ramsar designation and its significance and factors that have adverse effects on the site's ecological character.

O. Land tenure and administrative authority:

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

Almost all land (including the lagoon) within the boundaries of the Ramsar site are owned by the indigenous community. A small portion of land within the site is owned by the Catholic Church.

Under the Foreshore and Land Reclamation Ordinance, the general position is that the national Government owns the foreshore and the seabed, subject to public right of navigation, fishing and passing over the foreshore, as well as any private rights that may exist. Foreshore in this case includes areas affected by tidal movement and not areas of seabed permanently covered by water. It is stressed by Pulea and Farrier (1994), in their Kiribati Environmental Legislation Review that the legislation does not seek to override customary rights in marine areas, which under the Laws of Kiribati Act 1989 apply to: 1) the ownership by custom of rights in, over, or in connection with any sea or lagoon area, inland waters or foreshore or reef, or in or on the seabed, including rights of navigation and fishing; and , 2) the ownership by custom of water, or of rights in, over or to water. Under the Foreshore and Land Reclamation Ordinance, foreshore can also be declared "designated foreshore", under which a licence is required from the Chief Lands Officer for the removal of sand, gravel, reef mud, coral, rock and any similar substances. It also stipulates that landowners who "may be affected thereby" must be consulted.

Also relevant to the issue of marine tenure and resource use are the Fisheries Ordinances of 1977 and amendments and the Fisheries Act of 1984, which emphasise

the Minister's role in "*developing the fisheries of Kiribati by taking appropriate measures to ensure that fisheries resources are "exploited to the full for the benefit of the country*". As stressed by Pulea and Farrier (1994), there are specific references to the President's power, with the advice of Cabinet, to make regulations relating to: 1) the conservation and protection of species of fish; 2) the establishment of closed seasons; 3) the designation of prohibited areas; 4) limits on size and quantity caught; 5) prohibitions on fishing practices and equipment likely to damage fish stocks; and, 6) the taking of coral and seaweed. Under this legislation immature and egg-bearing female lobsters (*Panulirus* spp.) are protected. The taking of coral has reportedly also been banned on Tarawa although this may have no legal basis.

Administrative authority: Eutan Tarawa Council (the local government of North Tarawa). The site is directly managed by Eutan Tarawa Council (the local government of North Tarawa) with technical assistance from MELAD. This is the first co-management initiative between Nooto village as the country's first Ramsar Site and the Government of Kiribati.

P. Ramsar listed? Yes

Q. Ramsar Criteria met:

Criterion 1. Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Criterion 2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
Criterion 4. Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

R. Justification for Ramsar Criteria met:

Criterion 1: The site contains relatively pristine and healthy ecosystems representative of wetland types found within the Marshall, Gilbert and Ellis Islands biogeographic region including coral reefs, reef patches, lagoons, inter-tidal mudflats and mangroves.
Criterion 2: Endangered Green Turtles (*Chelonia mydas*) visit the sites each year to nest. The Vulnerable Giant Clam (*Tridacna gigas)* occurs on the reef.
Criterion 4: The site is important for providing a breeding area for different marine species. The beach on the seaward side of the Nooto is an important nesting and foraging site for the endangered Green Turtle (*Chelonia mydas*) and the existing reef patches within the Nooto village lagoon are important breeding sites for the Near Threatened bonefish (*Albula vulpes*). The site has healthy marine ecosystems with corresponding populations of reef fish and associated invertebrates. This includes coconut crabs (*Birgus latro*), mangrove crabs (*Scylla serrata*), trochus (*Trochus niloticus*) - a marine snail, sea cucumbers (*Holothuria atra*), and a variety of reef fish, sharks, and four species of giant clams (*Tridacna* spp.), including the Vulnerable *Tridacna gigas*.

S. Conservation and management status of the wetland:

Island by-laws currently exist on the islands that look into sustainable management of terrestrial and marine natural resources. One of the existing by-laws in Nooto is the prohibition of unsustainable traditional fishing methods such as "Te Ororo" which is the

practice that involves the use of fishing nets and crow bars to frighten and drive the fishes into the net.

The constraint is the ineffectiveness of this particular by-law. The Eutan Tarawa Council (Island Council for North Tarawa) is currently working towards amending the By-law.

The Nooto site has been officially declared by the Nooto Community together with the Mayor of North Tarawa to be designated both as a protected area and as a Ramsar Site. A signed consent letter confirming this has been obtained and is vital evidence of community support for Kiribati's acceding to the Ramsar Convention.

T. Ecosystem services:

Ethnically the indigenous peoples of the site are Micronesians who have probably inhabited the islands for 3 000 years or more. The I-Kiribati (people of Kiribati), share a common culture, a common language, and a common resource-use tradition. The people of Nooto - North Tarawa are almost exclusively I-Kiribati.

Fishing continues to be an important commercial and subsistence activity for the local community at the site, although some resources are under increasing pressure from outside commercial fishermen, especially from South Tarawa. Subsistence fishing, including fishing by men for finfish in the lagoon and, less commonly, in the open ocean, and reef gleaning, mainly by women and children on the expansive intertidal reef flats and fringing reef, mainly for shellfish, is a daily activity at the site.

The plants of the site possess great cultural value, being used for medicine, general construction, body ornamentation, fuel wood, ceremony and ritual, cultivated or ornamental plants, toolmaking, food, boat or canoe making, dyes or pigments, magic and sorcery, fishing equipment, cordage and fibre, games or toys, perfumes and scenting coconut oil, fertilizer and mulching, woodcarving, weapons or traps, food parcels, subjects of legends, mythology, songs, riddles, and proverbs, domesticated and wild animal feed, handicrafts, cooking equipment, clothing, fish poisons, items for export of local sale, adhesives or caulking, and musical instruments.

U. Current recreation and tourism:

Visits to the wetland for recreation or tourism purposes have been very minimal.

V. Existing scientific research:

There has been several research projects carried out at Nooto, some of which were carried out by staff of the Environment and Conservation Division. These include: i) mangrove planting trials to see which sites in Nooto's lagoon area are most suitable for mangrove habitation; ii) Turtle nesting monitoring (as part of SPREP's Marine Turtle Tagging Project) was initially trialled in Nooto and remains an ongoing activity to date; iii) Data collection and survey on the biological diversity found in Nooto and their cultural, ecological and economic importance were documented.

Another scientific study conducted at the site was on phaetic fish coordinated by Eco-Care research.

W. Management plans and monitoring programs: To be developed.

X. Current communication and public education programs

Ministry of Environment, Land and Agriculture Development (MELAD) through Environment and Conservation Division (ECD) is directly involved in all communications, education and public awareness activities related to or benefiting the site. ECD through the Media and Public Awareness Unit (MPAU) staff are working closely with Nooto community, Nooto primary school, North Tarawa Junior Secondary School and North Tarawa Island Council, in terms of information sharing that focus on promoting Nooto village as Kiribati's first Ramsar Site.

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Z. Compiler:

Original compilers (for 1993 edition): Aobure Teataata and K. Teeb'aki.
Updated by: Doug Watkins and Kiritian Batoromaio, June 2014.

3.2 McKean Island

A. Overview:

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. A small, shallow, landlocked and highly saline lagoon occupies the centre of the island, and fills the area of the former phosphate workings.

B. Area and boundary:

Area: 69 ha (polygon area using Google Earth Pro). Island area 74.3 ha, land area 48.77 ha (PIPA 2009).
Boundary: The island and marine waters to 6 m at low tide.

C. Location:

Coordinates: 3°35'44" S 174°07'23" W
Location description: In the Phoenix Islands, 285 km west-south-west of Kanton Island and 90 km east of Birnie.
Administrative region: Phoenix Islands

D. Site maps: See below.

E. Ramsar Wetland Types:

Dominant types:

- A Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.
- E Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks
- Ss Seasonal/intermittent saline/brackish/alkaline marshes/pools.

Types also present:

- C Coral reefs.

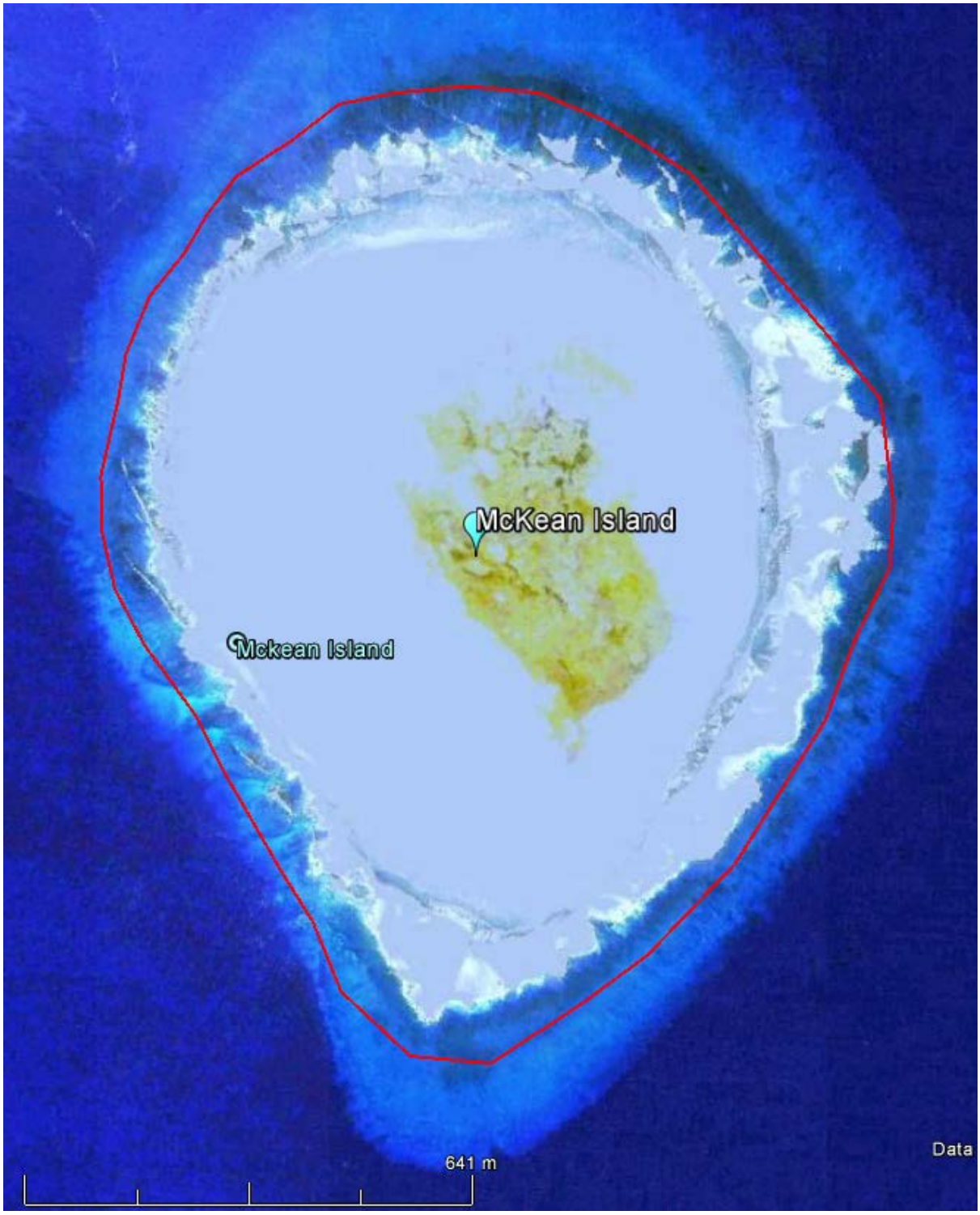
F. Geomorphic setting:

Elevation: -6 m at low tide to 5 m on the northern beach crest.

Geology: The Phoenix Islands formed during the Cretaceous and Cenozoic period as mid ocean volcanoes (Larson and Chase 1972). The sea floor in the Phoenix Islands is 4km below the surface. Over millions of years volcanic subsidence and corresponding reef growth resulted in an accumulation of coralline limestone (PIPA 2009). During the sea level changes of the Holocene, lagoons and dunes developed. Fringing coral reefs continue to develop around the islands.

McKean Island is the most circular of the Phoenix Islands and is 107 m on its longest axis (MEALAD 2009). The island has a 20.7 ha (Pierce *et al.* 2010) brackish pond in its centre.

McKean Island, Phoenix Islands, Kiribati (Image from Google Earth)



The fringing reefs around the Phoenix Islands are considered to have a highly consistent topography (Obura 2011). The reef profile consists of the following zones;

- Surge zone – surface to 5-6 m.
- Platform – from the bottom of the surge zone to the reef edge at 12-20 m depth and with an averaging width of 200 m.
- Reef Edge – a 12-15m wide transition zone between the reef platform and the reef slope.

- Reef Slope – below 20-25 m and extending below visible depths with a slope of 45°– 80°.

The fringing reefs of McKean Island have been estimated at 127 ha (12 ha of which is in the surge zone) and a perimeter of 6.25 km (Obura 2011).

G. Biogeographical region:

Phoenix/Tokelau/Northern Cook Islands Marine Ecoregion (Spalding *et al.* 2007).

H. Climate:

Rainfall in the Phoenix Islands is among the lowest in the Central Pacific with most islands receive less than 1 000 mm annually with a dry period from March through June (MELAD 2009). The inferred mean annual rainfall for McKean Island is 800 mm. The prevailing winds are easterly trades.

The one metrological recording station in the Phoenix Islands in on Kanton Island. Kanton has a warm and humid climate all year round. The average temperature each month is 27°C with average monthly highs of 30-31°C and average monthly lows of 23-24°C (Weatherbase 2014b).

I. Soil:

The soils are primarily derived from the coral reefs and have high pH, low fertility and very little humus (Mason 1960).

J. Water regime:

The water regime of the 20.7 ha pond in the centre of the island can be anticipated to be highly depended on rainfall and often dry.

Based on NOAA prediction from Tarawa and the Line Islands the tidal range is estimated to be approximately 1.5 m in the Phoenix Islands.

K. Water chemistry: No available information.

L. Biota:

McKean was found to be a very important nesting site for seabirds during the 1960's field work of the Pacific Ocean Biological Survey Program of the Smithsonian Institution. Twenty-nine species have been recorded on the island, and 17 are known to breed. At least six of the nesting populations have been considered to be of international significance. Seabird numbers collated by Garnet (1983) are; Audubon's Shearwater (*Puffinus lherminieri*) 5 000, White-throated Storm Petrel (*Nesofregetta albigularis*) 1 000, Lesser Frigatebirds (*Fregata ariel*) 40 000, Grey-backed Terns (*Onychoprion lunatus*) 23,400, Brown Noddy (*Anous stolidus*) 20 000 and Blue Noddy (*Procelsterna cerulea*) 15 000. Data collected in the 1960's estimated the number of Lesser Frigatebird (*Fregata ariel*) at 85 000 (King 1973).

In the early 2000's the Asian ship rat (*Rattus tanezumi*) was introduced to the island, most probably from the grounding of a Korean fishing vessel c.2001 based on the wreckage and genetic sampling of the rats (Pierce *et al.* 2006). In 2006 the densities of rats was recorded up to 110 animals per hectare (Pierce *et al.* 2006). A 40% decline in

the diversity of seabirds on the island has been attributed to the arrival of the Asian ship rat, with numbers of Blue Noddy (*Procelsterna cerulea*) falling from 15 000 to 1 individual, a decline in Red-tailed Tropicbirds and the elimination of several procellariiform species (Pierce *et al.* 2006).

Before the introduction of the Asian ship rat (*Rattus tanezumi*), the relatively diverse and undisturbed terrestrial vegetation was considered to be of international conservation importance (Garnett, 1983). The vegetation comprised stunted *Sida fallax* scrub with low herbs and grasses. Seven species were recorded in five main vegetation types. The western part of the island was covered by an extensive mat of *Tribulus cistoides*, while inland saline flats support *Sesuvium portulacastrum*. Most of the remainder of the island supported a mixture of *Portulaca lutea* and *Boerhavia albiflora*. The highest ground was covered by *Digitaria pacifica* grass with scattered mats of *Boerhavia* and *Tribulus* on a coarse rubble substrate. *Lepturus pilgerianus* was located mostly on the west coast of the island, mixed with *Tribulus cistoides* (Garnett, 1983).

In 2008, a major restoration program was initiated involving a successful rat eradication program on McKean Island (Pierce *et al.* 2008, 2010). The 2009 field work found a "spectacular" vegetation response since 2008, with increased coverage, height of plants and flowering and seeding (Pierce *et al.* 2010).

M. 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 the deposits 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.

N. Pressures and trends:

The key threat to the values of the island is the potential introduction of invasive species (as evidenced with rats in the 2000's). Advice on enhancing biosecurity has been developed (Pierce and Teroroke 2011; Conservation International Pacific Islands Program 2011) and the issue is prominent in the Phoenix Islands Protected Area Management Plan (PIPA 2009).

O. Land tenure and administrative authority:

Land tenure: national Government owned.

Administrative authority: Under the Phoenix Islands Protected Area Regulations 2008, the Protected Area is administered by the Minister of the Ministry of Environment, Lands and Agriculture Development (MELAD). Direct management of the Phoenix Islands Protected Area is under the responsibility of the Secretary of MELAD. A Phoenix Islands Protected Area Management Committee has been established, comprised of representatives of all government agencies and other specified non-government entities with a responsibility for the Phoenix Islands. This Committee is chaired by the Secretary of Minister of the Ministry of Environment, Lands and Agriculture Development (MELAD) and it meets regularly with meeting decisions and follow-up implementation documented and reported by the Director of the PIPA Office.

P. Ramsar listed? No

Q. Ramsar Criteria met:

Criterion 1. Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Criterion 2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
Criterion 4. Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
Criterion 6. Regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

R. Justification for Ramsar Criteria met:

Criterion 1. McKean Island is representative of a suite of island wetlands of the Phoenix/Tokelau/Northern Cook ecoregion.
Criterion 2. The island has been recorded supporting up to 1 000 nesting *Vulnerable* White-throated Storm Petrel (*Nesofregetta albigularis*).
Criterion 4. At times, the island is a nesting site of over 100 Brown Noddy (*Procelsterna cerulea*) and Lesser Frigatebirds (*Fregata ariel*).
Criterion 6. White Tern (*Gygis alba)* have been recorded in internationally important numbers.

S. Conservation and management status of the wetland:

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.

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) 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.

BirdLife International identified McKean Island as an Important Bird Area on the basis of the numbers of White-throated Storm (*Nesofregetta albigularis*) Petrel, Lesser Frigatebird (*Fregata ariel*) and Sooty Tern (*Onychoprion fuscatus*) that congregate on the island to breed (Gupta 2007).

McKean Island became part of the Phoenix Island Protected Area in 2007, and as such became part of the Phoenix Island Protected Area World Heritage Site in 2009 (PIPA 2008).

In the late 2000's, a major restoration program for the Phoenix Islands was initiated with the support and involvement of the Governments of Kiribati, New Zealand, the Critical Ecosystem Partnership Fund, Conservation International Pacific Islands Program and the Pacific Invasives Initiative. In 2006 a conservation assessment was conducted and the feasibility of pest eradication (Pierce *et al.* 2006). In May – June 2008, pest eradication work was undertaken on Rawaki Island (rabbits (*Oryctolagus cuniculus*)) and McKean Island (Asian ship rats (*Rattus tanezumi*)). In November-December 2009, a follow-up visit

did not found any Asian ship rats on McKean Island or any rabbits on Rawaki Island. Field work was conducted to plan work pest eradication on other islands (Pierce and Brown 2009).

U. Current recreation and tourism:

Nil. Tourism is addressed in the Phoenix Island Protected Area Management Plan (PIPA 2009). Tourist operators other visitors require a visitor permit from Phoenix Island Protected Area Director (PIPA 2009).

V. Existing scientific research:

The island was visited by the Smithsonian Institution's Pacific Ocean Biological Survey Program in the 1960s.

In 2005, the Government of Kiribati partnered with New England Aquarium and Conservation International to design and establish the Phoenix Island Protected Area. A component of this involved two extensive scientific studies of the area. Key themes of the research were: an assessment of coral reef bleaching recovery and associated reef and atoll monitoring (2005); assessment of status of protected bird species (2006) and assessment of impact of invasive species and feasibility of priority eradications (2006).

A formal research permit system has been established under the Phoenix Island Protected Area Regulation 2008.

W. Management plans and monitoring programs:

Management of McKean Island is addressed in the Phoenix Island Protected Area Management Plan 2010-1014 (PIPA 2009).

X. Current communication and public education programs:

The Phoenix Island Protected Area has a dedicated web site (http://www.phoenixislands.org/) and Facebook page

Y. References cited:

Conservation International Pacific Islands Program. 2011. Biodiversity Conservation Lessons Learned Technical Series 8: Biosecurity Guidelines for the Phoenix Islands Protected Area, Kiribati. Conservation International, Apia, Samoa

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Z. Compilers:

Original compilers (for 1993 edition): Aobure Teataata and K. Teeb'aki.
Updated by: Doug Watkins and Kiritian Batoromaio, June 2014.

3.3 Birnie Island

A. Overview:

A small coral island with interesting vegetation cover, a landlocked supersaline lagoon and large nesting colonies of seabirds. The island has never been inhabited and is the least disturbed of the Phoenix Group. Low reef island surrounded by fringing coral reefs. The island is a wildlife sanctuary.

B. Area and boundary:

Area: 97 ha (polygon area using Google Earth Pro); total area 50.95 ha, land area 48.2 ha (MELAD 2009).
Boundary: The island and marine waters to 6 m at low tide.

C. Location:

Coordinates: 3°35' S 171°31' W
Location description: In the Phoenix Islands 90 km south-south-east Kanton Island and 90 km east of McKean Island.
Administrative region: Phoenix Islands

D. Site map: See below.

E. Ramsar Wetland Types:

Dominant types:

- A Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.
- E Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks
- Ss Seasonal/intermittent saline/brackish/alkaline marshes/pools.

Types also present:

- C Coral reefs.

F. Geomorphic setting:

Elevation: -6 m at low tide to 4 m on the eastern beach crest.

Geology: The Phoenix Islands formed during the Cretaceous and Cenozoic period as mid ocean volcanoes (Larson and Chase 1972). The sea floor in the Phoenix Islands is 4km below the surface. Over millions of years volcanic subsidence and corresponding reef growth resulted in an accumulation of coralline limestone (PIPA 2009). During the sea level changes of the Holocene, lagoons and dunes developed. Fringing coral reefs continue to develop around the islands.

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. 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 Island, Phoenix Islands, Kiribati (Image from Google Earth)

The fringing reefs around the Phoenix Islands are considered to have a highly consistent topography (Obura 2011). The reef profile consists of the following zones;

- Surge zone – surface to 5-6 m
- Platform – from the bottom of the surge zone to the reef edge at 12-20 m depth and with an averaging width of 200 m.
- Reef Edge – a 12-15m wide transition zone between the reef platform and the reef slope.
- Reef Slope – below 20-25 m and extending below visible depths with a slope of 45°– 80°.

The reef averages 280 m wide with area of 264 ha and perimeter of 8.12 km (MELAD 2009). Obura (2011) estimates that the area of reef in the surge zone is 44 ha.

G. Biogeographical region:

Phoenix/Tokelau/Northern Cook Islands Marine Ecoregion (Spalding *et al.* 2007).

H. Climate:

Rainfall in the Phoenix Islands is among the lowest in the Central Pacific with most islands receive less than 1 000 mm annually with a dry period from March through June (MEALAD 2009). 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.

The one metrological recording station in the Phoenix Islands in on Kanton Island. Kanton has a warm and humid climate all year round. The average temperature each month is 27°C with average monthly highs of 30-31°C and average monthly lows of 23-24°C (Weatherbase 2014b).

I. Soil:

The soils are primarily derived from the coral reefs and have high pH, low fertility and very little humus.

J. Water regime:

The water regime of the 2.75 ha pond in the centre of the island can be anticipate to be highly depended on rainfall and to be often dry.

Based on NOAA prediction from Tarawa and the Line Islands the tidal range is estimated to be approximately 1.5 m in the Phoenix Islands.

K. Water chemistry: No available information.

L. Biota:

The vegetation has low species diversity. 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, *Lepturus repens*, have been recorded, but have since become locally extinct (Garnett, 1983). The undisturbed atoll vegetation is considered to be of international significance (Garnett, 1983).

Birnie Island is an important nesting site for seabirds; 22 species have been recorded and six are known to breed. Garnett (1983) reported populations of Brown Booby (*Sula leucogaster*) 100 and Blue Noddy (*Procelsterna cerulea*) 100 and Masked Boobies (*Sula dactylatra*) 350-800. 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.

M. Land use:

Uninhabited. While the island was claimed under the Guano Islands Act for the United States, there is no evidence of guano ever being mined.

The presence of Polynesian Rats (*Rattus exulans*) suggests that Birnie was visited by Polynesians in pre-historic times, but there is no evidence that the island was ever settled.

N. Pressures and trends:

The key threat to the values of the island is the potential introduction of invasive species. Advice on enhancing biosecurity has been developed (Pierce and Teroroke 2011; Conservation International Pacific Islands Program 2011) and the issue is prominent in the Phoenix Islands Protected Area Management Plan (PIPA 2009).

O. Land tenure and administrative authority:

Land tenure: Government Owned

Administrative authority: Under the Phoenix Islands Protected Area Regulations 2008, the Protected Area is administered by the Minister of the Ministry of Environment, Lands and Agriculture Development (MELAD). Direct management of the Phoenix Islands Protected Area is under the responsibility of the Secretary of MELAD. A Phoenix Islands Protected Area Management Committee has been established, comprised of representatives of all government agencies and other specified non-government entities with a responsibility for the Phoenix Islands. This Committee is chaired by the Secretary of Minister of the Ministry of Environment, Lands and Agriculture Development (MELAD) and it meets regularly with meeting decisions and follow-up implementation documented and reported by the Director of the PIPA Office.

P. Ramsar listed? No

Q. Ramsar Criteria met:

Criterion 1. Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Criterion 2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

R. Justification for Ramsar Criteria met:

Criterion 1. Birnie Island is a representative suite of island wetlands of the Phoenix/Tokelau/Northern Cook ecoregion.
Criterion 2. Supports a nesting colony of the Endangered White-throated Storm Petrel (*Nesofregetta albigularis*). The island may also regularly support the nesting of the Vulnerable Green Turtle (*Chelonia mydas*).

S. Conservation and management status of the wetland:

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.

Birnie Island 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 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.

In the late 2000's, a major restoration program for the Phoenix Islands was initiated with the support and involvement of the Governments of Kiribati, New Zealand, the Critical Ecosystem Partnership Fund, Conservation International Pacific Islands Program and the Pacific Invasives Initiative. In 2006 a conservation assessment was conducted and the feasibility of pest eradication (Pierce *et al.* 2006). In May – June 2008, pest eradication work was undertaken on Rawaki Island (rabbits (Oryctolagus cuniculus)) and McKean Island (Asian ship rats (Rattus tanezumi)). In November-December 2009, a follow-up visit did not found any Asian ship rats on McKean Island. Field work was conducted to plan work pest eradication on other islands (Pierce *et al.* 2009).

U. Current recreation and tourism:

Nil. Tourism is addressed in the Phoenix Island Protected Area Management Plan (PIPA 2009). Tourist operators and other visitors require a visitor permit from Phoenix Island Protected Area Director (PIPA 2009).

V. Existing scientific research:

The island was visited by the Smithsonian Institution's Pacific Ocean Biological Survey Program in the 1960s.

In 2005, the Government of Kiribati partnered with New England Aquarium and Conservation International to design and establish the Phoenix Island Protected Area. A component of this involved two extensive scientific studies of the area. Key themes of the research were: an assessment of coral reef bleaching recovery and associated reef and atoll monitoring (2005); assessment of status of protected bird species (2006) and assessment of impact of invasive species and feasibility of priority eradications (2006).

The ongoing island restoration program is generating valuable data on the status of species and response to the eradication of invasive animals.

A formal research permit system has been established under the Phoenix Island Protected Area Regulation 2008.

W. Management plans and monitoring programs:

Management of Birnie Island is addressed in the Phoenix Island Protected Area Management Plan 2010-1014 (PIPA 2009).

X. Current communication and public education programs:

The Phoenix Island Protected Area has a dedicated web site (http://www.phoenixislands.org/) and Facebook page

Y. References cited:

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Weatherbase 2014b. Retrieved June 16, 2014. http://www.weatherbase.com/weather/weather.php3?s=101419&cityname=Kanton-Island-Kiribati

Z. Compilers:

Original compilers (for 1993 edition): Aobure Teataata and K. Teeb'aki.
Updated by: Doug Watkins and Kiritian Batoromaio, June 2014.

3.4 Rawaki (Phoenix) Island

A. Overview:

Rawaki Island is a low coral island measuring 1.1 km by 0.8 km, with a circumferential beach crest. Inland areas slope gently downwards to a 25.5 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 platform reef, 30-200 m wide, and on the east coast there are storm ridges of broken coral.

B. Area and boundary:

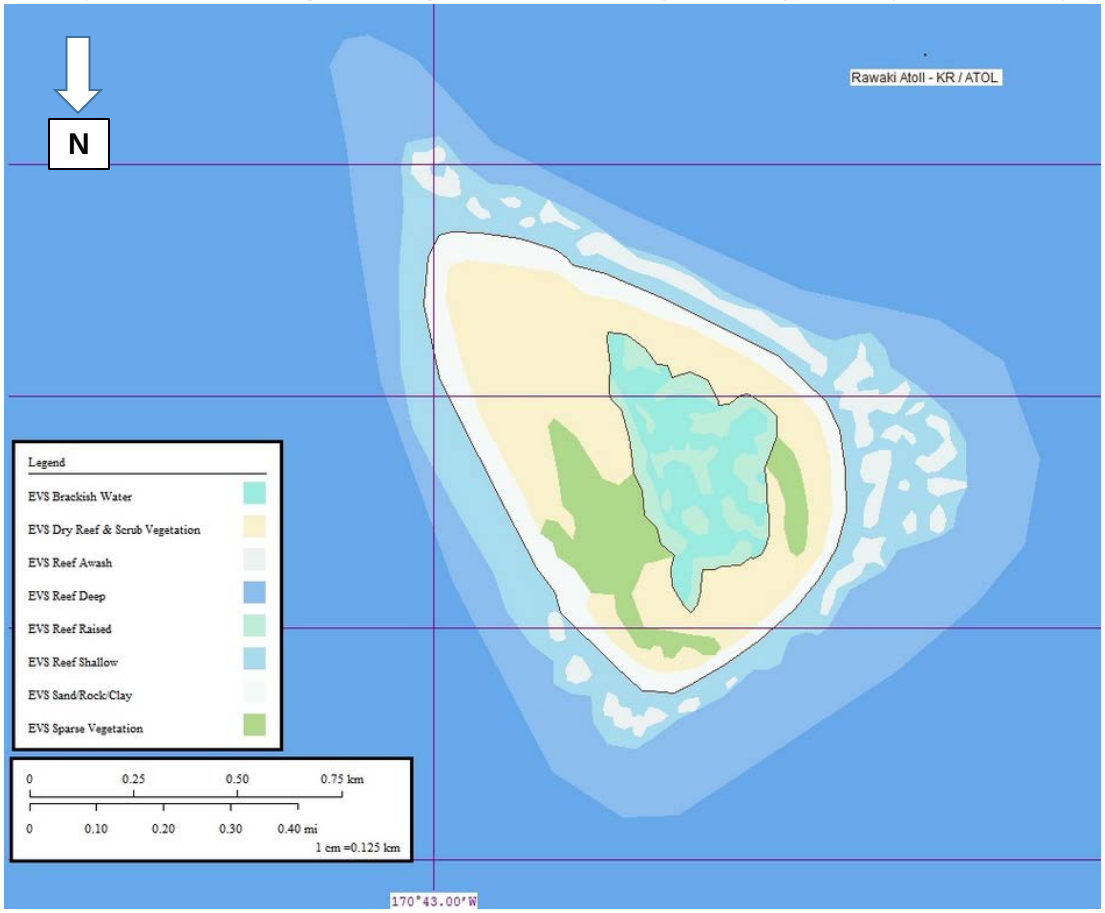
Area: Island area of 74.32 ha of which the land area is 48.77 ha (Pierce *et al.* 2006). No estimate of the area site was possible using Google Earth as an image was not available.
Boundary: The island and marine waters to 6 m at low tide.

C. Location:

Coordinates: 7°38' N, 134°36' E
Location: The most easterly of the Phoenix Islands, about 150 km south-east of Canton Island and 90 km east of Birnie Island.
Administrative area: Phoenix Islands

D. Site map: See below.

Diagram of Rawaki (Phoenix) Island, Kiribati (from wikipedia.org/wiki/Rawaki)



E. Ramsar Wetland Types:

Dominant types:

A Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.

E Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks

Ss Seasonal/intermittent saline/brackish/alkaline marshes/pools.

Types also present:

C Coral reefs.

F. Geomorphic setting:

Elevation: -6 m at low tide to 6 m on the beach crest.

Geology: The Phoenix Islands formed during the Cretaceous and Cenozoic period as mid ocean volcanoes (Larson and Chase 1972). The sea floor in the Phoenix Islands is 4 km below the surface. Over millions of years volcanic subsidence and corresponding reef growth resulted in an accumulation of coralline limestone (PIPA 2009). During the sea level changes of the Holocene, lagoons and dunes developed. Fringing coral reefs continue to develop around the islands.

The fringing reefs around the Phoenix Islands are considered to have a highly consistent topography (Obura 2011). The reef profile consists of the following zones;

- Surge zone – surface to 5-6 m
- Platform – from the bottom of the surge zone to the reef edge at 12-20 m depth and with an averaging width of 200 m.
- Reef Edge – a 12-15 m wide transition zone between the reef platform and the reef slope.
- Reef Slope – below 20-25 m and extending below visible depths with a slope of 45°– 80°.

The total reef area has been calculated at 74 ha of which 12 ha are in the surge zone (Obura 2011).

G. Biogeographical region:

Phoenix/Tokelau/Northern Cook Islands Marine Ecoregion (Spalding *et al.* 2007).

H. Climate:

Rainfall in the Phoenix Islands is among the lowest in the Central Pacific with most islands receive less than 1 000 mm annually with a dry period from March through June (MELAD 2009). Rawaki Island 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.

The one metrological recording station in the Phoenix Islands in on Kanton Island. Kanton has a warm and humid climate all year round. The average temperature each month is 27°C with average monthly highs of 30-31°C and average monthly lows of 23-24°C (Weatherbase 2014b).

I. Soil:

The soils are primarily derived from the coral reefs and have high pH, low fertility and very little humus.

J. Water regime:

The water regime of the 25.5 ha pond in the centre of the island can be anticipate to be highly depended on rainfall and often dry.

Based on NOAA prediction from Tarawa and the Line Islands the tidal range is estimated to be approximately 1.5 m in the Phoenix Islands.

K. Water chemistry: No available information.

L. Biota:

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*, *Tribuluis* sp., *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), Fosberg and Stoddart (1994) and Pierce *et al.* (2006a). No introduced plants are known to occur on the island.

Rawaki Island is a critically important nesting area for seabird populations. In 2006, the island supported the highest diversity (18 species) of seabirds in the Phoenix Islands, including a nesting population of the Endangered Phoenix Petrel (*Pterodroma alba*), the Endangered White-throated Storm Petrel (*Nesofregetta albigularis*) and the Blue Noddy (*Procelsterna cerulea*) (Pierce *et al.* 2006).

Numbers of seabirds counted on Rawaki Islands over the last 50 years were reviewed for an Important Bird Area project conducted by BirdLife International (Gupta 2007). The BirdLife report used data from four studies (Sibley and Clap 1967, King 1973, Obura and Stone 2002 and Pierce *et al.* 2006). Fieldwork conducted in the Phoenix Islands from 2006 to 2013 has enabled contemporary estimates to be developed for Rawaki and the larger PIPA area (Pierce pers. comm). These estimates, previous published maximum numbers, are shown in the table below.

The island supports small numbers of migratory shorebirds. Importantly, approximately 60 Bristle-thighed Curlew (Numenius tahitiensis) were recorded in 2006. This species is IUCN Red Listed as Vulnerable. It nests in Alaska during the northern hemisphere summer and migrates to the South Pacific each year. Counts of other shorebirds include >100 Pacific Golden Plover (Pluvialis fulva) and >100 Ruddy Turnstone (Arenaria interpres) (Pierce *et al.* 2008).

Small numbers of Green Turtles (*Chelonia mydas*) nest on the beaches. Insects are abundant, but exhibit low species diversity (Garnett, 1983).

Estimated numbers of nesting seabirds on Rawaki Island (and the PIPA).

Common name	Scientific name	Maximum Published	Ref	Pierce Estimate	Pierce PIPA Estimate
Audubon's Shearwater	*Puffinus lherminieri*	1 600	2		
Christmas Shearwater	*Puffinus nativitatis*	1 000	2	1 600	1 600
Wedge-tailed Shearwater	*Puffinus pacificus*	500	2	500	600
Phoenix Petrel	*Pterodroma alba*	1 000	1	100	120
Bulwer's Petrel	*Bulweria bulwerii*	1	2	100	100
White-throated Storm Petrel	*Nesofregetta albigularis*	40	2	100	100
Red-tailed Tropicbird	*Phaethon rubricauda*	140	2	200	4 800
Masked Booby	*Sula dactylatra*	3 000	1	2 000	10 000
Brown Booby	*Sula leucogaster*	500	1	48	460
Red-footed Booby	*Sula sula*	100	1	20	6 000
Great Frigatebird	*Fregata minor*	1 000	1	20	2 500
Lesser Frigatebird	*Fregata ariel*	30 000-50 000	1	30 000	42 000
Sooty Tern	*Onychoprion fuscatus*	20 000	2	1 200 000	2 000 000
Grey-backed Tern	*Onychoprion lunatus*	150 000	1	6 000	16 000
Black Noddy	*Anous minutus*	80 000	1	vagrant	8 400
Brown Noddy	*Anous stolidus*	8 000	2	8 000	44 000
Blue Noddy	*Procelsterna cerulea*	19 000	2	5 000	5 000
White Tern	*Gygis alba*	40	2	40	1 800

Notes: References: 1. Obura and Stone 2002; 2. Pierce *et al.* 2006
Rawaki and PIPA estimates based on fieldwork conducted 2006-2014 (Pierce pers. comm.)

M. Land use:

Rawaki Island is uninhabited. It 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, Rawaki Island 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.

N. Pressures and trends:

The key threat to the values of the island is the potential introduction of invasive species. Advice on enhancing biosecurity has been developed (Pierce and Teroroke 2011; Conservation International Pacific Islands Program 2011) and the issue is prominent in the Phoenix Islands Protected Area Management Plan (PIPA 2009).

O. Land tenure and administrative authority:

Land tenure: National Government owned
Administrative authority: Under the Phoenix Islands Protected Area Regulations 2008, the Protected Area is administered by the Minister of the Ministry of Environment, Lands and Agriculture Development (MELAD). Direct management of the Phoenix Islands Protected Area is under the responsibility of the Secretary of MELAD. A Phoenix

Islands Protected Area Management Committee has been established, comprised of representatives of all government agencies and other specified non-government entities with a responsibility for the Phoenix Islands. This Committee is chaired by the Secretary of Minister of the Ministry of Environment, Lands and Agriculture Development (MELAD) and it meets regularly with meeting decisions and follow-up implementation documented and reported by the Director of the PIPA Office.

P. Ramsar listed? No

Q. Ramsar Criteria met:

Criterion 1. Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Criterion 2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
Criterion 4. Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
Criterion 5. Regularly supports 20 000 or more waterbirds.
Criterion 6. Regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

R. Justification for Ramsar Criteria met:

Criterion 1. Rawaki Island contains a representative suite of wetlands of the islands in the Phoenix/Tokelau/Northern Cook ecoregion.
Criterion 2. In the past decade, Rawaki Island has been recorded supporting a nesting colony of the Endangered White-throated Storm Petrel (*Nesofregetta albigularis*) and the Endangered Phoenix Petrel (*Pterodroma alba*). The island may also regularly support the nesting of the Vulnerable Green Turtle (*Chelonia mydas*).
Criterion 4. During the period 2004-2014, Rawaki Island supported seabird nesting colonies of up to 18 species and totalling over 20 000 birds.
Criterion 5. During the period 2004-2014, Rawaki Island has been recorded supporting over 20 000 terns and noddy.
Criterion 6. During the period 2004-2014, internationally important numbers have been recorded of Sooty Terns (*Onychoprion fuscatus*).

S. Conservation and management status of the wetland:

Rawaki 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.

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 Rawaki, McKean, Birnie, 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.

In 1977 McKean Island became part of the Phoenix Island Protected Area in 2007, and as such became part of the Phoenix Island Protected Area World Heritage Site in 2009.

In the late 2000's, a major restoration program for the Phoenix Islands was initiated with the support and involvement of the Governments of Kiribati, New Zealand, the Critical Ecosystem Partnership Fund, Conservation International Pacific Islands Program and the Pacific Invasives Initiative. In 2006 a conservation assessment was conducted and the feasibility of pest eradication (Pierce *et al.* 2006). In May – June 2008, pest eradication work was undertaken on Rawaki Island (rabbits (*Oryctolagus cuniculus*)) and McKean Island (Asian ship rats (*Rattus tanezumi*)). In November-December 2009, a follow-up visit did not found any rabbits on Rawaki Island. Field work was conducted to plan work pest eradication on other islands (Pierce *et al.* 2009).

U. Current recreation and tourism:

Nil. Tourism is addressed in the Phoenix Island Protected Area Management Plan (PIPA 2009). Tourist operators other visitors require a visitor permit from Phoenix Island Protected Area Director (PIPA 2009).

V. Existing scientific research:

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.

In 2005, the Government of Kiribati partnered with New England Aquarium and Conservation International to design and establish the Phoenix Island Protected Area. A component of this involved two extensive scientific studies of the area. Key themes of the research were: an assessment of coral reef bleaching recovery and associated reef and atoll monitoring (2005); assessment of status of protected bird species (2006) and assessment of impact of invasive species and feasibility of priority eradications (2006).

In the late 2000's a major restoration program was initiated for the Phoenix Islands. This was supported by the Critical Ecosystem Partnership Fund, Conservation International Pacific Islands Program, Pacific Invasives Initiative, the Governments of Kiribati and New Zealand. In 2008, under this program, rat eradication was undertaken on McKean Island (Pierce *et al.* 2008) and a return assessment was made in 2009 (Pierce *et al.* 2010). It was concluded that rats had been successfully exterminated (Pierce *et al.* 2010). During 14 person hours of field work 630 pairs of Grey-backed Tern (*Onychoprion lunatus*) 305 pairs of Brown Noddy (*Anous stolidus*) were recorded along with hundreds of juveniles Brown Noddy (*Anous stolidus*) and Lesser Frigatebird (*Fregata ariel*) (Pierce *et al.* 2010).

A formal research permit system has been established under the Phoenix Island Protected Area Regulation 2008.

W. Management plans and monitoring programs:

Management of Rawaki Island is addressed in the Phoenix Island Protected Area Management Plan 2010-1014 (PIPA 2009).

X. Current communication and public education programs:

The Phoenix Island Protected Area has a dedicated web site (http://www.phoenixislands.org/) and facebook page

Y. References cited:

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Z. Compilers:

Original compilers (for 1993 edition): Aobure Teataata and K. Teeb'aki.
Updated by: Doug Watkins and Kiritian Batoromaio, June 2014.

3.5 Teeraina (Washington) Island

A. Overview:

Teeraina Island is a raised, wet coral limestone island with an average annual rainfall of 2 970 mm. It is unique in Kiribati in that it has a freshwater lake of 275 ha in the centre of the island. The lake is surrounded by a swampy woodland rich in epiphytes and ferns and two unique peat bogs covering 130 ha.

B. Area and boundary:

Area: 1 813 ha (polygon area using Google Earth Pro).
Boundary: The complete island and fringing reef to 6 m at low tide.

C. Location:

Coordinates: 4°43' N, 160°25' W
Location: In the northern Line Islands 140 km north-west of Tabuaeran Island and 450 km north-west of Kiritimati Island.
States: Teeraina Council (Line Islands)

D. Site map: See below.

Teeraina Island, Line Islands, Kiribati (Image from Google Earth)

E. Ramsar Wetland Types:

Dominant types:

- A Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.
- E Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.
- O Permanent freshwater lakes (over 8 ha); includes large oxbow lakes.
- Tp Permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season.
- U Non-forested peatlands; includes shrub or open bogs, swamps, fens.
- W Shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils.
- Xf Freshwater, tree-dominated wetlands; includes freshwater swamp forests, seasonally flooded forests, wooded swamps on inorganic soils.

Types also present:

- C Coral reefs.

F. Geomorphic setting:

Elevation: -6 m at low tide to 5 m.

Geology: The Line Islands are located on the central Pacific Plate. The islands initially developed as volcanoes that rose from the ocean floor between 150-80 million years ago (Thiede *et al.* 1993). By the late Cretaceous (80-65 million years ago) reefs flourished in the central and southern Line Islands (Schlanger *et al.* 1984).

By 70-80 million years ago carbonate banks were established around and on top of the eroded volcanoes (Valencia 1977) as evidenced from reefal and shallow-water skeletal debris in sedimentary rocks of this age (Schlanger *et al.* 1984). Volcanic activity may have occurred in the region as late at 40 million years ago (Schlanger *et al.* 1984).

While geological process provided the volcanic basements for the islands, what is seen today on the islands and reef shelf has been primarily due to the growth of coral reefs and these have been greatly influenced by sea level changes and climate (Valencia 1977). At the time the Line Islands formed the Last Glacial Period had resulted in the sea level being approximately 120 m below the present level (Lewis *et al.* 2013). By 20 000 years ago the glacial period turned and there was a rapid melt of the glaciers between 16 000 – 12 500 years ago (Lambeck *et al.* 2002). In Tahiti, the period of the rapid increase in sea levels has been documented as shortly before 13 800 year ago (Bard *et al.* 1996). It is during the periods of stability in sea levels that the reef shelfs around the islands on Kiribati were formed.

The fringing reef surrounding Teeraina Island is generally 180 meters wide, except at three places: 915 meters at the east point, 732 meters at the northwest point, and 549 meters wide at the southwest point. It is at these wide points of the island that the reef flats are seen during low tide, otherwise the rest of the reef flats surrounding the island are always submerged (Office of Te Beretitenti and T'Makei Services 2012).

Wester *et al.* (1992) identified the following geomorphological components on Teeraina Island: shoreline and beach ridges, inland beach ridge and peat complex, phosphate soils and phosphate rock, and peat bog.

The freshwater lake measures approximately 3 km by 11 km, and averages about 2 meters deep during rainy seasons. The bed of the lake is not uniform and the maximum depth recorded is 30 m (Wester *et al.* 1992). It is considered that the base of the lake is at the same general level as existing ocean reef shelf (Wester *et al.* 1992).

G. Biogeographical region: Line Islands Marine Ecoregion (Spalding *et al.* 2007).

H. Climate:

Across the Line Islands the daily temperatures ranges between 24° and 30°C. Teeraina Island has an annual rainfall of 2 900 - 4 000 mm a year (Kishore 2002) with most falling in the December to May period. Teeraina Island has the highest rainfall in Kiribati. South of Teeraina Island, the annual rainfall decreases to 873 mm on Kiritimati Island and 690 on Malden Island.

The strong gradient of decreasing rainfall from the north to the south is caused by the Intertropical Convergence. The Intertropical Convergence Zone is a band of air convergence that runs around the globe. In the Pacific it is positioned to the north of the equator and is a zone in which air is drawn from the south-west and north-east and lifted high into the atmosphere. This forms a band of thunderstorms, trade winds and higher rainfall within the Intertropical Convergence Zone. The El Niño-Southern Oscillation interacts with the Intertropical Convergence Zone and brings about the high variability in rainfall and surface sea temperatures.

I. Soils:

The soils of Teeraina Islands differ from most other islands. While the underlying geological process remain the same, the unique development of the freshwater lake and bogs has greatly increased the amount of humus in the soil. Around the edge of the island the soils are much more rocky and sandy.

J. Water regime:

Around 1900 canals were constructed to link the lake and bogs with the sea (Wester *et al.* 1992). This was done to facilitate the transport of workers and coconuts. The water level of the lake is generally about 1 meter above sea level (Office of Te Beretitenti and T'Makei Services 2012a). Wester *et al.* (1992) found the lake level to be 70 to 170 cm about the inshore ocean reef flat but suggest that the level may have been higher before the canals were constructed.

The NOAA tidal predictions estimate a maximum tidal range at Tabuaeran Island and Kiritimati Island to be 91 cm and at 70 cm Caroline Island. As such Teeraina Island can be anticipated to have a tidal range of approximately 95 cm.

K. Water chemistry:

Saenger *et al.* (2006) found:

- lake water was not stratified (through a three meter depth range) but had high concentrations of floating algal matter. The high turbidity of the water was also reported by Wester *et al.* (1992).
- salinity of the lake and canal did not exceed to 0.22 ppt during field work in June-July 2005.
- the lake was slightly basic with variations of less than 0.05 pH.
- dissolved oxygen values generally ranged from 6.5 to 7.5 mg L^{-1}

In the western peat bog, Saenger *et al.* (2006) describes the profile as loose organic matter to an impenetrable hard laver at 0.5-0.7 cm flowed by a thicker sediment reaching nine meters of flocculated green organic matter (~0.5 m) and flocculated red organic matter (~0.5 m) underlain by fine white silty clay.

The oldest date from a peat core from the West Bog is 1060 ± 100 years BP (Wester *et al.* 1992).

L. Biota:

In a study of the vegetation of Teeraina Island Wester *et al.* (1992) describe the following seven communities: Coconut forest, *Pisonia* forest, strand communities, bog, *Pandanus* fringe, *Scaevola* - *Argusia* scrub, Breadfruit forest. The bog community is dominated by *Scirpus* and with a narrow strip of a few meters of *Pandanus* growing on water logged peat defining the edge of the bog community.

Wester *et al.* (1992) document a flora of 25 indigenous species, 46 cultivated species and 20 introduced species.

Fish reported in the lake include: a freshwater trevally (*Caranx* sp.), freshwater eel (*Anguilla marmorata*) and freshwater milkfish (*Chanos chanos*) and tilapia (*Oreochromis mossambicus*). The introduction of tilapia to Kiribati in the 1960's was not welcomed as they compete with the more favoured milkfish (SPC Aquiculture Portal 2014).

The wetlands of Teeraina Island 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 Teeraina 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 Endangered Kiritimati Reed-warbler or Bokikokiko (*Acrocephalus aequinoctialis*), which is now known only from this island and Kiritimati Island (Gupta 2007). It also supports the largest population of the Endangered Rimatara Lorikeet (*Vini kuhlii*), estimated at a minimum of 1 000 birds in 1993 (Watling 1995). This species is believed to have been introduced by early Polynesian colonists.

Perry (1980) reports the three most abundant seabirds nesting on the island as Red-footed Booby (*Sula sula*) 2 000, White Tern (*Gygis alba*) 2 000 and White-tailed Tropicbird (*Phaethon lepturus*) 100.

Green Turtles (*Chelonia mydas*) nest on the beaches (Scott 1993).

Polynesian Rats (*Rattus exulans*) occur on the island (Watling 1995). The presence of other rat species needs to be assessed.

M. Land use:

The population of Teeraina Island in the 2010 census was 1 690. The population of Teeraina grew by 535 people between 2005 and 2010, an annual population growth of 7.9%. In percentage terms, Teeraina is the fastest growing island in Kiribati, although the growth is much less significant in terms of absolute numbers (Office of Te Beretitenti and T'Makei Services 2012). Teeraina Island has nine villages on the island located along the coast

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.

The two key dryland crops on the island are Coconuts and Breadfruit (*Artocarpus altilis*). The freshwater lake is surrounded by swampy areas where the 'bwabwai' grow.

Teeriana Island

Credit: Dr. James P. McVey, NOAA Sea Grant Program.
http://www.photolib.noaa.gov/htmls/mvey0201.htm

Copra cutting provides the main source of income for households on Teeraina. Copra is harvested both around the villages and from forest areas. Canoes and boats are used to transport copra (Office of Te Beretitenti and T'Makei Services 2012).

All land on Teeraina Island, as well as reef and lake areas, is owned by the Government of Kiribati. The land use policies of the Government are designed to encourage migration from Tarawa Island to Teeraina Island. About a third of households live on land that they now have the right to call their own, while the remaining two thirds live on Government leases or privately arranged subleases (Office of Te Beretitenti and T'Makei Services 2012).

N. Pressures and trends:

As the key threats to the wetland values of the site are predation on seabirds by feral cats and dogs.

O. Land tenure and administrative authority:

Land tenure: Largely national Government owned. Some of the copra plantations are freehold.
Administrative authority: Teeraina Island Council

P. Ramsar listed? No

Q. Ramsar Criteria met:

Criterion 1. Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Criterion 2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
Criterion 3. Supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
Criterion 6. Regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

R. Justification for Ramsar Criteria met:

Criterion 1: Teeraina Island is unique example, in the Line Islands ecoregion, of an island with a large freshwater lake and peat bogs.
Criterion 2: The site supports the Endangered Kiritimati Reed-warbler (*Acrocephalus aequinoctialis*) and the largest population of the Endangered Rimatara Lorikeet (*Vini kuhlii*). The island may also regularly support the nesting of the Vulnerable Green Turtle (*Chelonia mydas*).
Criterion 3: The site supports the Endangered Kiritimati Reed-warbler (*Acrocephalus aequinoctialis*) and the largest population of the Endangered Rimatara Lorikeet (*Vini kuhlii*). The freshwater habitats are also anticipated to support species that are only found at this site in the Line Islands ecoregion.
Criterion 6. Internationally important numbers have been recorded of the White Tern (*Gygis alba*).

S. Conservation and management status of the wetland:

Teeraina Island has a population of over 1 500 people. Most of these people rely on the natural resources of the island and its marine water for their livelihoods.

As part of the “Holding the Lines — Restoration of the Northern Line Islands, Kiribati“ supported by the Critical Ecosystem Partnership Fund, the Ministry of Environment, Land and Agricultural Development – Wildlife Conservation Unit undertook a major surveillance of Teeraina Island. This involved assessing the conservation values, threats and actions needed as a first step towards ecological restoration of the island (Skelton 2013).

U. Current recreation and tourism:

The island provides for local recreation for its population.

V. Existing scientific research: No information available.

W. Management plans and monitoring programs:

The Ministry of Environment, Land and Agricultural Development – Wildlife Conservation Unit in Kiritimai is developing of a restoration plan for Teeraina Island. This will focus on the control of feral and invasive animals (Skelton 2013).

X. Current communication and public education programs:

No information available.

Y. References cited:

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Z. Compilers:

Original compilers (for 1993 edition): Aobure Teataata and K. Teeb'aki.
Updated by: Doug Watkins and Kiritian Batoromaio, June 2014.

3.6 Tabuaeran (Fanning) Island

A. Overview:

Tabuaeran Island 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 2 500 mm.

B. Area and boundary:

Area: 15 280 ha (polygon area using Google Earth Pro). Land area 3 378 ha (Office of Te Beretitenti and T'Makei Services 2012).
Boundary: The complete island and fringing reefs to 6 m at low tide.

C. Location:

Coordinates: 3°52' N, 159°20' W
Location: In the northern Line Islands 300 km north-west of Kiritimati Island and 140 km south-east of Teeraina Island.

D. Site map: See below.

E. Ramsar Wetland Types:

Dominant types:

- J Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.
- A Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.
- C Coral reefs.
- G Intertidal mud, sand or salt flats.
- H Intertidal marshes; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.
- E Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.

F. Geomorphic setting:

Elevation: -6 m at low tide to 3 m.

Geology: The Line Islands are located on the central Pacific Plate. They initially developed as volcanoes that rose from the ocean floor between 150-80 million years ago (Thiede *et al.* 1993). By the late Cretaceous (80-65 million years ago) reefs flourished in the central and southern Line Islands (Schlanger *et al.* 1984).

By 80-70 million years ago carbonate banks were established around and on top of the eroded volcanoes (Valencia 1977) as evidenced from reefal and shallow-water skeletal debris in sedimentary rocks of this age (Schlanger *et al.* 1984). Volcanic activity may have occurred in the region as late at 40 million years ago (Schlanger *et al.* 1984).

While geological process provided the volcanic basements for the islands, what is seen today on the islands and reef shelf has been primarily due to the growth of coral reefs and

these have been greatly influenced by sea level changes and climate (Valencia 1977). At the time the Line Islands formed, the Last Glacial Period had resulted in the sea level being approximately 120 m below the present level (Lewis *et al.* 2013). By 20 000 years ago the glacial period turned and there was a rapid melt of the glaciers between 16 000 – 12 500 years ago (Lambeck *et al.* 2002). In Tahiti, the period of the rapid increase in sea levels has been documented as shortly before 13 800 year ago (Bard *et al.* 1996). While sea levels have fluctuated since the Last Glacial Maximum, the overall trend has been an ongoing increase in sea level. It is during the periods of stability in sea levels that the reef shelfs around the islands on Kiribati were formed. On Kiritimati Island it is suggested that the sea levels have fallen by 0.5-0.9 m since the mid-Holocene (Falkland and Woodroffe 1997).

Tabuaeran Island, Line Islands, Kiribati (Image from Google Earth)

G. Biogeographical region: Line Islands Marine Ecoregion (Spalding *et al.* 2007).

H. Climate:

Across the Line Islands the daily temperatures range between 24°C and 30°C. Tabuaeran Island has an annual rainfall of 2 501 mm (climatemps.com 2014) with most falling in the January to May period. This compares to 2 900 - 4 000 mm per year on Teeraina Island and an annual rainfall of 873 mm on Kiritimati Island.

The strong gradient of decreasing rainfall from the north to the south is caused by the Intertropical Convergence. The Intertropical Convergence Zone is a band of air convergence that runs around the globe. In the Pacific, it is positioned to the north of the equator, and is a zone in which air is drawn from the south-west and north-east and lifted high into the atmosphere. This forms a band of thunderstorms, trade winds and higher rainfall within the Intertropical Convergence Zone. The El Niño-Southern Oscillation interacts with the Intertropical Convergence Zone and brings about the high variability in rainfall and surface sea temperatures.

I. Soil:

The soil is originally derived from calcareous reef material of coral remains, shells of molluscs and the "shell" of Foraminifera.

J. Water regime:

The lagoon is connected to the ocean by three channels; a deep channel (ca. 8 m in depth) at English Harbor and two shallow passes (or intertidal reef flats ca. 1 m in depth) at North Pass and Rapa Pass. It is estimated that 95% of the water exchange in the lagoon is via English Harbor (Maragos 1974).

The marine maximum tidal range is estimated as 0.91 m (tidesandcurrents.noaa.gov 2014). The tidal range within the lagoon is approximately half that of the ocean (Gallagher *et al.* 1971).

K. Water chemistry:

The average water temperature in the lagoon is 28° C with little fluctuation with depth (Gordon and Schiesser 1970). Salinity in the lagoon is variable, ranging from 34.56-35.28 psu with an average of 34.92 psu (Gordon and Schiesser 1970).

The turbidity of the lagoon water is due to calcium carbonate sediment. The concentration has been estimated at up to 4g $CaCO_3/m^3$ (Smith *et al.* 1971).

L. Biota:

The site is dominated by the lagoon which covers 11 000 ha (Office of Te Beretitenti and T'Makei Services 2012). Most of the lagoon is shallow except in the vicinity of English Harbour where the maximum depth is 15 m. The seaward fringing reefs extend 100 m to 200 m and then the reef drops abruptly to 25-30 m (Russell and Carlson 1978).

In a survey of the marine environment, Chave and Eckert (1974) describe the following seven habitats: lagoon shoreline, turbid lagoon patch reefs, clear lagoon patch reefs, channel, tide pools, outer reef flats and outer reef slopes. This research identified 214 species of fishes with the highest diversity (99 species) being in English Harbour Channel.

In describing the environments associated with the lagoon Guinther (1971), used six groups: sub-littoral, reef flat, littoral, cyanophyte basin, upper flat and forested.

Terrestrial vegetation includes atoll scrub and atoll forest with *Pisonia grandis* and *Argusia argentea*. St John (1974) lists a flora of 102 species and varieties, consisting of 39 ornamentals, 13 food plants, 28 adventives, 20 indigenous plants, and 2 endemics. Wester (1985) expanded the flora list to 123 species.

The most recent published data on numbers of nesting seabirds are from publications in the 1970's and may well represent data from the 1960's. This data, collated by Perry (1980), and Gupta (2007) shows the following numbers: White-tailed Tropicbird (*Phaethon lepturus*) 50, Red-footed Booby (*Sula sula*) 3 000, Great Frigatebird (*Fregata minor*) 1 000, Brown Noddy (*Anous stolidus*) 2 000, Black Noddy (*Anous minutus*) 2 000 and White Tern (*Gygis alba*) 2 000. As early as 1925 it had been noted that extensive disturbance to native vegetation was causing considerable loss of nesting sites for birds (Kirby 1925).

There is a small population of the Rimatara Lorikeet (*Vini kuhlii*) on the north-western islet. This species, which also occurs on Teeraina and Kiritamati Islands, is believed to have been introduced by early Polynesian colonists.

Tabuaeran Island is one of only four islands on which the Kiritimati Reed-warbler or Bokikokiko (*Acrocephalus aequinoctialis*) is known to have occurred (Kirby 1925), but it had disappeared by 1980 (Perry 1980). An evaluation of the re-introduction of Kiritimati Reed-warbler has been proposed (Skelton 2013).

M. Land use:

While the island has relics of early Polynesian occupation it is considered not to have been permanent until about 1860 (Perry 1980, Wester *et al.* 1992).

During the late 1980's to the late 2000's, because of increasing population pressures in South Tarawa, the Government encouraged people to relocate to other islands. This policy resulted in the population of Tabuaeran Island increasing from 450 in 1985 to 1,615 in 1995. The population peaked at 2 539 in 2005 and declined by 25% to 1 960 in 2010. In 2010, 41% of the population was under 15 years of age. People live in eight villages along the western side of the island. Only 20% of people identified themselves as "from Tabuaeran" in the 2010 census (Office of Te Beretitenti and T'Makei Services 2012).

The major sources of income are sale of fish/crops/crafts (mainly copra), wages and remittances from family working in South Tarawa or overseas (Office of Te Beretitenti and T'Makei Services 2012). Seaweed export and visit of cruise ships have been an important sources of income for the island.

Almost all households fish in the lagoon and about half also fish in the ocean (Office of Te Beretitenti and T'Makei Services 2012).

In 1977, *Eucheuma* seaweeds (now redescribed as *Kappaphycus)* were introduced to Kiribati. It proved not to be economic on most islands and by 2008 the production was focused at Tabuaeran Island (Ministry of Internal and Social Affairs. 2008).

N. Pressures and trends:

Key pressures impacting in the site are: fishing, invasive species and shipwrecks.

Fishing: Increasing research in the Pacific is showing that human-related disturbance is strongly correlated with coral reef and fisheries decline (DeMartini *et al.* 2008, Sandin *et al.* 2008, Dinsdale *et al.* 2008, Williams *et al.* 2011). Reports from Tabuaeran pre-1950's, document an abundance of sharks and large fish. Between 1997 and 2008, a time in which the population of Tabuaeran increased by 500% (Office of Te Beretitenti and

T'Makei Services 2012), the fish biomass halved (Sandin *et al.* 2008). The decline of diurnal reef predators is changing the behaviour of other reef fishes (Williams *et al.* 2011).

Invasive species: Knowledge is limited on the status of invasive species. The Wildlife Conservation Unit based in Kiritimati is planning to; improve quarantine controls for invasive species, promote dog and cat control measures to Tabuaeran Council and develop a management plans for invasive species (Skelton 2013). In Butaritari Island introduced seaweed (*Kappaphycus* spp.) has become a major problem and is killing off the coral reef (Ministry of Internal and Social Affairs 2008, Pala 2008). *Kappaphycus* spp. were introduced to Hawaii, at a similar time to Kiribati, and is now considered a major problem species (Conklin and Smith 2005, Schaffelke and Hewitt 2007). The impact of *Kappaphycus* spp., and the potential for it to become a problem species within the Tabuaeran lagoon, is not known.

Shipwrecks: The seaward coral reefs around near the English Harbor have been impacted by a 40 year old rusting shipwreck. The release of iron is resulting in the blackening of the reef and growth of crustose algae. This black reef, consisting predominately of dead coral and rubble covered with thick cyanobacterial mats and turf algae, now covers 10% of the surrounding reef of Tabuaeran Island. Similar impacts have been recorded around shipwrecks at Kingman, Caroline, Palmyra, Starbuck Islands (Kelly *et al.* 2012).

Concern has also be raised about coastal erosion caused by the construction of causeways linking the islets (Office of Te Beretitenti and T'Makei Services 2012).

O. Land tenure and administrative authority:

Land tenure: Largely Government owned. In the villages approximately one third of households own their land, one third live on Government leased land and a third live on private leased land (Office of Te Beretitenti and T'Makei Services 2012).
Administrative authority: Tabuaeran Island Council.

P. Ramsar listed? No.

Q. Ramsar Criteria met:

Criterion 1. Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Criterion 2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
Criterion 6. Regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

R. Justification for Ramsar Criteria met:

Criterion 1. Tabuaeran Island is a unique example of a ringed atoll lagoon in the Line Islands Marine Ecoregion.
Criterion 2. The site supports the Endangered Rimatara Lorikeet (*Vini kuhlii*) and may also regularly support the nesting of the Vulnerable Green Turtle (*Chelonia mydas*).
Criterion 6. Internationally important numbers have been recorded for White Tern (*Gygis alba*).

S. Conservation and management status of the wetland:

Tabuaeran Island has a population of approximately 2 000 people. Most of these rely on the natural resources of the island and its marine waters for their livelihoods. The coastal fishery is being significantly impacted by the fishing pressure of local people.

U. Current recreation and tourism:

In additional to providing for the recreation needs of the residents the island has been promoted for international tourism.

V. Existing scientific research:

Fanning Island Expedition, January 1970 (Hawaii University). During the 2000's and early 2010's much of the scientific research work was conducted opportunistically by visiting researchers.

W. Management plans and monitoring programs: None

X. Current communication and public education programs: No information available.

Y. References cited:

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Z. Compilers:

Original compilers (for 1993 edition): Aobure Teataata and K. Teeb'aki.
Updated by: Doug Watkins and Kiritian Batoromaio, June 2014.

3.7 Kiritimati (Christmas) Island

A. Overview:

Kiritimati Island is the world's largest coral atoll with a total land area of 32 100 ha and an approximately equal area of lagoons. With its multi-complex system of subsidiary land-locked lagoons, the island and its several hundred islets, harbours some of the world's largest concentrations of seabirds, and is of global significance both in terms of diversity and abundance. Most of the island is a Wildlife Sanctuary within which there are five Closed Areas.

B. Area and boundary:

Area: 67 730 ha (polygon area using Google Earth Pro). Land area: 38 839 ha (Office of Te Beretitenti and T'Makei Services 2012).
Boundary: The complete island and fringing reef to 6 m at low tide.

C. Location:

Coordinates: 2°00' N, 157°20' W
Location: In the northern Line Islands, 3 300 km east of Tarawa Island. The site is 285 km south-south-east of Tabuaeran Island and 700 km north of Malden Island.
State: Line Islands.

D. Site map: See below.

E. Ramsar Wetland Types:

- A Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.
- C Coral reefs.
- E Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.
- G Intertidal mud, sand or salt flats.
- J Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.
- Sp Permanent saline/brackish/alkaline marshes/pools.
- Ss Seasonal/intermittent saline/brackish/alkaline marshes/pools.

F. Geomorphic setting:

Elevation: -6 m at low tide to 13 m.

Geology: The Line Islands are located on the central Pacific Plate. They initially developed as volcanoes that rose from the ocean floor between 150-80 million years ago (Thiede *et al.* 1993). By 70-80 million years ago coral reefs flourished (Schlanger *et al.* 1984) and carbonate banks were established around and on top of the eroded volcanoes (Valencia 1977) as evidenced from reefal and shallow-water skeletal debris in sedimentary rocks of this age (Schlanger *et al.* 1984). Volcanic activity may have occurred in the region as late at 40 million years ago (Schlanger *et al.* 1984).

The Kiritimati Island of today is a limestone platform on top of the volcanic basalt. The limestone, which formed about 200 000 years ago in the mid-Pleistocene, varies in thickness across the island from 30 m to over 120 m (Jenkin and Foale 1968).

Kiritimati (Christmas) Island, Line Islands, Kiribati (Image from Google Earth)

At the time the Line Islands formed, the Last Glacial Period had resulted in the sea level being approximately 120 m below the present level (Lewis *et al.* 2013). By 20 000 years ago the glacial period turned and there was a rapid melt of the glaciers between 16 000 – 12 500 years ago (Lambeck *et al.* 2002). In Tahiti, the period of the rapid increase in sea levels has been documented as shortly before 13 800 year ago (Bard *et al.* 1996). It is during the periods of stability in sea levels that the reef shelfs around the islands on Kiribati were formed. On Kiritimati Island it is suggested that the sea levels have fallen by 0.5-0.9 m since the mid-Holocene (Falkland and Woodroffe 1997).

Thirteen units have been used to describe the geomorphology (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.

A reef platform extends 30-120 m from the shoreline around the whole island, being widest along the north coast.

A 16 000 ha tidal lagoon opens to the northwest. At the eastern end of this lagoon, there are several hundred smaller landlocked saline or hypersaline lagoons that cover 14 000 ha (Morrison and Woodroffe 2009). 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.

G. Biogeographical region: Line Islands Marine Ecoregion (Spalding *et al.* 2007).

H. Climate:

Kiritimati Island lies within the equatorial dry zone. The diurnal temperature ranges between 24°C and 30°C with little seasonal variation. The mean annual rainfall is 873 mm, varying widely between a minimum of 177 mm and a maximum of 2 621 mm (Morrison and Woodroffe 2009). Rainfall is usually heaviest in March and April, and lightest in October and November. The prevailing winds are easterly trades.

The El Niño Southern Oscillation has a major impact on the weather of Kiritimati Island. Rainfall is much higher during an El Niño and much lower during a La Niña (Australian Bureau of Meteorology and CSIRO 2011).

I. Soil:

The soil is originally derived from calcareous reef material of coral remains, shells of molluscs and the “shell” of Foraminifera. Based on landform position, particle size distribution and presence/absence of hardpan, Hammond (1969) divided the soils into six mappable categories. Organic matter in the soil is low, the pHs are high (>7.7) and Carbon:Nitrogen ratios are approximately 12 (Morrison and Woodroffe 2009). The soils have very limited profile development so Jenkin and Foale (1968) grouped the soils as entisols, lithosols and regosols. Morrison and Woodroffe (2009) have published a detailed paper on the soils and included cross tables of previous study of soils.

J. Water regime:

The maximum tidal range is approximately 0.9 m (NOAA 2014).

A sub-surface freshwater lenses occur in the eastern and south-western parts of the island. Salinities varying between 0 and 3.5 ppt, and with a water table generally at a depth of between 0 and 2 m.

Water depth in the lakes was variable to a maximum of 6 m (Saenger *et al.* 2006).

K. Water chemistry:

Saenger *et al.* (2006) surveyed over 100 lakes and documented salinities ranging for nearly fresh to 150 ppt. This variation was related to groundwater inflow and extreme tides. Height variability was also recorded in dissolved oxygen (0.61 to 9.46 mg l^{-1}) and pH values (7.5 – 8.8).

Helms *et al.* (2010) distinguished four types of lake waters: seawater and lagoonal waters, brackish lakes, meso- and hypersaline lakes and their pore waters and fresh to brackish ground waters.

L. Biota:

The perimeter of the fringing reefs around Kiritimati Island, at the 10 m isobath, is 146.8 km (Sandin *et al.* 2008). This is the largest area of fringing reef in Kiribati and it supports an important fishery. The benthic community of the leeward fringing reefs are dominated (68% cover) by macroalgae (including species of Halimeda, Caulerpa, Avrainvillea, Dictyosphaeria, and Lobophora) and algal turfs (Sandin *et al.* 2008). Cover of stony corals and crustose coralline algae was 21% (Sandin *et al.* 2008).

Sandin *et al.* (2008) recorded 281 species of fish and 83 species of coral. In 2007 the top reef predators accounted for 19% of the fish biomass, compared to 21% at Tabuaeran and 65% at Palmyra and Kingman (Sandin *et al.* 2008). The predators were dominated by small groupers (mean length of 13 cm) while sharks were in very low numbers. The most numerous fish, accounting for 26% of biomass, were planktivores only a few centimetres in length (Sandin *et al.* 2008).

The large shallow lagoon and complex inner lagoon system provides habitat for key commercial species, including the milk-fish (*Chanos chanos*) and bone fish (*Albula glossodonta*). This supports artisanal and recreational tourist fishing (Office of Te Beretitenti and T'Makei Services 2012).

In a review of the flora, Wester (1985) identified 69 plants species on Kiritimati Island. This consisted of 19 indigenous species, 25 cultivated or persisting species and 25 adventive species. One endemic plant species, *Cuscuta campestris,* was identified.

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 *Argusia argentea* and *Suriana maritima*. Lower lagoon flats are dominated by *Suriana*, growing to a maximum height of 2 m. *Argusia* 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 *Portulaca oleracea*. Extensive *Sida* dwarf scrub, mixed with *Heliotropium*, *Boerhavia repens*, Portulaca, *Cassytha filiformis* 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*). About 50 introduced species occur, mainly around villages, abandoned military installations and other disturbed sites. Most alien species are believed to have arrived during the 20th centuary (Jenkin and Foale 1968).

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.

Kiritimati Island is one of the most important seabird nesting colony in the Pacific. In the mid 2000's it supporting over 500 000 seabirds (Pierce *et al.* 2007), and in the past may have supported over 10 million seabirds. Estimates of the numbers of seabirds using Kiritimati Island over the past 50 years have varied widely and there is limited access to the details on the estimate methodology. In the table below, primacy is given the most recent detailed surveys by Pierce *et al.* (2007) and these are compared to estimates from other key references.

Estimates of the numbers of seabirds using Kiritimati Island

Species	Pierce *et al.* 2007	Other estimates
Sooty Tern (*Onychoprion fuscatus)*	350 000 - 650 000	25 million (King 1973), 15 million (Gould 1974)
Black Noddy (*Anous minutus)*	100 000	14 500 (Perry 1980)
Red-footed Booby (*Sula sula)*	28 000 - 44 000	8 500 (Perry 1980)
Brown Noddy (*Anous stolidus)*	15 000 - 31 000	4 000 (Perry 1980)
Christmas Shearwater (*Puffinus nativitatis)*	4 000 - 7 000	15 000 (Perry 1980)
Wedge-tailed Shearwater (*Puffinus pacificus)*	4 500 - 8 000	500 000 (Garnett 1981) 100 000 (Perry 1980)
Audubon's shearwater (*Puffinus lherminieri)*	3 100 – 4 100	500 (Perry 1980)
Phoenix Petrel (*Pterodroma alba)*	2 300 – 3 800	25 000 (Perry 1980)
White Tern (*Gygis alba)*	2 500	5 000 (Perry 1980)
Red-tailed Tropicbird (*Phaethon rubricauda)*	820 – 1 100	8 000 (Perry 1980)
Grey-backed Tern (*Onychoprion lunatus)*	800 - 900	1,500 (Perry 1980)
Great Frigatebird (*Fregata minor)*	700 - 900	10 000 (Perry 1980)
Blue Noddy (*Procelsterna cerulea)*	570	2 700 (Perry 1980)
White-throated Storm Petrel (*Nesofregetta albigularis)*	200 - 500	350 (Perry 1980)
Lesser Frigatebird (*Fregata ariel)*	100	5 000 (Garnett 1981), 2 000 (Perry 1980)
Masked Booby (*Sula dactylatra)*	20 - 30	1 000 (Perry 1980)
Brown Booby (*Sula leucogaster*)	20 - 30	300 (Perry 1980)
White-tailed Tropicbird (*Phaeton lepturus*)	2 - 10	

The island supports the majority of the nesting population of the Endangered White-throated Storm Petrel and 23% - 38% of the global population of the Endangered Phoenix Petrel (BirdLife 2014a, b; Pierce *et al.* 2007).

Numbers of nesting seabirds have declined dramatically in the past century and even more so in the past 20 years (Skelton 2013). One of the documented correlated factors was the 1982 and 1983 El Nino-Southern Oscillation (Schreiber and Schreiber, 1984, 1989). Other major factors are considered to be the impact on nesting seabirds of alien invasive species such as Black Rat (*Rattus rattus*) and feral cats (*Felis catus*) (Skelton 2013). Seabird species that have had higher estimates in the mid-2000's than previously recorded include Black Noddy (*Anous minutus),* Red-footed Booby (*Sula sula),* Brown Noddy (*Anous stolidus) and* Audubon's Shearwater (*Puffinus lherminieri)* (see table above).

There is only one indigenous land bird, the Endangered Kiritimati Reed-Warbler (known locally as Bokikokiko) (*Acrocephalus aequinoctialis*), which has a population in the low hundreds and is patchily distributed across the island (Pierce *et al.* 2007). The only other occurrence of this species is on Teeraina Island. Preliminary research on Kiritimati suggests its habitat preference is influenced by the height of *Argusia argentea*, cover of *Scaevola taccada* and the presence *Cassytha filiformis* (Pierce *et al.* 2007). The second land bird is the Endangered Rimatara Lorikeet (*Vini kuhlii*) which has been introduced several times in the past 60 years but remains scarce and local (Watling 1995). It has been suggested that low rainfall years on Kiritimati may be the reason that it has not established successfully (Watling 1995).

Common migratory shorebirds include the Pacific Golden Plover (*Pluvialis fulva*), Wandering Tattler (*Heteroscelus incanus*), the Endangered Bristle-thighed Curlew

(*Numenius tahitiensis*) and Ruddy Turnstone (*Arenaria interpres*). The type specimen of the extinct Tuamotu Sandpiper (*Prosobonia cancellatus*) (Birdlife 2014a), is thought to have been collected on the island in 1778, but there were no subsequent records (Pierce and Blanvillain 2004).

The Polynesian Rat (*Rattus exulans*) is widespread and abundant on the island and was presumably introduced by early Polynesians. Alien invasive species include Black Rat (*Rattus rattus*) and feral cats (*Felis catus*).

Green Turtles (*Chelonia mydas*) regularly come ashore in small numbers to nest. Mourning Geckoes (*Lepidodactylus lugubris*) and Snake-eyed Skinks (*Cryptoblepharus 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 grayi*) and land hermit crabs (*Coenobita perlatus*).

M. Land use:

Archaeological work by Anderson *et al.* (2000), suggest that the island had a period of settlement from 1200 – 1600 based on radiocarbon determinations. The origin of the people has yet to be determined. When European explorers visited in the between the mid 1500's and early 1800's there was no resident population. The development of the copra trade brought the establishment of coconut plantations on the island in the mid 1890's. Pacific Plantations Ltd planted 70 000 coconuts on the island in the early 1900's but low rainfall resulted in the death of 75% of the plants. Over the next few decades <560 000 coconuts were planted with 400 000 surviving (IUCN 1991).

From 1942 to the mid-1960's Kiritimati had three military related roles. During World War II up to 10 000 US personnel were stationed on the island (Defence Nuclear Agency 1983). By 1948 the last US personnel were withdrawn but in 1955 the United Kingdom Government selected the island as a base for nuclear testing. During 1957 and 1958 six atmospheric nuclear test were conducted near Kiritimati. Four years later the US and UK returned and tested seven nuclear bombs in the vicinity of the island (Norris *et al.* 1994).

A variety of aquaculture ventures has been trailed but with limited success. These have included Brine shrimp (*Artemia salina*) in the hypersaline ponds, Tilapia (*Oreochromis mossambicus*), Milkfish (*Chanos chanos*) and eucheuma seaweed (SPC 2014).

In 2000 the population of the island was 3 431people. By 2005 it had jumped to 5 115 and in 2010 it was 5 586. The jump in population in 2005 was due to Government encouragement for people in Tarawa to relocate to other islands (Office of Te Beretitenti and T'Makei Services 2012). Kiritimati Island is now the third highest populated area in Kiribati.

A Household Expenditure and Income Survey in 2006 found that sales of fish, home produce and agricultural produce are almost as important as wages and salaries in the total cash income of households (Office of Te Beretitenti and T'Makei Services 2012). Tourism is also now an important element of the Kiritimati Island economy.

N. Pressures and trends:

Key environmental issues identified by Kiritimati delegates to the 2011 National Summit identified were; water, limited land space/overcrowding and a reduction in marine resources. The water and overcrowding both related to the direct living conditions for the community. The specific water issues were its limited supply and the contamination of shallow ground from water septic tanks and toilet pits (Office of Te Beretitenti and T'Makei Services 2012).

The community concern about the lagoon and reef fishery is strongly backed by scientific studies. The structure and biomass of fish communities around Kiritimati is now very different from those around uninhabited atolls (DeMartini *et al.* 2008, Knowlton and Jackson 2008, Sandin *et al.* 2008). In the period 1997 to 2007 the fish biomass at Kiritimati Island halved and most of the top predators were no longer recorded (Sandin *et al.* 2008). Reef scientists have recommended the establishment of small no-take areas (totalling 20–30% of the area) as a means to increase the sustainability of the fishery (DeMartini *et al.* 2008).

A comparative study of coral at Kiritimati, Tabuaeran, Palmyra and Kingman showed that Kiritimati had the highest prevalence of coral disease and lowest coral coverage (Dinsdale *et al.* 2008). While bleaching from warmer water plays a key role in reducing coral coverage, research is showing that local effects from human habitation is also impacting on the resistance and resilience of coral reefs to withstand global anthropogenic impacts (Knowlton and Jackson 2008).

During the 2000's there was a major export-based wild-capture aquarium trade operating from Kiritimati and generating up to US$ 1 million annually (Preston 2008). A management plan is being developed for the aquarium fish industry in Kiritimati, however some concern has been expressed that it may not provide sufficient resource protection to ensure sustainability (Govan 2014).

New regulations have been proposed to prohibit the catching and possession of bonefish on Kiritimati Island (Govan 2014).

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). It is not known if the island ecology was adversely affected by atmospheric nuclear bomb test programmes during 1956-58 and 1962.

Four invasive mammal species occur on Kiritimati; feral house cat (*Felis catus*), Pacific rat (*Rattus exulans*), black rat (*Rattus rattus*), and locally, pigs (*Sus scrofa*) (Pierce *et al.* 2007). These have had major impacts on the native fauna. They occur across most the island but access to some islands in the lagoons is restricted by water levels. The most recent arrival has been the black rats (*Rattus rattus*) which is thought to have arrived in the late 1990's (Anderson 2002 in Pierce *et al.* 2007). Cats and rats are considered to have had a major impact on nesting populations of the smaller seabird species and there is concern that poaching is also a serious problem (Pierce *et al.* 2007).

O. Land tenure and administrative authority:

Land tenure: Mostly Government owned with some freehold. The Government has undertaken to make more land available for freehold in recognition of people relocating to the island (Office of Te Beretitenti and T'Makei Services 2012)
Administrative authority: Kiritimati Island Council.

P. Ramsar listed? No.

Q. Ramsar Criteria met:

Criterion 1. Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Criterion 2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
Criterion 3. Supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
Criterion 4. Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
Criterion 5. Regularly supports 20 000 or more waterbirds.
Criterion 6. Regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

R. Justification for Ramsar Criteria met:

Criterion 1 Kiritimati Island is a unique example of a large coral island with lagoon and saline ponds in the Line Islands Marine Ecoregion.
Criterion 2 The site supports nesting Endangered White-throated Storm Petrel (*Nesofregetta albigularis*) and the Endangered Phoenix Petrel (*Pterodroma alba*); the Endangered Kiritimati Reed-warbler (*Acrocephalus aequinoctialis*); small numbers of the Endangered Rimatara Lorikeet (*Vini kuhlii*) and non-breeding Endangered Bristle-thighed Curlew (*Numenius tahitiensis*). The island may also regularly support the nesting of the Vulnerable Green Turtle (*Chelonia mydas*). The Endangered Giant Clam (*Tridacna gigas*) have been recorded in the lagoon.
Criterion 3 The site supports one of two populations of the Endangered Kiritimati Reed-warbler (*Acrocephalus aequinoctialis*) and the largest population of the Endangered Rimatara Lorikeet (*Vini kuhlii*).
Criterion 4 The site regularly supports seabird nesting colonies of over 10 species and totalling over 100 000 birds.
Criterion 5 The island been recorded supporting over 20 000 terns and noddy.
Criterion 6. Internationally important numbers have been recorded for Black Noddy (*Anous minutus*), Sooty Terns (*Onychoprion fuscatus*) and White Tern (*Gygis alba*).

S. Conservation and management status of the wetland:

Kiritimati Island 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 *Pisonia* woodland in the main lagoon; Motu Upua (19 ha), a larger islet with *Argusia*, *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 (*Pterodroma alba*) and Christmas Shearwater (*Puffinus nativitatis*). 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 seabird populations, enforce strict wildlife conservation legislation, control feral cats and pigs, and provide a conservation education programme.

The Wildlife Conservation Unit, has biodiversity conservation responsibilities across the Line and Phoenix Island. While that means their efforts need be spread across a very large area, it does provide greater access to capacity building activities and the opportunity to develop large biodiversity initiatives. Since 2008, support has been provided from the Critical Ecosystem Partnership Fund (CEPF via CI), NZAID, the Pacific Invasive initiative and Secretariat for the Pacific Regional Environment Programme, aimed at biodiversity recovery in the Phoenix and Line Islands. In 2008 NZAID funded pest eradication training with Government of Kiribati staff on Kiritimati (Brown and Pierce 2008) followed by pest eradications on two of the Phoenix Islands (Pierce *et al.* 2009).

The three year CEPF "Holding the Lines" project placed an emphasis on providing technical assistance and capacity building to enable the Wildlife Conservation Unit to address the priorities in the National Invasive Species Action Plan for Kiribati (2007). Key overall impacts of the project activities (some of which were part funded by the New Zealand Government) include; enhancing the conservation status of the Phoenix Petrel (*Pterodroma alba*), building a commitment to regional agencies to continue to support invasive species management, identification of priority sites for seabird protection measures, enhance the skills of staff to implement invasive species control programs, increased community awareness of biodiversity issues (Pierce *et al.* 2007).

To address concerns over non-sustainable fishing of bonefish in the lagoon the Government has proposed the introduction of Regulations that prohibit the catching and possession of bonefish in Kiritimati (Preston 2008, Campbell and Hanich 2014).

U. Current recreation and tourism:

In addition to catering for the recreation needs of the local community, Kiritimati Island has well recognised potential for international eco-tourism. Tourism amounts to 20% of national GDP and Kiritimati is a significant beneficiary (MCTTD 2009). The Kiribati National Tourism Action Plan 2009-14 calls for the following key infrastructure developments on Kiritimati: upgrading of Cassidy International Airport and terminal facility, Cruise Shipping Port of entry and a tourism master plan precinct in London. It identifies the importance of the private sector and suggests establishment of several business in Kiritimati that could be of "national significance" including new fishing lodges, an International Standard Game Fishing business and new commercial flights within the Line Islands (linking with Tabuaeran and Teeraina) and internationally (Nadi-Kiritimati-Honolulu, US west coast- Kiritimati-Kanton).

Recreational fishing in Kiritimati has an estimated value of $ 2.5 million (Preston 2008, in Gillett 2009). The number of recreational fishers was estimated at 800 per year. Fees from "catch and release" licences for recreational fishing in the lagoons on Kiritimati raised $27 966 in 2007 (Gillett 2009).

V. Existing scientific research:

Much of the scientific research work on Kiritimati is conducted opportunistically by visiting researchers. This reflects the international interest in the global importance of the coral reefs and the seabird nesting colonies and the limited funding available from within Kiribati for research.

The Kiribati Meteorological Service has an observatory on Kiritimati and is involved in projects on sea level rise and sea water temperature.

Historically, seabirds have been a focus of visiting researchers. In the last 20 years increased attention has been given to the marine environment and to inland lagoons.

W. Management plans and monitoring programs:

The Wildlife Conservation Unit has developed a number of focused plans and monitoring activities as part of the CEPF project (Pierce *et al.* 2007) including:

- Rat Management Plan for Kiritimati
- Operational Plan for the control of feral cats on Kiritimati (Brown and Pierce 2012)
- Biosecurity Plan for Kiritimati
- Monitoring program for Kiritimati Reed-Warbler.

X. Current communication and public education programs:

The Wildlife Conservation Unit is involved in conducting a range of community awareness programs.

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Z. Compilers:

Original compilers (for 1993 edition): Aobure Teataata and K. Teeb'aki.
Updated by: Doug Watkins and Kiritian Batoromaio, June 2014.

3.8 Malden Island

A. Overview:

A dry, low-lying coral island with sparse scrub and a shallow, enclosed lagoon connected to the sea by underground fissures. Malden Island supports significant populations of several species of seabirds and has been a closed Wildlife Sanctuary since 1975.

B. Area and boundary:

Area: 4 100 ha (polygon area using Google Earth Pro).
Boundary: The complete island and fringing reef to 6 m at low tide.

C. Location:

Coordinates: 4°03' S, 155°01' W
Location: In the central Line Islands, 710 km south-south-east of Kiritimati Island.
State: Line Islands.

D. Site map: See below.

Maiden Island, Line Islands, Kiribati (Image from Google Earth)

E. Ramsar Wetland Types:

A Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.
E Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.
J Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.
C Coral reefs.

F. Geomorphic setting:

Elevation: -6 m at low tide to 8 m at the beach crest.

Geology: The Line Islands are located on the central Pacific Plate. They initially developed as volcanoes that rose from the ocean floor between 150-80 million years ago (Thiede *et al.* 1993). By the late Cretaceous (80-65 million years ago) reefs flourished in the central and southern Line Islands (Schlanger *et al.* 1984).

By 70-80 million years ago coral reefs flourished (Schlanger *et al.* 1984) and carbonate banks were established around and on top of the eroded volcanoes (Valencia 1977) as evidenced from reefal and shallow-water skeletal debris in sedimentary rocks of this age (Schlanger *et al.* 1984). Volcanic activity may have occurred in the region as late at 40 million years ago (Schlanger *et al.* 1984).

While geological process provided the volcanic basements for the islands, what is seen today on the islands and reef shelf has been primarily due to the growth of coral reefs and these have been greatly influenced by sea level changes and climate (Valencia 1977). At the time the Line Islands formed, the Last Glacial Period had resulted in the sea level being approximately 120 m below the present level (Lewis *et al.* 2013). By 20 000 years ago the glacial period turned and there was a rapid melt of the glaciers between 16 000 – 12 500 years ago (Lambeck *et al.* 2002). In Tahiti, the period of the rapid increase in sea levels has been documented as shortly before 13 800 year ago (Bard *et al.* 1996). It is during the periods of stability in sea levels that the reef shelfs around the islands on Kiribati were formed.

Geomorphology: 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 fringing reef is about 100 m wide and extends 300-400 m at its north-western and south-eastern points. The shoreline-fringing reef profile for Malden is as follows; a steep rubble or sand shore, a sub-tidal reef platform of 20-60 m wide, wave zone at 0-5 m, reef flat from 509 m, reef crest at 7-12 m and the reef slope from 12-60+ m (Kerr and Wragg 2009).

G. Biogeographical region: Line Islands Marine Ecoregion (Spalding *et al.* 2007).

H. Climate:

Malden has an arid island, with a mean annual rainfall of 726 mm. Annual rainfall is very variable, ranging from as little as 100 mm to 2 400 mm. The highest rainfall months are April and May (Weatherbase 2014c). The mean annual temperature is 28°C (Weatherbase 2014c). The prevailing winds are easterly trades, and severe storms are rare.

I. Soil:

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.

J. Water regime:

There is no standing fresh water on the island, but there may be a freshwater lens. The maximum tidal range is estimated at 0.9 m given its mid position between Caroline and Kiritimati Islands.

K. Water chemistry: No information available.

L. Biota:

The water to 6 m at low tide covers the reef platform, wave zone and part of the reef flat. Surveys of the lee shore in 2008 found <10% live coal in the wave zone and 20%-40% live coral on the reef flat (Kerr and Wragg 2009).

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 *Onychoprion fuscatus*. 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).

Malden Island has been a very important nesting site for seabirds. During the 1970's nineteen species were recorded nesting. The collated maximum counts from the late 1960s to late 1970's (Perry 1980) are: Red-tailed Tropicbirds *Phaethon rubricauda* 40, Masked Booby *Sula dactylatra* 3 000, Brown Booby *Sula leucogaster* 2 000, Red-footed Booby (*Sula sula*) 5 000, Great Frigatebird (Fregata minor) 3 000, Lesser Frigatebird (*Fregata ariel*) 7 000, Sooty Tern (*Onychoprion fuscatus*) 10 000, Grey-backed Terns (*Onychoprion lunatus*) 2,500, Blue Noddy (*Procelsterna cerulea*) 200, Brown Noddy (*Anous stolidus*) 500 and White Tern (*Gygis alba*) 50. The island supports some of the largest concentrations of Lesser Frigatebirds (*Fregata ariel*), Grey-backed Terns (*Onychoprion lunatus*) and potentially Masked (*Sula dactylatra*) and Brown Boobies (*Sula leucogaster*) in the Line Islands. Tidal mudflats bordering the lagoon are frequented seasonally by Pacific Golden Plovers (*Pluvialis fulva*), the Endangered Bristle-thighed Curlews (*Numenius tahitiensis*) and Wandering Tattlers (*Heteroscelus incanus*).

The current status of feral cats (*Felis catus*), House Mice (*Mus musculus*), and potentially Polynesian Rat (*Rattus exulans*), is not known.

Small numbers of Green Turtles (*Chelonia mydas*) nest on the beaches. During a three day visit to the island, Kerr and Wragg (2009) recorded 2 Green Turtles and 4 unidentified turtles during marine surveys and 50-100 turtle tracks on the western shore of the island.

Two species of lizard, the Mourning Gecko (*Lepidodactylus lugubris*) and Snake-eyed Skink (*Cryptoblepharus boutonii*) have been recorded. Invertebrates include hermit crabs (*Coenobita* spp.) and a brown libellulid dragonfly (Garnett 1983).

M. Land use:

Early Polynesian habitation is evidenced by a number of stone structures on the north and west edges of the island. These were investigated in 1924 as part of the Kaimiloa Expedition and 21 archaeological sites documented (Emory 1934). Emory concluded that the formal inhabitants had close cultural relationships with the early Polynesians of Raivave, Austral Islands (French Polynesia) (McKean 1936).

In 1864 extraction of guano commenced on the island (The Argus 1866). The original guano reserves have been estimated at 360 000 tons making it the largest deposit in the Line and Phoenix Islands (Beck 1955). The island was occupied by up to 180 people during the Guano quarrying (Dominion 1908). The guano export occurred until 1927 (Beck 1955).

Between 1956 and 1959 British servicemen were stationed on the island to monitor the Kiritimati Island atmospheric nuclear bomb test programme. In May-June 1957, three thermonuclear tests were conducted by the British Government over Malden Island. These explosion were detonated at a height of 2.2 - 2.4 km above the island (Andryushi *et al.* 2014). An airstrip was constructed in the north-west edge of the island in 1958 and was in regular use until July 1979. Since then, the island has been uninhabited.

Malden Island was designated as a Closed Wildlife Sanctuary in 1975.

N. Pressures and trends:

Extensive exploitation of guano and phosphate deposits between 1864 and 1927 resulted in the disappearance of the Phoenix Petrel (*Pterodroma alba*), at least two other procellarids and the Red-tailed Tropicbird (*Phaethon rubricauda*) as nesting species, although the tropicbird has since returned (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 nesting species and disappearance of many of the nesting White Terns (Perry 1980).

Cats (*Felis catus*), pigs (*Sus scrofa*), goats (*Capra aegagrus*) and House Mice (*Mus musculus*) were introduced during the phosphate quarrying period. 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).

Fires are a potential hazard; a fire in 1977 threatened nesting seabirds (Perry, 1980).

Malden Island is occasionally visited by passing yachtsmen and fishermen.

O. Land tenure and administrative authority:

Land tenure: National Government owned (Government of the Republic of Kiribati).

P. Ramsar listed? No.

Q. Ramsar Criteria met:

Criterion 1. Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Criterion 2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

R. Justification for Ramsar Criteria met:

Criterion 1. Malden Island is a representative example of a small coral island with saline lagoons and significant nesting colonies of seabirds in the Line Islands Marine Ecoregion.
Criterion 2. The site supports small numbers of non-breeding Endangered Bristle-thighed Curlew (*Numenius tahitiensis*) and may regularly support the nesting of the Vulnerable Green Turtle (*Chelonia mydas*).

S. Conservation and management status of the wetland:

Malden Island was gazetted as a Closed Wildlife Sanctuary in May 1975 under the 1975 Wildlife Conservation Ordinance. Practical enforcement of the regulations is difficult as the staff are based on Kiritimati Island, some 700 km away. 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.

U. Current recreation and tourism: None.

V. Existing scientific research:

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. Staff of the Wildlife Conservation Unit visit the island almost annually. No detailed research has, however, been undertaken, and there are no research facilities on the island.

In the late 1980's some research was conducted as part of a Pacific Expeditions Ltd voyage to the Southern Line Islands (Kerr and Wragg 2009).

W. Management plans and monitoring programs: None.

X. Current communication and public education programs: None.

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Z. Compilers:

Original compilers (for 1993 edition): Aobure Teataata and K. Teeb’aki.
Updated by: Doug Watkins and Kiritian Batoromaio, June 2014.

3.9 Starbuck Island

A. Overview:

A small coral island with several saline lagoons that supports a very large nesting colony of Sooty Terns and nesting populations of at least four other seabirds. The island is a closed Wildlife Sanctuary.

B. Area and boundary:

Area: 3 050 ha (polygon area using Google Earth Pro).
Boundary: The complete island and fringing reef to 6 m at low tide.

C. Location:

Coordinates: 5°37' S, 155°56' W
Location: In the central Line Islands, 860 km south-south-east of Kiritimati Island. The island is 200 km north-east of Vostok Island.
States: Line Islands.

D. Site maps: See below

Starbuck Island, Line Islands, Kiribati (Image from Google Earth)

E. Ramsar Wetland Types:

- A Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.
- E Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.
- R Seasonal/intermittent saline/brackish/alkaline lakes and flats.
- C Coral reefs.

F. Geomorphic setting:

Elevation: -6 m at low tide to 8 m on a steep bank behind the reef.

Geology: The Line Islands are located on the central Pacific Plate. They initially developed as volcanoes that rose from the ocean floor between 150-80 million years ago (Thiede *et al.* 1993). By the late Cretaceous (80-65 million years ago) reefs flourished in the central and southern Line Islands (Schlanger *et al.* 1984).

By 70-80 million years ago coral reefs flourished (Schlanger *et al.* 1984) and carbonate banks were established around and on top of the eroded volcanoes (Valencia 1977) as evidenced from reefal and shallow-water skeletal debris in sedimentary rocks of this age (Schlanger *et al.* 1984). Volcanic activity may have occurred in the region as late at 40 million years ago (Schlanger *et al.* 1984).

While geological process provided the volcanic basements for the islands, what is seen today on the islands and reef shelf has been primarily due to the growth of coral reefs and these have been greatly influenced by sea level changes and climate (Valencia 1977). At the time the Line Islands formed, the Last Glacial Period had resulted in the sea level being approximately 120 m below the present level (Lewis *et al.* 2013). By 20 000 years ago the glacial period turned and there was a rapid melt of the glaciers between 16 000 – 12 500 years ago (Lambeck *et al.* 2002). In Tahiti, the period of the rapid increase in sea levels has been documented as shortly before 13 800 year ago (Bard *et al.* 1996). It is during the periods of stability in sea levels that the reef shelfs around the islands on Kiribati were formed.

Starbuck is a low coral limestone island with fringing and offshore reefs. 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.

G. Biogeographical region: Line Islands Marine Ecoregion (Spalding *et al.* 2007).

H. Climate:

Starbuck is one of the drier Line Islands with an inferred mean annual rainfall of about 800 mm. The prevailing winds are easterly trades.

I. Soil:

Soils appear to be mainly coral sand interspersed among larger areas of coral rag and broken reef rock (IUCN 1991).

J. Water regime:

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 fresh ground water lens may form.

K. Water chemistry: No information available.

L. Biota:

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).

Starbuck Island is a very important nesting site for seabirds. In the 1960's and 1970's fifteen species were recorded around the island, and as many as 11 species nesting (Perry 1980). The island is particularly important for its large colony of Sooty Terns (*Onychoprion fuscatus*), which at times has been estimated at about 3 million birds (Gould 1974). Polynesian Rats (*Rattus exulans*) occur on the island, and Green Turtles (*Chelonia mydas*) have been recorded, although it is not known if they nest.

Starbuck Island

April 2006 "Image courtesy of the Earth Science and Remote Sensing Unit, NASA Johnson Space Center"

M. Land use:

From 1870 until 1930 guano was shipped from Starbuck Island. The original phosphate deposit on the island has been estimated at 45 000 ton (Beck 1955). The foundation of building can still be seen on the north-west of the island. The island has seldom been visited in recent years, and there is no safe anchorage.

N. Pressures and trends:

Feral cats are present on the island and these have probably caused a decline in the numbers of nesting tern, noddy and ground-nesting booby (Garnett 1983).

O. Land tenure and administrative authority:

Land tenure: national Government owned.

P. Ramsar listed? No.

Q. Ramsar Criteria met:

Criterion 1. Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Criterion 2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
Criterion 4. Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
Criterion 5. Regularly supports 20 000 or more waterbirds.
Criterion 6. Regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

R. Justification for Ramsar Criteria met:

Criterion 1. Starbuck Island is a representative example of a small coral island with saline lagoons and a large nesting colony of Sooty Tern (*Onychoprion fuscatus*) in the Line Islands Marine Ecoregion.
Criterion 2. The site may regularly support the nesting of the Vulnerable Green Turtle (*Chelonia mydas*).
Criterion 4. The site has been recorded supporting over 100 000 Sooty Tern (*Onychoprion fuscatus*).
Criterion 5. The site has been recorded support over 20 000 terns and noddy.
Criterion 6. Internationally important numbers have been recorded for Sooty Terns (*Onychoprion fuscatus*).

Starbuck Island

Credit: Angela Keppler. https://commons.wikimedia.org/wiki/File:Starbuck_AKK_Wall.jpg

Starbuck Island

Credit: Angela Keppler. The bare interior of Starbuck Island, Line Islands, Kiribati.
https://commons.wikimedia.org/wiki/File:Starbuck_Island_Interior.jpg

S. Conservation and management status of the wetland:

Starbuck Island was declared a closed Wildlife Sanctuary in 1975. The elimination of feral cats would considerably enhance the nature conservation value of the island (Garnett 1983).

U. Current recreation and tourism:

Nil. As a closed Wildlife Sanctuary all visitors to the island require a permit to land on the island.

V. Existing scientific research:

The Line Islands Expedition visited Starbuck in 1974.

Starbuck Island – north west end

https://en.wikipedia.org/wiki/Starbuck_Island

W. Management plans and monitoring programs: None.

X. Current communication and public education programs: None.

Y. References cited:

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Valencia MJ. 1977. Christmas Island (Pacific Ocean): Reconnaissance geologic observations. Atoll Res. Bull. 197:1–17.

Z. Compilers:

Original compilers (for 1993 edition): Aobure Teataata and K. Teeb'aki.
Updated by: Doug Watkins and Kiritian Batoromaio, June 2014.

3.10 Vostok Island

A. Overview:

Vostok is a small, triangular-shaped sand and coral island with a fringing reef. There is no standing fresh water on the island and no evidence of a fresh ground water lens. The interior of the island is a *Pisonia grandis* forest, up to 30 m. These are growing in moist peat soils up to one metre thick over phosphoric hardpan. 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.

Vostok Island Credit: Angela K Kepler (en.wikipedia.org/wiki/Vostok_Island#mediaviewer/File:Vostok_Island_AKK.jpg)

B. Area and boundary:

Area: 43.1 ha (polygon area using Google Earth Pro).
Boundary: The complete island and fringing reef to 6 m at low tide.

C. Location:

Coordinates: 10°06' S, 152°23' W
Location: In the southern Line Islands, 1 450 km south-south-east of Kiritimati Island. The island is 625 km south-south-east of Starbuck Island and 230 km west-north-west of Caroline Island.
State: Line Islands.

D. Site map: See below.

E. Ramsar Wetland Types:

A Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.
C Coral reefs.
E Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.

Vostok Island, Line Islands, Kiribati (Image from Google Earth)

F. Geomorphic setting:

Elevation: -6 m at low tide to 5 m.

Geology: The Line Islands are located on the central Pacific Plate. They initially developed as volcanoes that rose from the ocean floor between 150-80 million years ago (Thiede *et al.* 1993). By the late Cretaceous (80-65 million years ago) reefs flourished in the central and southern Line Islands (Schlanger *et al.* 1984).

By 70-80 million years ago coral reefs flourished (Schlanger *et al.* 1984) and carbonate banks were established around and on top of the eroded volcanoes (Valencia 1977) as

evidenced from reefal and shallow-water skeletal debris in sedimentary rocks of this age (Schlanger *et al.* 1984). Volcanic activity may have occurred in the region as late at 40 million years ago (Schlanger *et al.* 1984).

While geological process provided the volcanic basements for the islands, what is seen today on the islands and reef shelf has been primarily due to the growth of coral reefs and these have been greatly influenced by sea level changes and climate (Valencia 1977). At the time the Line Islands formed, the Last Glacial Period had resulted in the sea level being approximately 120 m below the present level (Lewis *et al.* 2013). By 20 000 years ago the glacial period turned and there was a rapid melt of the glaciers between 16 000 – 12 500 years ago (Lambeck *et al.* 2002). In Tahiti, the period of the rapid increase in sea levels has been documented as shortly before 13 800 year ago (Bard *et al.* 1996). It is during the periods of stability in sea levels that the reef shelfs around the islands on Kiribati were formed.

Vostok Island has a fringing reef shelf that extends out several hundred meters at each corner of the island (Clapp and Sibley 1971). The south and west beaches are up to 45 m wide while the east beach ranges from 23-30 m (Clapp and Sibley 1971). Storm waves are anticipated to push water into the forest area (Clapp and Sibley 1971).

G. Biogeographical region: Tuamotus Marine Ecoregion (Spalding *et al.* 2007).

H. Climate:

Vostok Island has a tropical Oceania climate. Based on information from Caroline Island (Kepler and Kepler 1994), it can be anticipated that the annual maximum temperature is 30°C. The annual rainfall is anticipated to be approximately 1 500 mm but will vary considerably from year to year. The dominate winds are from the east, north-east and south-east.

I. Soil:

Most of the island is vegetated by *Pisonia* forest and this has formed a 35 cm thick humus on top of a phosphoric hardpan (Clapp and Sibley 1971).

J. Water regime: No information available

K. Water chemistry: No information available.

L. Biota:

The vegetation has low species diversity. The central portion of the island (about 10-15 ha) is occupied by *Pisonia grandis* forest and 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 and Sibley, 1971). Elsewhere, there are open areas of sand, and sand with coral rubble.

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 (Clapp and Sibley, 1971).

Vostok Island is a very important nesting site for seabirds, especially five tree-nesting species, the Red-footed Booby (*Sula sula*), Great Frigatebird (*Fregata minor*), Lesser Frigatebird (*Fregata ariel*), Black Noddy (*Anous minutus*) 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 dactylatra*), Brown Booby (*Sula leucogaster*) and Brown Noddy (*Anous stolidus*).

Only one comprehensive count of seabirds is available (Clapp and Sibley 1971); Masked Booby (*Sula dactylatra*) 475, Brown Booby (*Sula leucogaster*) 25, Red-footed Booby (*Sula sula*) 3 000 and Great Frigatebird (*Fregata minor*) 4 500, Lesser Frigatebird (*Fregata ariel*) 500, Sooty Tern (*Onychoprion fuscatus*) 40, Brown Noddy (*Anous stolidus*) 500, Black Noddy (*Anous minutes*) 3 000 and White Tern (*Gygis alba*) 1 250. During a two day visit in June 1965, six Masked Booby (*Sula dactylatra*) banded on Jarvis, Enderbury, Birnie and Rawaki Islands were recovered and two banded on Vostok Island were subsequently recovered on Rawaki and Enderbury Islands (Clapp and Sibley, 1971).

Vostok Island: wind-shorn *Pisonia* Credit: Angela K. Kepler
(en.wikipedia.org/wiki/Vostok_Island#mediaviewer/File:Vostok_AKK_wind-shorn_Pisonia.jpg)

Several migratory shorebirds from the northern hemisphere have been recorded including the Pacific Golden Plover (*Pluvialis fulva*), the Endangered Bristle-thighed Curlew (*Numenius tahitiensis*) and Wandering Tattler (*Heteroscelus incanus*) (Clapp and Sibley, 1971). The only mammal known to occur on Vostok is the Polynesian Rat (*Rattus exulans*), which is abundant. 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 (Clapp and Sibley 1971).

M. Land use:

While the island was bonded under the 1856 American Guano Act in 1860, and a British claim was made in 1873, there is no record of any mining of phosphate deposits. 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, however no commercial use was made.

N. Pressures and trends:

Vostok Island is the least disturbed of the Line Islands, and the only island in this group not affected by introduction of alien mammals. 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 nesting seabirds. Yachts occasionally cruise past the island and anchor offshore, but the level and types of disturbance which these visits cause are unknown.

O. Land tenure and administrative authority:

Land tenure: Government of the Republic of Kiribati.

P. Ramsar listed? No

Q. Ramsar Criteria met:

Criterion 1. Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Criterion 2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
Criterion 6. Regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

R. Justification for Ramsar Criteria met:

Criterion 1. Vostok Island is a unique example of a small coral island forested in *Pisonia grandis* forest and growing on a moist peat soil in the Northern Tuamotus Marine Ecoregion.
Criterion 2. Supports small numbers of the non-breeding Endangered Bristle-thighed Curlew (*Numenius tahitiensis*) and may regularly support the nesting of the Vulnerable Green Turtle (*Chelonia mydas*).
Criterion 6. Internationally important numbers have been recorded for Black Noddy (*Anous minutus*) and White Tern (*Gygis alba*).

S. Conservation and management status of the wetland:

Since 1979 all animals on Vostok Island have been protected under Schedule 2 of the Wildlife Conservation Ordinance (Chapter 100). The island is also protected by its remoteness and inhospitable nature. 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).

U. Current recreation and tourism: None.

V. Existing scientific research:

Scientific visits to the island include; 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.

W. Management plans and monitoring programs: None.

X. Current communication and public education programs: None.

Y. References cited:

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Z. Compilers:

Original compilers (for 1993 edition): Aobure Teataata and K. Teeb'aki.
Updated by: Doug Watkins and Kiritian Batoromaio, June 2014.

3.11 Caroline Atoll

A. Overview:

Caroline Atoll combines features of physical and biological interest with natural scenic beauty. The atoll harbours impressive nesting populations of seabirds, while its pristine lagoon supports a rich and varied marine life.

B. Area and boundary:

Area: 2 670 ha (polygon area using Google Earth Pro), land area 399 ha (Kepler and Kepler 1994).
Boundary: The complete island and fringing reef to 6 m at low tide.

C. Location:

Coordinates: 10°00' S, 150°14' W
Location: In the south-eastern Line Islands, 1 540 km south-east of Kiritimati Island and 230 km east-south-east of Vostok Island.
State: Line Islands.

D. Site map: See below.

E. Ramsar Wetland Types:

A Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.
C Coral reefs.
E Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.
G Intertidal mud, sand or salt flats.
J Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.

F. Geomorphic setting:

Elevation: -6 m at low tide to 3 m (Barott *et al.* 2010).

Geology: The Line Islands are located on the central Pacific Plate. They initially developed as volcanoes that rose from the ocean floor between 150-80 million years ago (Thiede *et al.* 1993). By 70-80 million years ago coral reefs flourished (Schlanger *et al.* 1984) and carbonate banks were established around and on top of the eroded volcanoes (Valencia 1977) as evidenced from reefal and shallow-water skeletal debris in sedimentary rocks of this age (Schlanger *et al.* 1984). Volcanic activity may have occurred in the region as late at 40 million years ago (Schlanger *et al.* 1984).

Vostok Island, Line Islands, Kiribati (Image from Google Earth)

While geological process provided the volcanic basements for the islands, what is seen today on an around the islands has been primarily due to the growth of coral reefs and these have been greatly influenced by sea level changes and climate (Valencia 1977). At the time the Line Islands formed, the last glacial period had resulted in the sea level being approximately 120 m below the present level (Lewis *et al.* 2013). By 20 000 years ago the glacial period turned and there was a rapid melt of the glaciers between 16 000 – 12 500 years ago (Lambeck *et al.* 2002). In Tahiti, the period of the rapid increase in sea levels has been documented as shortly before 13 800 year ago (Bard *et al.* 1996). It is during the periods of stability in sea levels that the current reef shelfs around the islands on Kiribati were formed.

Caroline Island consists of a reef of approximately 2 500 ha with 39 separate islets surrounding a shallow lagoon. The atoll is approximately 12.5 km by 2.5 km. The lagoon has an average depth from 8.8 m to 13.7 m and a maximum depth of 33 m (Barott *et al.* 2010). The three largest islets are Nake (104 ha), Long (76 ha) and South (107 ha). The seaward fringing reefs average 562 m, with a range of 396 – 759 m (Kepler and Kepler 1994).

G. Biogeographical region: Tuamotus Marine Ecoregion (Spalding *et al.* 2007).

H. Climate:

Caroline Island has a tropical Oceania climate. The annual maximum temperature is 30°C with a range of 25°C to 31°C (Kepler and Kepler 1994). The annual rainfall is approximately 1 500 mm but can be anticipate to vary considerably from year to year (Kepler and Kepler 1994). The dominate winds are from the east, north-east and south-east (Kepler and Kepler 1994). The island is subject to tropical cyclones and the associated storm surges may be several meters in height (Kepler and Kepler1994).

I. Soil:

Kepler and Kepler (1994) describe the soils as of "coral and molluscan origin". More generally, Reese (1987) defines atoll soils as being of five types: "*accumulations of coral rubble, mainly of stone size; unaltered coral sand and gravel; soils with a weakly developed A horizon with the color only slightly darker than the unaltered sand below but with no evidence of structural development; soils with a more developed A horizon that is deeper and darker in color with some structural development and soils with an accumulation of raw humus on the surface and with a relatively deep A horizon".* Caroline Island has examples of each of these five soil types (Kepler and Kepler 1994)

J. Water regime:

There is no standing fresh water on the atoll. Fresh ground water 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 (Garnett 1983).

Maximum tidal variation is anticipated to be less than 0.5 m (NOAA 2014).

K. Water chemistry: No available information.

L. Biota:

Barott *et al.* (2010) describe the lagoon as having three major habitat types: the perimeter reefs and associated back reefs surround each of the islets; the interior of the lagoon with its small patch and line reefs; and the lagoon floor. Within the lagoon, 32 species of coral have been recorded with two species of *Acropora* dominating (approx. 90% by area and number of colonies), followed by *Montipora*, *Fungia*, *Pavona* and *Leptastrea* (Barott *et al.* 2010). The fringing seaward reefs consist of coal rubble and sand and occasionally colonised by cyanobacterial mats (*Schizothrix*) (Barott *et al.* 2010). The Small Giant Clams (*Tridacna maxima)*, while not uniform in distribution, were found to be abundant on the high flow line and patch reefs in 10 m water (Barott *et al.* 2010).

Surveys conducted in the lagoon by Barott *et al.* (2010) recorded 89 fish species representing 30 families. The most representative families were the wrasses (*Labridae*, 12 species) followed by the surgonfishes (*Acanthuridae*, 10 species), butterflyfishes (*Chaetodontidae*, 9 species), dameselfishes (*Pomacentridae*, 7 species), and parrotfishes (*Scaridae*, 6 species) (Barott *et al.* 2010). The lagoons appear to provide important habitats for juvenile fishes (Barott *et al.* 2010). The IUCN endangered listed Napoleon wrasse (*Cheilinus undulatus*) occur in the patch reefs in the lagoon (Barott *et al.* 2010).

On the outer reefs, 207 species have been recorded along the 10 m isobath (Barott *et al.* 2010).

The island supports 26 species of plants and these have been described across seven plant communities (Kepler and Kepler 1994): Natural Herb Mat; Beach Scrub with *Suriana*; *Pandanas* Forest; *Argusia* Scrub and Forest; *Cordia* Forest; *Pisonia* Forest and Coconut Woodlands. The main plant formations are forests of *Pisonia grandis* and *Calophyllum* sp., forest/scrub dominated by the Beach Heliotrope *Argusia argentea*, *Suriana* scrub, and dwarf scrub with *Morinda citnfolia* and *Argusia* sp. There are undisturbed stands of *Pisonia* forest on many of the islets, and these provide habitat for a large proportion of the nesting seabirds. The vegetation is in near-pristine condition or has re-established from disturbance over 100 years ago (Kepler and Kepler 1994).

Caroline Island is a very important atoll for seabirds, with eleven nesting species (Kepler and Kepler 1994) including Masked Booby (*Sula dactylatra*), Brown Booby (*Sula leucogaster*), Red-footed Booby (*Sula sula*), Great Frigatebird (*Fregata minor*), Lesser Frigatebird (*Fregata ariel*), Sooty Tern (*Onychoprion fuscatus*), Brown Noddy (*Anous stolidus*), Black Noddy (*Anous minutus*) and White Tern (*Gygis alba*). Between 1965 and 1990, 21 colonies of Sooty Tern were recorded nesting on 20 islets (Kepler *et al.*1994). Over 900 000 Sooty Terns (*Onychoprion fuscatus*), were estimated to be using the island in September 1988 (Kepler *et al.*1994). Estimates of the numbers of other species include (Kepler *et al.*1994):

White Tern (*Gygis alba*)	8 000
Red-footed Booby (*Sula sula*)	7 000
Black Noddy (*Anous minutus*)	7 000
Great Frigatebird (*Fregata minor*)	5 471
Grey-backed Tern (*Onychoprion lunatus)*	3 000
Lesser Frigatebird (*Fregata ariel*)	1 000

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*), the Endangered Bristle-thighed Curlew (*Numenius tahitiensis*) and Wandering Tattler (*Heteroscelus incanus*), are non-breeding visitors. In September 1988 the number of Bristle-thighed Curlew (*Numenius tahitiensis*) on the island was estimated to be 300 (Kepler and Kepler 1994).

Green Turtles (*Chelonia mydas*) occur in the lagoon and nest on the beaches.

M. Land use:

An intact Tuamotuan marae (ancient religious site) shows that the island was used by Polynesians (Kepler and Kepler 1994). In 1864 a small European settlement was established briefly, followed by a small stock-raising and copra operation from 1846 to the late 1930s. Between 1873 and 1895 it is estimated that 10 000 tons of guano was mined from the island (Clapp and Sibley 1971). In recent decades, the atoll has been uninhabited, although South Island, Long Islet and Nake Islet are visited by Polynesian copra gatherers under an agreement with the Government in Tarawa. While there were proposals in the 1990's for tourism developments these have not eventuated.

N. Pressures and trends:

A solid coconut plantation occupies the whole of South Island. 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.

Caroline Atoll is regularly visited by yachts, and these presumably cause some disturbance to wildlife.

O. Land tenure and administrative authority:

Land tenure: Government owned.

P. Ramsar listed? No.

Q. Ramsar Criteria met:

Criterion 1. Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Criterion 2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
Criterion 4. Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
Criterion 5. Regularly supports 20 000 or more waterbirds.
Criterion 6. Regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

R. Justification for Ramsar Criteria met:

Criterion 1. Caroline Island is a unique example of a ringed atoll lagoon in the Northern Tuamotus Marine Ecoregion.
Criterion 2. Supports modest numbers of non-breeding Endangered Bristle-thighed Curlew (*Numenius tahitiensis*). The Vulnerable Green Turtle (*Chelonia mydas*) regularly nests on the island and the Endangered Napoleon wrasse (*Cheilinus undulatus*) have been recorded on the reefs in the site.
Criterion 4. The site has been recorded supporting seabird nesting colonies totalling over 20 000 birds.
Criterion 5. The site has been recorded supporting over 20 000 terns and noddy.

Criterion 6. Internationally important numbers have been recorded for Black Noddy (*Anous minutus*), Sooty Terns (*Onychoprion fuscatus*) and White Tern (*Gygis alba*).

S. Conservation and management status of the wetland:

Since 1979 all animals on Caroline Island have been protected under Schedule 2 of the Wildlife Conservation Ordinance (Chapter 100). The social and cultural values of Caroline Atoll lie mainly in its conservation significance.

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.

U. Current recreation and tourism:

Limited to visiting cruising yachts.

V. Existing scientific research:

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.

W. Management plans and monitoring programs: None.

X. Current communication and public education programs: None.

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