Status report for Kiribati's coral reefs

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Taratau Kirata

Tooti Tekinaiti

Introduction

Spanning 4200 km of the Central Pacific Ocean, the Republic of Kiribati straddles the equator. The island groups are scattered over 3 550 000 km². of ocean on either side of the equator and the international date line. It is a country comprised entirely of coral reefs perched on submerged seamounts and is synonymous with the atoll environment, in which all coral reef forms exist. The I-Kiribati have an intimate relationship with the coral reefs whose treasured value reflects their dependence on its marine resources. All is derived from the reef and its islands, whether it be the proliferation of palms that provide food and shelter, the freshwater held within the islands or abundant seafood. The coral reef is a good provider.

Geography

The Republic of Kiribati is comprised of three island groups. The Gilbert Islands or Tungaru Group has 16 islands (171^0 E Long. to 177.16^0 E Long). Also included in this group is the outlier Banaba I. (169.5^0 E Long.; 0.5^0 S Lat.). The Phoenix Group has ten islands (174.83^0 W Long. to 170.16^0 E Long.), and the Line Islands has nine. The group is comprised of the Northern Line Islands (159.33^0 E Long. to 156.16^0 E Long.) and Southern Line Islands (155.83^0 E Long. to 150.83^0 E Long.). Three of the islands in the Line islands are US dependencies (Jarvis, Kingman and Palmyra) as are two islands (Baker and Howland Is.), north of the Phoenix Is. The Republic has the largest land area and marine jurisdiction in Micronesia.

The coral reef areas are characterized by atolls with islands around the rim. Banaba I. is an elevated limestone cap surrounded by a fringing reef. The islands of Makin, Tamana, Arorae, Enderbury, Flint and Vostok all lack lagoons but have fringing reefs. The many small islands comprise a total land area of 823 km². Kiritimati (Christmas) I. comprises half of the total having the largest landmass of any atoll. In the Gilbert Islands, the windward or eastern margins have a continuous reef with low islands of sand and rubble. Varying degrees of coral reef development occur on the western atoll margins. The atolls rise from deep water (4000-6000 m) with the angle of the outer slope (>20m depth) of 30^0-60^0.

An oceanic-equatorial climate has light east to south-east trade winds with a mean day air temperature of 32^0 and in the stormy season (November–February) is characterized by occasional westerlies. The sea temperature is 27^{0}C-30^{0}C. The prevailing currents are south equatorial, running east to west. Tarawa lies in the region of equatorial upwelling (UNEP/IUCN, 1988). Table 1 provides an outline of the coral reefs of Kiribati.

Marine Area (km^2)	Total No. Island Systems	Total Land Area	Total Population	No. of Recognizable Reef Systems				Tot. Lagoon And Reef Area (Km^2)	Tot. Reef Perim (km)
				Reef Communities or submerged Reefs	Fringing	Barrier Or Lagoon	Atoll		
3,550,000	33	823	77,658 (1995)	3	15	-	18	?	?

Table 1
Kiribati: Islands coral reefs and people.

The people and their marine resources

The population is concentrated in the Gilbert Group where 96% of the population resides. The people are heavily dependent on the marine fisheries for their livelihood due to the limited land based resources. The country's economy reflects this with the fees collected from foreign fishing vessels to fish in Kiribati waters accounting for more than half of the Government's annual revenue.

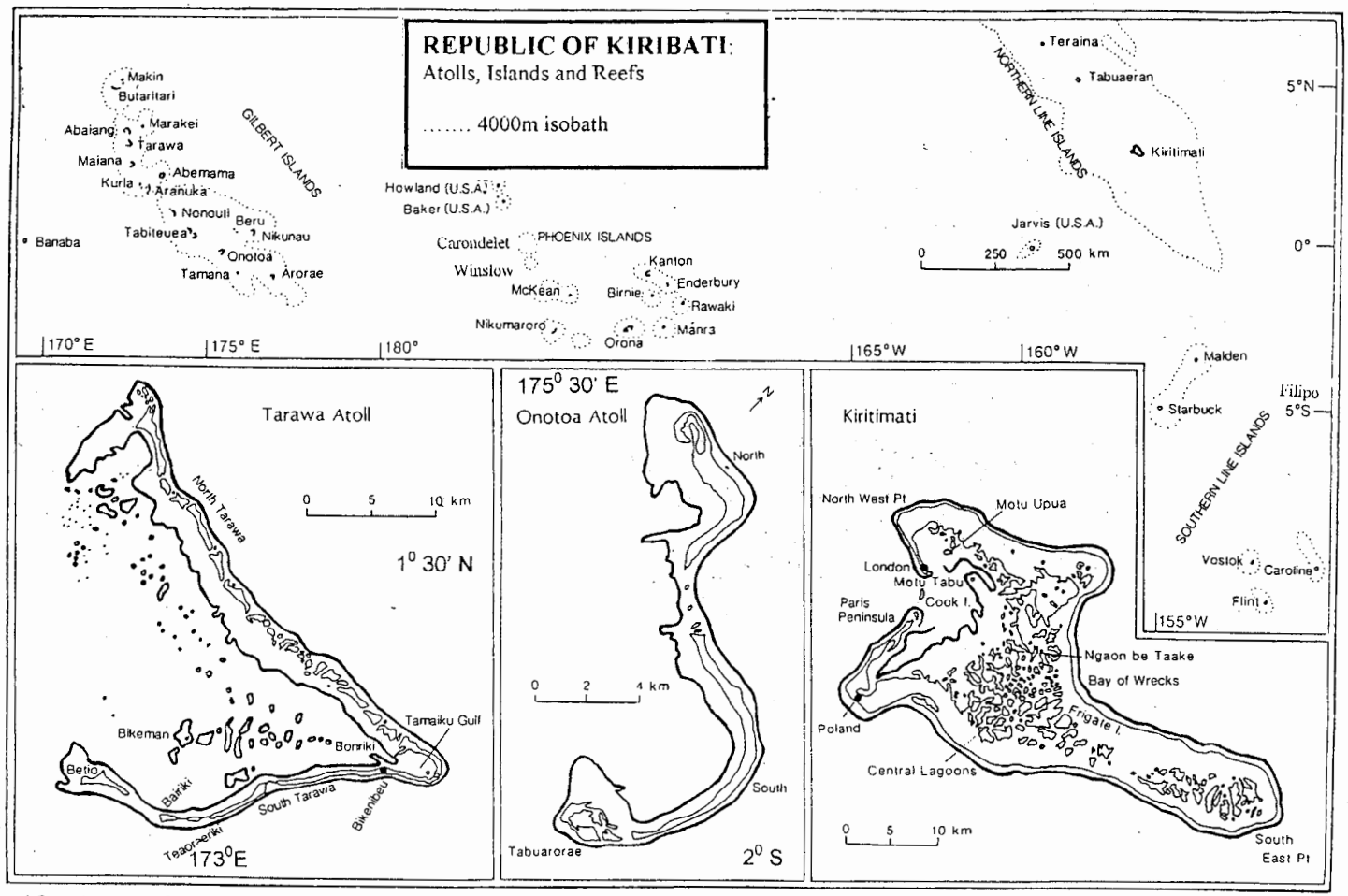
Generally, the economy is based on marine products and to a lesser extent on copra and other land-based resources like wooden handicraft (mostly coconut tree). Tourism is at its developing stages due to the fact that the country is isolated. This remote characteristic has been perceived by some as benefiting the country by virtue of little outside interference and impact on the marine environment. Nevertheless, Kiritimati (Christmas) Island in the Line and Phoenix group is now a very popular tourist destination where visitors outnumber the Tarawa visitors even though it is the capital (Kiritimati 1712 , Tarawa 1471 visitors in 1999). This is because of its isolation and natural attraction of an abundance of fish and birds, which were in amazingly high in numbers.

Most of the Kiribati Islands are dry and infertile, so the sea provides most of the protein in the diets of the I-Kiribati. Per capita fish consumption is among the highest in the world with whole fish consumption of 656 g/head/day on rural atolls and 320 g/head/day on urban South Tarawa. Reefs are very heavily fished, although on a subsistence basis, yields are 6-25 tonnes of finfish per km^2 per year. Many hundreds of taxa of marine organism are eaten, including algae, jellyfish, sipunculid worms, molluscs, crustaceans, echinoderms, and virtually all non-toxic species of fish over a few cm in length, turtles and cetaceans. Invertebrates and algae only comprise a small part of the diet on most islands. Bivalves (*Anadara maculata*, *Grafarium tumida* and *Asaphis violascens*) have become staples in the diet, with landing exceeding that of all finfish combined. On reef islands, flying fish and tuna are more important (Zann, 1985).

Research

The Atoll Research Program (formerly Atoll Research Unit) is supported by the University of the South Pacific and is located at Teaorareke, Tarawa. It and the Fisheries Division are the only active marine research facilities in Kiribati. Mariculture facilities have been developed on Tarawa (*Anadara:* Tebano 1987a,b; 1988) and other atolls (seaweed and black pearls: Sims *et al.*, 1990) with associated research efforts.

Research has been done on many of the atolls. Benthic surveys on Tarawa were conducted by Bolton (1982) and Zann (1982). Expeditions researching the natural history and geology of Tabuaeran



After UNEP/IUCN (1988)

Figure 1
Map of Kiribati.

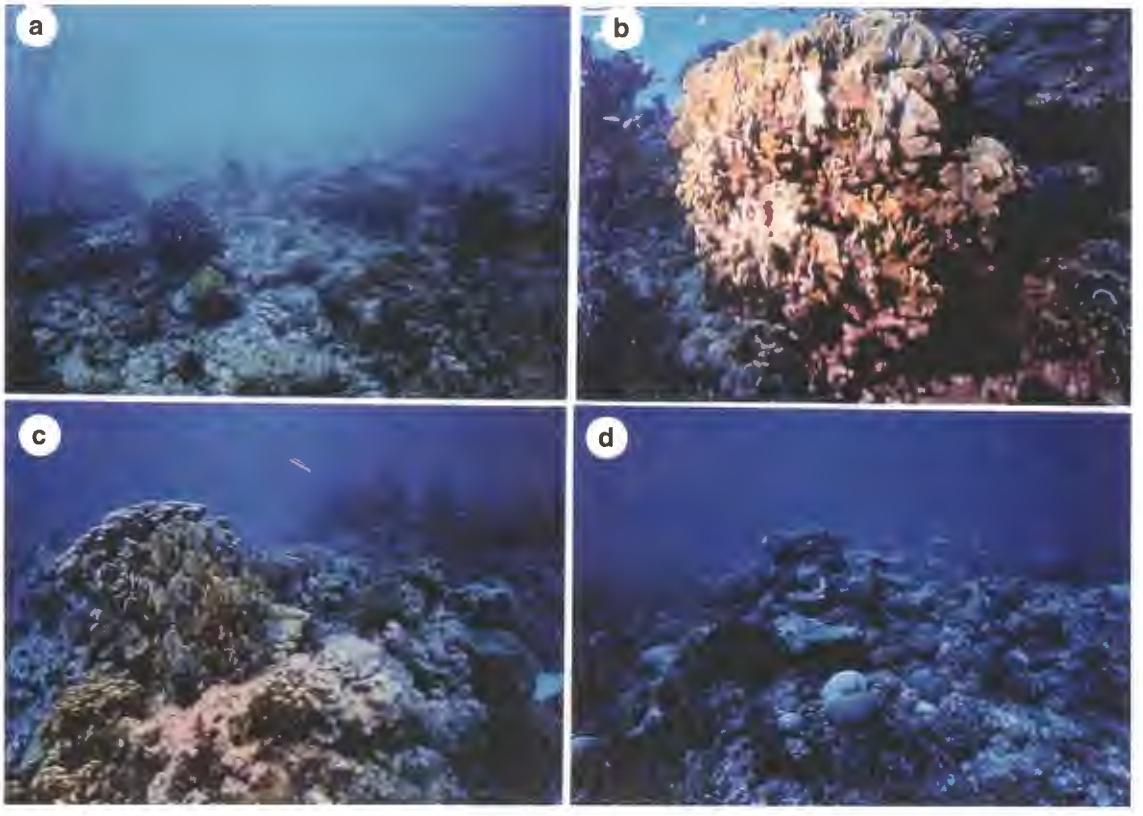


Figure 2/1
The coral reef environment of Tarawa, Gilbert Group.

Caption to Figure 2/1
a) Low coral and species richness characterizes the reef off Bikenibeu on the south coast of Tarawa Atoll.
b) Though rare or absent in many parts of the Pacific, *Heliopora coerulea* (Alcyonaria) or blue coral is abundant on Tarawa.
c) A colony of Heliopora coerulea on the north margin of the Tarawa Reef. This species, though absent in Fiji and to the southeast, occurs throughout the group. It is absent from the Phoenix and the Line Islands.
d) The windward reef off Taenia at 6m showing the ocean swell affected assemblage. Due large wave events, the area is periodically disturbed resulting in a relatively high diversity with small colony sizes. The rarity of *Heliopora coerulea* on the windward reefs is in contrast to the more protected seaward

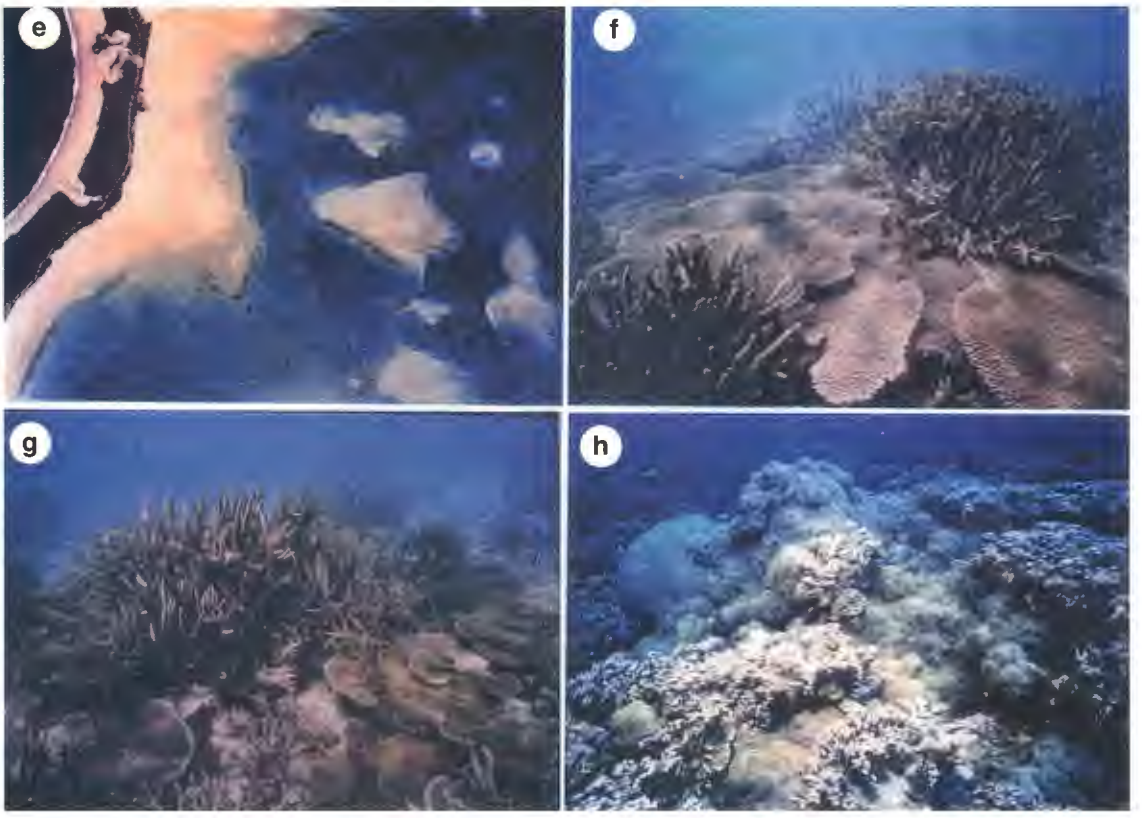


Figure 2/2
The coral reef environment of Tarawa, Gilbert Group.

Caption to Figure 2/2
e) An aerial view of western Tarawa atoll with the seaward margin (top left), showing the reef flats and the inshore reef patches of the western lagoon. (Schlencker Mapping Pty Ltd. 1998).
f) The most luxuriant *Acropora* assemblage is found in the western lagoon on patch reefs. Unlike the seaward exposed areas, this is the only area where the *Acropora* monopolize the reef area.
g) As above, the dominant species are *Acropora muricata* and *A. hyacinthus.* Though the water is relatively turbid, patch reefs flourish.
h) The mixed assemblage is dominated by extensive patches of corallimorpharians and Porites rus along the southern seaward reef slope of Tarawa near Ambo. The massive colony center left is *Plerogyra sinuosa.* Normally uncommon, these large colonies are present in abundance. Photo 18m depth.

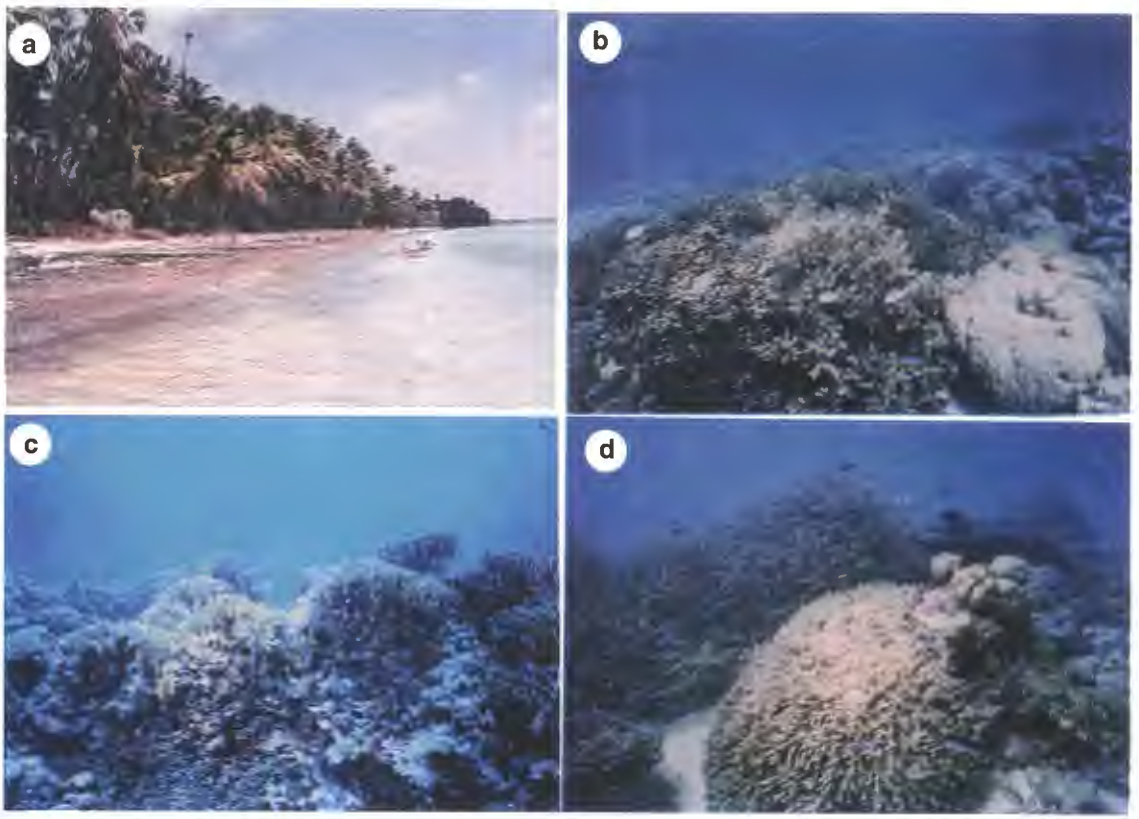


Figure 3/1
The coral reef environment of Abaiang , Gilbert Group.

Captions to Figure 3/1
a) A typical atoll island on Abaiang Atoll dominated by palms with a broad foreshore reef flat of low biodiversity.
b) Lagoon reef assemblage with the occasional stand of *Acropora* and massive *Porites sp.* and *Favid* sp., near Bolton Passage
c) A view of the western seaward reef of Abaiang shows *Heliopora coerulea* on the reef slope ridges. *Halimeda sp.* is in abundance (center bottom).
d) A large colony of *Porites cylindrica* on the southern margin of Abaiang Atoll.

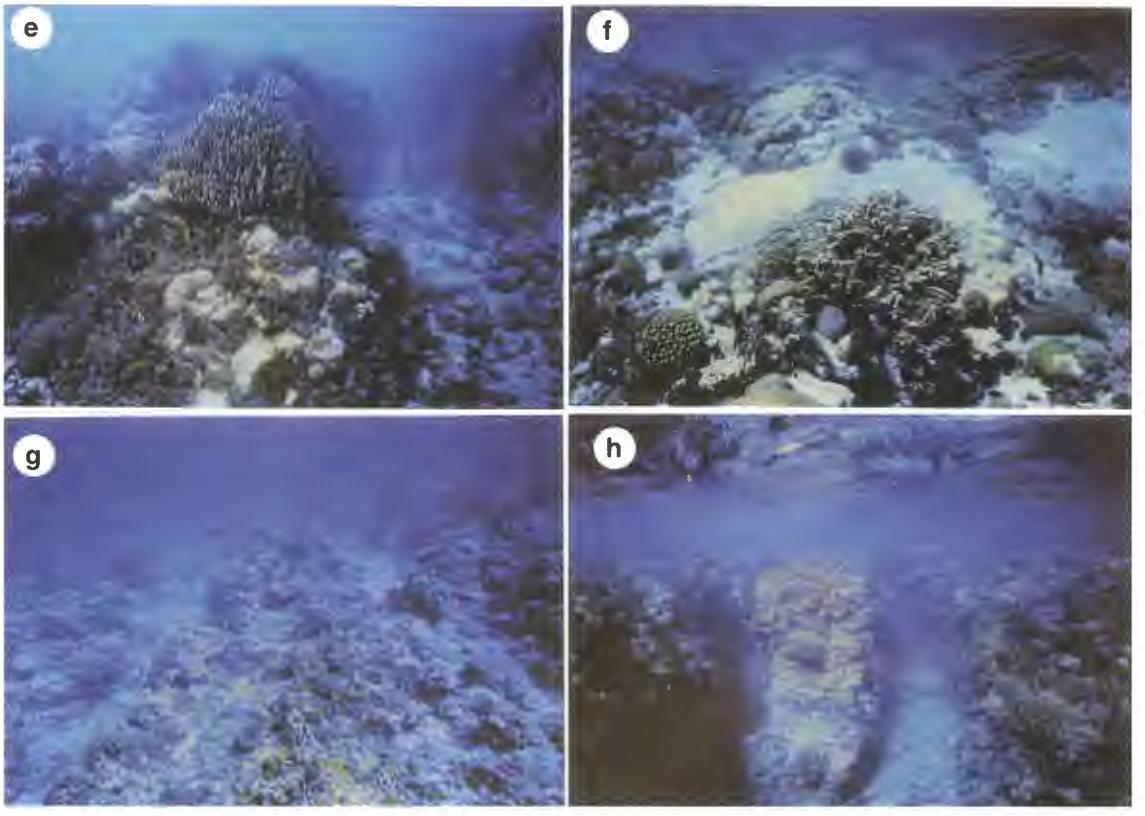


Figure 3/2
The coral reef environment of Abaiang, Gilbert Group.

Captions to Figure 3/2
e) *Heliopora coerulea* and the mixed species of *Halimeda sp.* are evident on the seaward slope of the North Reef. The sand and rubble floored channel is extending seaward from the spur and groove system in shallow water.
f) The leeward northwest reef characterized by fine sand being deposited among the corals by the prevailing east-southeast winds.
g) A northern reef slope channel extending to depth from the shallow spur and groove system.
h) The spur and grove system adjacent Nuotaea Village on northwest Abaiang Atoll.

(Fanning) (Chave 1970; Chave and Kay 1974; Wainwright 1963; Vaughan 1918). General descriptions of Kiritimati (Christmas) (Helfrich 1973; Ryland 1981) and Canton (Kanton) (Smith and Henderson 1974) were made. Description of the coral reef at McKean (Dana 1979) and its fishes on Onotoa (Banner and Randall, 1952) were compiled.

Previously, The Pacific Equatorial Research Station, operated by the University of Hawaii, was located on Tabuaeran (Fanning I.) in the Line Group. The National Tidal Facility project is part of a program being conducted on Betio I. It monitors sea level, sea and air temperature, air pressure and records wind data (velocity, force and direction).

Name	Island Type & Number	Island Area (km2)	Reef Type	Reef Perimeter (km)	Lagoon Area (km2)	No. of Passes and Channels	No. of Lagoon Reefs
Gilbert (or Tungaru) Group							
Abaiang	31 low coral	28	Atoll	102	?	10	?
Abemama	6 low coral	23	Atoll	66	?	2	?
Aranuka	14 low coral	15.5	Atoll	36	?	1	?
Arorae	1 low coral	26	Fringing (table)	20	0	0	0
Banaba	1 raised limestone	8.5	Fringing (table)	11	0	0	0
Beru	1 low coral	21	Atoll	36	?	0	?
Butaritari	23 low coral	11.7	Atoll	110	?	8	?
Kuria	2 low coral	12.7	Fringing (table)	27.5	0	0	0
Little Makin	7 low coral	5.4	Fringing (table)	29	?	0	?
Maiana	17 low coral	27	Atoll	58	?	1	?
Marakei	2 low coral	10	Atoll	26	?	0	?
Nikunau	1 low coral	18	Fringing (table)	31	0	0	0
Nonouti	24 low coral	25	Atoll	101	?	11	?
Onotoa	12 low coral	13.5	Atoll	52.5	54	7	?
Tabiteuea	63 low coral	49	Atoll	191	?	2	?
Tamana	1 low coral	5.2	Fringing (table)	12.5	0	0	0
Tarawa	64 low coral	20	Atoll	107	375	1	?
Totals: Island groups: 18	Low coral 269 Limestone cap: 1	719 km2	Fringing: 6 Atoll: 11 Raised limestone: 1	1716.5 km	?	43	?
Line Group							
Filippo	1 low coral	0	Submerged reef	?	0	0	0
Flint	1 low coral	2.6	Fringing (table)	4	0	0	0
Kiritimati	1 low coral	321	Atoll	144	328	2	?
Malden	1 low coral	39.3	Fringing (table)	28	0	0	0
Millenium I.	24 low coral	2.27	Atoll	51	?	0	?
Starbuck	1 low coral	16.2	Fringing (table)	25.5	0	0	0
Tabuaeran	4 low coral	33.7	Atoll	51	?	1	?
Teraina	1 low coral	7.4	Fringing	16	0	0	0

			(table)				
Vostok	1 low coral	0.24	Fringing (table)	4	0	0	0
Totals: Island groups: 9	35 low coral	422.7 km2	Fringing: 5 Atoll: 3 Submerged: 1	723.5? km	?	?	?
Phoenix Group							
Birnie	1 low coral	0.2	Fringing (table)	12.5	0	0	0
Carondelet	0	0	Submerged reef	?	0	0	0
Enderbury	1 low coral	5.1	Fringing (table)	4	0	0	0
Kanton	4 low coral	9.1	Atoll	39	?	1	?
Manra	1 low coral	4.4	Fringing (table)	12.5	0	0	0
McKean	1 low coral	0.6	Fringing (table)	4	0	0	0
Nikumaroro	2 low coral	4.1	Atoll	17.5	?	0	?
Orona	25 low coral	3.9	Atoll	28	0	0	0
Rawaki	1 low coral	0.5	Fringing (table)	4	0	0	0
Winslow	0	0	Submerged reef	?	0	0	0
Totals: Island groups: 8	36 low coral	27.9 (km2) Atolls: 3	Fringing: 5 Submerged: 2	109? Km	?	?	?
Kiribati Totals	340 low coral 1 limestone cap	1165.6 (km2)	Fringing: 16 Barrier: 0 Atolls: 17 Submerge: 3 Other: mangroves & seagrasses	2149 km	?	?	?

Adapted from Maragos and Holthus (1999): UNEP/IUCN (1988); Guinther, Maragos, and Thaman (1992)

Table 2
Summary of data on islands and coral reefs of Kiribati.

Status of coral reefs

Environment and habitat

As compared to many coral reef areas in the world, Kiribati reefs are in the best condition and are subject to less human impact. The Eastern Pacific has been heavily impacted by past El Niño events. The western coral reefs of the Asian /Indo-West-Pacific areas are subject to high anthropomorphic stress or as in the case of Palau, devastating coral bleaching.

As part of the Marshall-Gilbert-Ellice chain, habitat diversity is particularly high on the atolls of Kiribati in the wetter equatorial belt. Habitats include lagoon reefs, passes, dead-end channels, reef holes, shallow reef flats, reef slopes and deeper reef terraces, mud flats, and sand flats. Quasi-estuarine environments occur during the wet season. Isolated coral islets on table reefs support lower habitat

diversity limited to shallow reef flats, ocean reef slopes, and some reef terraces. Passes are shallow except where dredged for navigation (Kanton and Kiritimati; Maragos, 1997). Higher rainfall occurs on Teraina (Washington) and Tabuaeran (Fanning) Is. The other coral islands are in the arid zone south of the Equator with the exception of some in the Phoenix Islands (Nikumaroro, Manra and Orona) and in the Line Islands (Millenium I. (Caroline), Flint and Vostok Is.). Photographs from the two atolls, Tarawa and Abaiang, provide an impression of the nature of the atoll coral reef environment.

Island statistics

Details of the islands and coral reefs of Kiribati are listed in the following table.

It is evident from Table 2 that there are gaps in the knowledge of the country's coral reefs. Utilization and value to both the fisheries sector and tourism is, to some extent, compromised by this lack of information. As coral reef management is based on a full understanding of these natural assets, such information is integral to the development of reef management plan.

Reef types

Atolls are concentrated in the older Central Pacific, characterizing most of the coral reefs of Kiribati. According to Darwin's 1842 subsidence theory, atoll formation is the result of the sinking of a land-form leaving a coral reef growing on the submerged seamount. With the subsidence of the barrier reef surrounding the island, it eventually becomes the rim of the atoll. Subsequent deposition on this rim results in island formation about the perimeter. Only prolonged subsidence results in atoll formation.

Atolls have more ecological diversity than do many reef types because of the variety of habitats present. They lack the large-scale nutrient run-off from land that is characteristic of high islands with substantial agriculture. They are exposed to large waves. Also during episodes of sea-level fall, the reef flat and lagoon habitat can disappear confining coral growth to the seaward fringes. As a result, species diversity is lower for atolls as compared to barrier reef systems due to the long periods of fewer specialized habitats. Isolation through distance and current regimes retards immigration from other more diverse reef areas (Maragos and Holthus 1999).

Only three of the Kiribati reefs are submerged reefs. These lack land and are perpetually subtidal. They are unsheltered with the exception of depth. Their exposure and lack of varied habitat results in low biodiversity.

Species diversity

Regionally, there is diminishing island and reef complexity from west to east across the central Pacific. This results in the same trend of diminished habitat and species diversity. Seagrasses, mangroves and barrier reefs decline and atolls are less numerous relative to low coral islands. Geographic isolation, the equatorial current regime, distance between islands, habitat complexity and, perhaps, a slightly lower temperature regime due to upwelling are factors that reduce the coral diversity and, in relative terms, characterize the ' depauperate central Pacific'. (Maragos, 1997).

115 coral specimens were collected from the coral reefs of both Tarawa and Abaiang atoll (Lovell *et al.*, (in prep); Zann, 1982). This compares with 159 recorded from Guam representing the trend of

higher diversity to the west and 222 recorded from American Samoa (AS), which is more central in the radiation of hard coral diversity from the area of highest diversity in the Australian- Indonesian area. McKean Island (McK) in the Phoenix Group has 46 records. Tabuaeran I. (Fanning I.) has 71 hard coral records. Palmyra (Pal), in the northern Line Islands, reflects the diminution of the coral species in a westward direction across the Pacific with 82 records. Johnson Atoll (JA: 29 records) is low, probably due to its isolation. These more numerous records from Hawai'i (HA: 51 records) are the result of thorough collections and a larger and more diverse coral reef system. The more peripheral areas of the Northern Hawaiian Islands (N HI) and the Commonwealth of the Northern Marianas (CNMI) have only 13 and 53 records, respectively.

Summary information on the live coral coverage and species richness of sites in Kiribati. N equals the total number of sites for each survey. These are generally quantitative surveys.

A benthic survey of the coral reefs of Tarawa and Abaiang was conducted to describe the atoll's coral reefs (Lovell *et al.*, (in prep)). The survey followed the Global Coral Reef Monitoring protocols, assessing the benthos at two depths (3m and 10m) using the line transect and manta tow methods (English *et al.*, (1997).

Locality	Kiribati	AS	Pal	McK	Tab	JA	Ha	N HI	Wake	CNMI	Guam
No. of Hard Coral species	115	222	82	46	71	29	51	13	39	53	159

Table 3
The number species of hard coral recorded from the central Pacific and areas north.

Island Group	Islands	N	Percentage Live Coral Levels				Species Richness Levels					References
			0-25	26 - 50	51- 75	76- 100	1-15	16- 30	31 - 45	46- 60	>60	
Gilbert	Tarawa	9	11	56	33	-	-	-	-	-	-	Lovell *et al.* (in prep.)
	Tarawa	4	50	50	-	-	-	-	-	-	-	Zann, 1982
	Abaiang	12	-	67	33	-	-	-	-	-	-	Lovell *et al.* (in prep)
Phoenix	Kanton	7	29	71	-	-	-	-	-	-	-	Jokiel and Maragos (1978)
Line	Fanning	1	-	-	100	-	-	-	-	100	_	Maragos (1974b)

After Maragos, (1997)

Table 4
Summary of research in Kiribati: live coral coverage and species richness.

Depth	Hard Coral	Algae	Abiotic	Acropora Component	Non-Acropora	Macro-algae	Turf algae	Coralline algae
3m	6.5 – 57.3	2 – 41.8	0.8 – 69.5	0.2 – 9.75	4.5 – 50.7	0	0	0 – 33.3
10m	28.1 – 71.7	0 – 32.8	16.1 - 79	0 – 34.75	22.7 – 62	0	0	0 – 39.8

Table 5
For Tarawa and Abaiang atolls, the range of the percentages of benthic forms are listed in the following table.

Reef Name	Depth (m)	Benthic Forms%				Hard coral %		Algae %		
		Hard coral	Algae	Abiotic	Other	Acropora	Non-Acropora	Macro-	Coralline	Turf
Bairiki	3	33	3.83	20.33	42.83	.17	32.83	0	3.83	0
Bairiki	10	56.13	0	2.5	41.38	0	56.13	0	0	0
Bikenibeu	3	6.5	12	79	2.5	2	4.5	0	4	0
Bikenibeu	10	28.14	2.39	69.47	0	5.4	22.74	0	2.39	0
Ambo	3	44.5	2	53.25	0.25	3.38	41.13	0	0	0
Ambo	10	53.3	0.1	46.2	0.4	0	53.3	0	0	0
North Reef	3	50.06	31.94	16.06	1.94	0.25	49.81	0	14.19	0
North Reef	10	39.43	32.77	27.1	0.7	1.4	38.03	0	0	0
North Reef	3	57.33	19.17	23.5	0	6.67	50.67	0	10.33	0
North Reef	10	40.5	18.3	39.9	1.3	2	38.5	0	0	0

Table 6/1
Benthic composition from the two atolls.
Tarawa Atoll

Reef Name	Depth (m)	Benthic Forms %				Hard coral %		Algae %		
		Hard coral	Algae	Abiotic	Other	Acropora	Non-Acropora	Macro-	Coralline	Turf
Inshore	2	15.2	3.4	81.4	0	3	12	0	0	0
W. Lagoon	4	42.3	5.4	52.3	0	15	27.3	0	0	0
Western	3	36.75	35.25	27.67	0.33	2.33	34.42	0	33.25	0
Western	10	28.33	6.17	63.17	2.33	1.17	27.17	0	0	0
Eke I.	3	50.75	20.38	24.5	4.38	0.63	50.13	0	13.63	0
Eke I.	10	46.25	29.6	10.4	13.75	1.6	44.65	0	5.6	0
North Reef	3	32.75	41.75	25	0.5	2.5	30.25	0	39.75	0
North Reef	10	44.94	7.2	47.86	0	7.35	37.59	0	0	0
Nuotaea	3	42.25	38.13	19.63	0	3.75	38.5	0	36	0
Nuotaea	10	49.6	22.6	26.9	0.9	4.5	45.1	0	6.2	0
Southern tip	3	44.5	34.25	21.25	0	2	42.5	0	30.5	0
Southern tip	10	71.67	7.17	20.67	0.5	9.75	61.92	0	0	0
Bolton Pass.	3	51.54	13.38	33.58	1.5	3.75	47.79	0	0	0
Bolton Pass.	10	65.75	24.5	0.75	9	34.75	31	0	23.25	0

Table 6/2
Benthic composition from the two atolls.
Abaiang Atoll

Other marine organisms

Gilbert group

Zann (1982) described the coral reefs and other benthos along southern Tarawa and around Betio. Bolton (1982) detailed the intertidal fauna of the Southern Tarawa Atoll Lagoon. Lovell *et al.* (in prep.) described of the coral reefs of Tarawa and Abaiang. Banner and Randall (1952) compiled a preliminary report on the marine biology while Cloud (1952) investigated the geology and marine environment of Onotoa Atoll, Gilbert Islands.

There has been no definitive description of algae to date although Why and Reiti (1987) reviewed the marine algal literature of Kiribati. Tsuda (1964) described the algae on the atolls of Abemama, Marakei, Nonouti, and Tamana. Tsuda and Wray (1977) and Tsuda (1981) provided a bibliography of the algae of Micronesia. Why (1985a,b; 1986a,b; 1988a) reported on the cultivation of *Eucheuma*. This cultivation has expanded and currently exporting record quantities. A Japanese consultant is now working with the Atoll Seaweed Company on the introduction of a foreign species which he believes would have a better chance of surviving the climate of Kiribati and have a higher market value.

Munro (1986) assessed the status of giant clam stocks and prospects for clam mariculture in the Central Gilbert Islands atolls of Abaiang, Abemama and Maiana. Four species of giant clam occur in the central Gilbert Islands. (*Tridacna gigas, T. squamosa, T. maxima* and *Hippopus hippopus*). The Fisheries Division at Tanaea is planning to setup a hatchery.

Marine turtles were described by Balazs 1975, Onorio (1979) and Anon (1979b). The Green Turtle is wide spread though low in numbers. The Hawksbill, *Eretmochelys imbricata,* has been reported but not nesting.

Phoenix group

Garnett (1983) proposed a management plan for nature conservation in the Line and Phoenix Islands. He described turtle breeding areas on Kanton, Enderbury, Rawaki, Orona, Millenium I., Starbuck, and Malden. He generally referred to green turtles. Dana (1979) reported species-numbers relationships in an assemblage of reef-building corals on McKean Island, Phoenix Islands. Dahl (1980) included the Phoenix Group in the *Regional Ecosystems Survey of the South Pacific Area*. Abundant fish, birds and coconut crabs characterized the islands. Dawson (1956) described some algae for Kanton Atoll.

Line islands

The Tabuaeran (Fanning) Reef was described by Chave and Kay (1974) during the Fanning Island Expedition in July-Aug. 1972. Reef development and sedimentation in turbid water in the lagoon was investigated by Roy and Smith (1971). Maragos (1974 a, b) investigated the community structure for coral communities on a seaward reef slope. A species list of 71 hematypic corals was compiled. Townsley and Townsley (1974) conducted a preliminary investigation of the biology and ecology of the holothurians. Coconut Crabs are abundant on the islands of Millenium, Flint, and Vostok. Pilsbry and Vanatta (1905) provided an early description on the mollusca of Flint and Caroline Islands.

Many of the Line and Phoenix Islands are uninhabited and have been designated wildlife reserves. Seabird population studies conducted by the Smithsonian Institute indicate that in the Phoenix Islands bird populations number in the millions but belong to less than a dozen families.

Name and Location	Vulnerable species	Current Threats	Actions needed
Line Islands. Kiritimati Island	One of last breeding sites for Phoenix Petrel and Polynesian Storm-petrel: Christmas Shearwater, Audubon's Shearwater, Blue-grey Noddy	Human consumption; Rats and cats invading predator-free islets	Protected and staffed but warden needs equipment, technical assistance, mammal control
Phoenix Islands: McKean Island and Phoenix Island	One of last breeding sites for Phoenix Petrel and Polynesian Storm-petrel: Christmas Shearwater, Audubon's Shearwater, Bulwer's Petrel, Blue-grey Noddy	Phoenix Island is the only one in the archipelago with no rats. McKean had Storm petrels in 1974 but rats now, threaten population.	Survey, law enforcement, mammal control

Table 7
Known seabird-breeding sites of world importance.

Total breeding species: 19. No. of atolls: 38 of which 18 are uninhabited. Seabird reserves: 10. Internal legislation to protect seabirds: moderate Signatory to Convention on Biological Diversity Signatory to Convention on International Trade in Endangered Species U.N. Convention on the Law of the Sea (After Flint, 1999). Seabird Populations and Conservation). King (1955) compiled an annotated list of birds observed on Christmas Island.

Status of fishes

Fisheries: subsistence and artisanal

The subsistence fisheries production is nearly three times the commercial catch in both weight and amount. This reflects the dependency of the population on the local fishery.

Taniera (1988a,b) conducted a baseline artisanal fisheries survey for Abaiang and Onotoa. A recent survey by the Fisheries Division details the high dependency throughout Kiribati on the subsistence and artisanal fishery.

Subsistence fisheries production (mt)	Nominal Value (US$	Commercial fisheries production (mt)	Value (US$	Total fisheries production (mt)	Nominal Value (US$)
9,084	13,373,667	3,240	4,770,000	12,342	18,143,667

After Adams and Dalzell (1999) in Eldridge *et al.* (1999)

Table 8
The mean annual subsistence commercial production from coastal fisheries in Kiribati between 1989 and 1992.

Island	Census Population 1995	Year surveyed	Est. Pop. during survey yr.	Est. FHHs during survey yr.	Est. total catch During survey (Kg)	Est. total catch per FHH (Kg)	Est. annual catch per island (kg)	Est. fish consumption per Head per day (g)
Makin	***1830	1986	1,738	61	8,602	33	412,896	649.1
Butaritari	*3909	1992	3,742	651	28,653	44	1,375,344	1,004.2
Marakei	2,274	1998	2,842	361	12,380	34	594,240	574.3
Abaiang	6,020	1995	6,020	717	21,632	30	1,038,336	471.3
N. Tarawa	4,004	1996	6,061	544	9,307	17	446,736	300.6
S. Tarawa	28,350	1999	29,994	4019	142,689	35.5	6,849,072	623.9
Maiana	*2184	1993	2,331	374	7,979	21.3	382,992	448.9
Kuria	*971	1994	957	515	13,752	26.7	660,096	1,884.6
Aranuka	*1015	1994	1,095	158	5,235	33.1	251,280	627.0
Abemama	3,442	1996	3,499	153	14,205	92.8	681,840	532.4
Nonouti	*3042	1990	2,801	535	25,914	48.4	1,243,872	1,213.3
Tabnorth	3,383	1999	3,579	482	9,772	20.3	469,056	358.1
Tabsouth	1,404	1995	1,404	258	7,616	29.5	365,568	711.4
Onotoa	*1918	1992	1,839	455	15,991	35.1	767,568	1,140.4
Nikunau	***2784	1987	2,823	452	16,155	35.7	775,440	750.5
Beru	2,009	1998	2,190	295	10,174	34.5	488,352	609.3
Tamana	1,181	1998	1,233	215	7,943	36.9	381,264	844.9
Arorae	1,248	1998	1,284	225	6,542	29.1	314,016	668.2
Banaba	339	1999	339	60	1,970	32.8	94,560	762.1
Tabuaeran	1,615	2000	1,733	241	19,298	40.1	926,304	1,460.4
Teraina	978	2000	1,409	167	23,363	140	1,121,424	2,920.9
Total average	56,697		76,553	10,938	409,172	889.7	19,640,256	701.0

Note:
***Refers to the 1985 Census; *Refers to the 1990 Census

Table 9
Fish consumption rate for most of the islands in Kiribati based on the most recent results of the artisanal survey. (Kiribati Fisheries Division Data).

The population for all islands have been raised to allow for yearly growth in the population. It is assumed that there are 48 fishing weeks in a year to give the annual catch per island. The fish consumption rate for each island is calculated by dividing the annual total catch by the island population during the survey year. For Tarawa the total catch for the lagoon in 1999 is 34,893 kg.

Current exports

In Kiritimati, plans were made to export reef organisms and fish (Carleton, 1982). This has now been realized with a Live Fish Reef Trade program in place to export to the Asian market (Yeeting, 1999). The Marine Resource Assessment and Monitoring Unit from the Fisheries Division has been running a ciguatera monitoring program, to keep up to date the current status of ciguatera affected islands. The information is also useful for locations that are not affected and could be used for the Live Fish Reef Trade. Tabuaeran and Teraina were recently surveyed along with the underwater visual census (UVC) during February 2000.

A team consisting of three personnel from the Fisheries Division visited Tabuaeran, Teraina and Christmas Island during early February 2000. The team conducted a UVC survey of the reef and lagoon areas. Their findings were to determine the status of fish species that were targeted for the Live Reef Fish Trade. The species *Anyperodon leucogrammicus, Aethaloperoa rogaa, Epinephelus merra, E .maculatus, E. fuscogutatus, E. cyanopodus, E. hexogonatus, E. polyphekadion, E. lanceolatus, E. tukula, Variola louti, Chelinus undulates, Plectropomus oligocanthus, P. areolatus, Cephalopholis leopardus, C. argus* were low in numbers at all three islands.

In the Gilbert Islands, an assessment program for the trade has also been carried out. Concentrating on the families Serranidae and Labridae. (Awira, 2000), the assessment points out that these reef fish are abundant where there is no exporting. Marakei I. was used as a control due to no exporting due to ciguatera fish poisoning. Surveys have been conducted on five islands: Butaritari, Abaiang, Nonouti, north Tabiteuea and Marakei. An outbreak of ciguatera poisoning was investigated on Kuria Atoll and focused to be spreading (Kirata, 1999).

The aquarium fish collection in Kiritimati has increased yearly and may prove problematic with the increase in licensing of fish-collecting companies from 4 in 1995 to 8 in 1999. There is a critical need to undertake an assessment survey of the targeted species and the extent of coral damage that occurs by operators using crowbars and other destructive techniques to harvest the target species.

Nature and anthropogenic threats to biodiversity

Natural threats

Crown-of -Thorns Starfish (Acanthaster planci)

Natural influences on coral reefs include the presence of elevated numbers of Acanthaster planci. They have been reported in the past on reefs in Tarawa, Abaiang and Kiritimati (Edmondson, 1946). Yeeting (1989) conducted a Crown-of-thorns (COT) survey of Makin atoll. During the fishery survey on Butaritari, the Fisheries monitoring team observed large numbers of COT's inside the lagoon. On Kiritimati, during a biodiversity survey, numbers of COT were observed inside the conservation area.

Anthropogenic stress

The history of anthropogenic stress on coral reef ecosystems in Kiribati involve military bombing, over- harvesting, coastal construction, sewage nutrient pollution, oil spills and vessel grounding, solid waste disposal, mangrove clearing and new settlements.

Gamberiodiscus toxicus and Ciguatera poisoning

The naturally occurring dinoflagellate *Gamberiodiscus toxicus* affects coral reefs though conferring toxicity to certain coral reef fishes and thereby reducing fishing pressure on particular species. Human activities can promote the incidence by creating habitat for the toxic algae to flourish, resulting in associated fish becoming toxic.

Increases in ciguatera poisoning have been attributed to human disturbance on the coral reef (Cooper, 1964; De Sylva and Hine, 1972; Tebano, 1984, 1992; Naughton, 1985) such as alteration to the reef through dredging and the construction of causeways (Tebano and Lewis 1990; Tebano, 1991, 1992). In Marakei Island ciguatera has become common with the alteration of the natural lagoon circulation due to causeway construction. Coral fragments may provide new surfaces for algal settlement and it has been found that coral damage may trigger the onset of ciguatera fish poisoning (Tebano, 1984; McCarthy and Tebano, 1984). This type of poisoning was not known in Maiana until after a channel was constructed at the western side of the island. The reef apparently became toxic in a pattern spreading out from the centre of disturbance, first appearing in herbivorous fish and later in the carnivores. On the islands of Marakei and Nikunau where ciguatera fish poisoning is a chronic problem, levels elevated and spread to the neighboring villages (Tebano, 1991).

Kaly and Jones (1988; 1989; 1990a,b) provide a review of the circumstances which give rise to fish poisoning. Some workers have identified blasting in the construction of boat channels as a probable cause for an increase in fish poisoning (Tebano, 1984). Other disturbances have also been implicated in fish poisoning, such as storms (Bagnis, 1973; Tebano, 1984); dieback of corals (Yasumoto *et al.*, 1980) and many other forms of disturbance (Withers, 1982). When interviewed, the people of Kiribati associated areas of toxicity with ship wrecks, WWII bombing, sewage, rubbish dumping and many other kinds of reef damage (Cooper, 1964; Tebano, 1984: McCarthy and Tebano, 1984). McCarthy and Tebano (1984) pointed out, however that the apparent association between wrecks and ciguatera in Kiribati, derived by interviewing fishermen, may have arisen because wrecks (and presumably other human structures) provide a convenient spatial and temporal marker for an otherwise obscure phenomenon. Halstead and Bunker (1954) reported on ciguatera in the Phoenix I. and Halstead and Schall (1958) in the Line Islands.

Military activity

During World War II Tarawa was subjected to a major military invasion and severe reef destruction must have occurred on southern Tarawa. Post-war construction resulted in impacts. Atmospheric nuclear bomb testing by the British and Americans, occurred on both Kiritimati and Malden Is. The immediate impacts are thought to be devastating to the marine environment and the long-term impacts from residual radiation are unknown and not apparent. Ballistic missile testing at Kanton impacted the reefs through construction of the facilities' infrastructure.

Overfishing

Virtually the entire population of Kiribati lives in the Gilbert Islands with only Banaba, Teraina Tabuaeran and Kiritimati being permanently inhabited elsewhere. High densities have given rise to overfishing being the principal potential form of disturbance (Lawrence, 1983, 1989; Zann, 1985). Locations distant from villages, deeper waters and strong wave action remain under-fished and may act as refuges (Zann, 1985). Ciguatera outbreaks are a problems in some areas (Cooper, 1964) often leading to reefs being left unfished for several years.

Species that have been overexploited are turtles, giant clams and coconut crabs. The coconut crab is probably extinct on Teraina (Garnett, 1983) There is evidence of intensive harvest for local consumption. Clams like *Tridacna maxima* are still common in the waters of Butaritari, Abaiang, Nonouti, and Abemama and some of the Line and Phoenix groups. The Fisheries Division has been involved with the giant clam stock assessment and is planning to start a project on reseeding them into other lagoons where there are very low numbers.

The high urban demand for fresh fish, changes in fishing technology, the development of mechanized artisanal and small-scale commercial fisheries have led to overfishing. Cold storage and improved communications are increasing the fishing pressure. Plans to export reef and lagoon fish from Tarawa and the rural atolls would also increase fishing pressure and could lead to increased conflict between subsistence and artisanal fisheries over fishing grounds. Similarly, there is conflict between the subsistence sector and the nation's tuna corporations over bait fishing (Zann, 1985). In Fiji, a baitfish study similar to one which was carried out in Kiribati (Rawlinson 1989; 1990; 1991a), indicated that the baitfish collection was sustainable. Village and provincial opposition (Lau Waters ban) to it continues to exist.

Destructive practices for the capture of eel and lobster result in coral damage through the use of metal crowbars.

Pollution

Johannes *et al.* (1979), Johannes (1979) determined high levels of fecal pollution in Tarawa lagoon to be a public health hazard due to the contamination of edible shellfish but that sewage and other pollution were not having an effect on the ecosystem. They cautioned that the construction of the Bairiki-Betio causeway would only worsen the situation by reducing lagoon flushing. Additionally the blocking of the sea access may affect the breeding cycle of food fish, reducing their abundance.

Rapid urbanization and inadequate sewage disposal facilities causes sewage pollution and extremely high fecal coliform concentrations in bivalves in Tarawa lagoon (Johannes *et al.,* 1979). However, Kimmerer and Walsh (1981) suggested that nutrients from sewage (10g-at/day/person x 8000 residents = 80 kg-at/day) did not contribute significantly to the total nitrogen budget for south Tarawa lagoon compared to the nitrogen flux from enriched equatorial seawater estimated at 21 kg-at/day for the southern lagoon and 550 kg-at/day for the Northern lagoon. However, the population of Tarawa (30,000; SPREP 1992) has almost quadrupled since the time of that study and the lagoon nutrient budget is currently being re-evaluated."(Hunter and Stephenson 1999).

There is no waste storage facility on the island and most of the waste from major urban centers such as Bikenibeu, Bairiki and Betio are disposed directly to the sea.

Foreshore development

The need for causeway construction to develop road transport has altered the circulation of the lagoons. The blocking or narrowing of the natural waterways may adversely impact lagoon fisheries (Makin and Marakei). In Butaritari and Tarawa the construction of causeways may have resulted in the blocking of spawning migration routes of adult lagoon species and prevented recruitment of larval fish from the ocean into the lagoon. Land fill and foreshore reclamation has given rise to coastal alteration and erosion (Howorth and Woodward, 1995; Forbes and Hosoi, 1995). The use of coral for constructing walls causes the depletion of habitat but is now illegal in Tarawa. Channel blasting to accommodate predominately waterborne transport, has created a need for guidelines and impact assessment.

Coastal erosion is a problem in Kiribati particularly in the urban areas. Most of it is a consequence of unregulated human activity, which has caused a change in the balance of the natural coastal processes (Holden, 1992). These include unguided construction and inappropriate design of sea walls built to reclaim land from the foreshore or to protect the shoreline, and the removal of beach rock, sand and gravel from the beach for construction purposes. The cutting down of mangroves and coastal vegetation is another problem (SPREP, 1999).

Port construction may result in sedimentation locally. The increase in shipping may result in a greater frequency of fuel and oil spills as well as groundings. Pollution from the harbour and lagoon from fish processing waste and human sewage may occur.

Tourism

Kiribati received 3,942 visitors in 1995, the last year for which figures are fully available. According to the National Statistics Office these figures are understated because of the failure of the relevant authorities on Kiritimati Island to fully account for their visitors. Visitors on cruise passenger vessels call into this port almost every month. Unofficial estimates for 1999 are 1712 visitors for Kiritimati and 1471 visitors for Tarawa.

Tourism is at a low level but Government intends to encourage a controlled increase. Development of tourist resorts on Kiritimati I. may create additional impacts on the reefs through damage from roads and additional pollution of marine areas and groundwater.

Mining

Phosphate mining on Banaba Island has led to reef damage caused by the transfer of phosphate rock from the island to ships.

Population

Rapid human population growth has occurred, being augmented by improved medical, sanitation, nutrition and economic conditions. The annual growth rate is 2.3%. South Tarawa Atoll is the largest urban center where 35% of the total population reside and is increasing at 3.1% annually. Establishment of settlements on Tabuaeran, Kiritimati and Teraina, initiated by the British, has continued. There are plans to expand the resettlement program on the Northern Line Islands and to settle some of the uninhabited islands in the Phoenix Group (Nikumaroro, Orona and Manra). Such migration will increase fishing pressure and may deplete vulnerable and protected species such as giant clams, coconut crabs, nesting seabirds, nesting sea turtles, pearl shell, trochus, and some species of reef fish.

Contraception, being a religious taboo, makes self-imposed control difficult.

Current and potential climate change impacts

Global warming and sea-level rise

The prospect of global warming and the resulting sea-level rise have given cause for concern as the atoll islands are low (2-4m above sea level) and subject to the pollution of freshwater resources and the threat of inundation. Accretion by corals and algae may be affected by the increasingly warming conditions.

Woodroffe and McLean (1992) provided a preliminary assessment the vulnerability to sea-level rise.

Solomon (1997) assessed the vulnerability of Betio to accelerated sea-level rise. At the governmental level, there is a Climate Change Working Committee now drafting a report on the potential impacts of climate change.

Coral bleaching

Although coral bleaching has not proved to be a problem in Kiribati, the widespread occurrence of bleaching globally has shown that all reef systems are potentially at risk. The current bleaching event in Fiji may portend a similar situation in the equatorial and northern latitudes if similar predisposing weather patterns occur allowing the water to warm (Wilkinson pers. comm.).

Marine protected areas and level of management

Marine protected areas

Managing coral reefs through protection is a way of maintaining natural biodiversity. Although adequate management of reefs is difficult, reef conservation is receiving high priority in all countries. Stresses by human activities on reefs can be remedied or reduced by sound resource management. Without this, there will be a continuing trend of reef degradation around population centers.

The Management Plan for the Line and Phoenix Islands (Garnett, 1983) is terrestrial in orientation and applies peripherally to the marine environment. This plan recommended the protection of Enderbury as a Wildlife Sanctuary based on its importance as a turtle-nesting site. Birnie, McKean, Rawaki and Vostok are closed areas. Protection of areas on Millenium, Flint and Kanton Islands as turtle nesting areas were established.

A National Park was proposed for the Phoenix group. Dahl (1980) suggested a national or international reserve for the Phoenix group. Birnie, Rawaki, Vostok and Malden were proposed as Islands for Science in 1971 (Elliot, 1973). Dahl (1980) recommended protection for areas in the Gilbert group which included seabirds, turtles and land crabs. In particular, he recommended reserves on Butaritari at Kotabu and Nabini Islands and on Teiro Islet on Abaiang for turtles (Dahl, 1980).

Kiribati has nine protected areas, which are wildlife sanctuaries for the protection of seabird breeding areas. Most of these do not include the marine environment although wildlife reserves can be considered to protect the coral reef ecosystem. Nesting seabirds feed on fishes that are part of the coral reef and transport this ashore to be left as guano, which has an effect on the near shore environment through eutrophic run-off. Protection prevents infrastructure development impacts. Protected areas which include the marine areas are designated by an (*).

Gilbert Islands

- North Tarawa Conservation Area*

Phoenix Islands

- Rawaki (Phoenix) Island (WS)
- Birnie Island (WS)

Line Islands

- Cook Islet Conservation Area (Kiritimati)
- Malden Wildlife Sanctuary (WS)
- Millenium I. (Caroraina) Atoll (WS)
- Starbuck Island (WS)
- McKean Island (WS)
- Vostok Island (WS)

Reference: Kelleher, Bleakley, and Wells, 1995)

The Fisheries Division is aiming to locate at least one protected area on all islands in the country where no fishing is allowed. Seasonal closed areas will be established as well to protect spawning aggregation sites of some commercially important reef fish. The areas have been designated on Butaritari with the council legalizing these areas under their By-laws. Areas on Tabnorth and Nonouti have been identified during the Marine Resource Assessment, Management and Monitoring Unit survey on the islands.

Four marine reserves were specifically set aside for the conservation of grouper. These are all located in the Gilbert Islands on the atolls of Butaritari, Tabiteuea, Nonouti, and Onotoa and are managed by the Fisheries Division.

In addition, the Foundation for the Peoples of the South Pacific (FSP) has begun investigating the extension of their community focused environmental education and awareness-raising activities in North Tarawa and will include the marine protected areas within the area. Participatory consultation methods with the community have been completed and the villages have requested FSP to work in the area. FSP's current project, the Kiribati Environmental Education Project has been running for 4 years and is now in its fifth and final year. It is a project operated in partnership with the Environment Division of the Ministry of Environment and Social Development.

FSP is negotiating on how to set up marine protected areas with the North Tarawa Council. The plan is to set up a conservation area where the northern lagoon area of Tarawa can be fished using specified fishing methods. Recently the Fisheries Division has been seeking to establish marine protected areas, with local communities, on Tarawa.

Management

The Wildlife Conservation Ordinance 1979 established the Wildlife Sanctuaries with which killing or capturing any animal other than fish, and disturbing breeding sites, is prohibited. Principally seabird sanctuaries to protect rookeries, they are Kiritimati (32,100ha), Malden (3930 ha), Starbuck (1620 ha), Rawaki 65 ha, McKean (57 ha), Vostok (24 ha), and Birnie (20 ha). Closed areas where access requires a permit have been declared on Malden, Starbuck and five areas within the Kiritimati Wildlife Sanctuary. There are no marine protected areas in the Gilbert Group. Kiribati is part of the World Heritage Convention, and there are intentions to list Millenium and other sites as Heritage areas.

The Wildlife Conservation Unit on Kiritimati is the only government division responsible for day to day work in conservation management in the Line and Phoenix Islands. This extends to ordinance enforcement, education, survey and research, control of introduced species and tourism.

Current monitoring and management capacity

The Fisheries Division is actively monitoring the presence of *Gamberiodiscus* in *Halimeda* beds.

The Marine Resource Assessment, Management and Monitoring Unit is involved in a current program to survey fish stocks using the Underwater Visual Census (UVC) techniques on the islands. They now combine the AIMS Reef Description and Monitoring methods to compliment their fish surveys. Awira (1999) described the results of a rapid underwater survey of Millenium Island.

Government policy, laws and legislation

Policy

The Kiribati National Environment Management Strategy (1994) has been developed with the assistance of SPREP. They have been involved with many projects which help safeguard the marine environment. Focus has been on the formation of many policies concerning sustainable and economical development of the marine resources. Kiribati is signatory to the Convention on Biological Diversity. The National Biodiversity Strategy Action Plan (BSAP) has been prepared by the Ministry of Environment and Social Development, though not finalised. The objective is to sustain biodiversity as well as enhance the well being of the people of Kiribati. It recommends that the Kiribati Government should put the notion of biodiversity in all its development projects. It places priority on the conservation and protection of the environment and animals so that there are no activities that would cause degradation.

Yeeting (1988a,b) discussed legislation, fisheries research and management problems in Kiribati. Miria-Tairea (1995) profiled the Fisheries legislation. Pulea and Farrier (1993) provided an overview of Environmental Legislation.

The Environment Act focuses mainly on a Development Control system and a Pollution Control system, both of which aim to protect species through pro-active planning and licensing. However, the Environment Unit are further developing regulations under the Act on waste management and biodiversity protection.

The constitution of Kiribati does not include set clauses relating directly to environmental and resource policy, but its preamble declaration that the "natural resources of Kiribati are vested in the people and their Government" can be taken to imply the notion of sustainable resource use. The Environment Unit has recently been reformed as the Environment and Conservation Division to reflect its new role as environmental regulator. Also, the Seventh National Development Plan promotes the concept of Sustainable Development for the first time in Kiribati.

Marine tenure and traditional practices

During pre-colonial times, a marine tenure system existed whereby the reefs and lagoons had exclusive rights to the fishing rights and rights of passage. Under British colonial rule, offshore tenure was not recognized with the exemption of fish weirs, reclaimed areas, fish ponds and other constructed facilities (Zann, 1985). There are still local laws and customs regulating fishing activities on many of the atolls. Limitation to fishing seasons, gear and catch limits may be imposed on species susceptible to over-fishing. Abemama prohibits the taking of *Tridacna* clams by visitors. Nikunau limits fishing close to villages. Tamana banned fishing by visitors on inter-island boats. Monofilament gill nets have been banned because they are too effective. Diet and local food taboos may provide and effective mechanism of conservation of fishery items. Fishing for turtles is generally forbidden. More numerous lagoon species and offshore pelagics are often sought in preference to reef fish (Zann, 1985).

Legislation

Environmental legislation is described in SPREP (1980) but was summarized in Pulea and Farrier (1993). The Fisheries Ordinance 1957 is the main body of regulations that prohibits fishing with explosives or poisons. The Wildlife Conservation Ordinance 1979 protects all birds and Green turtles

on land. This refers to their eggs and nests in the Line and Phoenix Islands, except on Kanton, Enderbury, Tabuaeran and Teraina.

The 1980 statement of the Government Policy concerning nature conservation in the Line and Phoenix Islands recognized the need to integrate conservation with development of the islands' resources. It is a commitment to survey the wildlife resources and implement the Wildlife Conservation Ordinance. It welcomes scientific expeditions to the island groups.

The Kiribati Environment Act 1999 provides legislation on the marine environment. It provides sections for environmental impact assessments, managing ozone-depleting substances, marine pollution and waste management including oil spill response, dumping of wastes by vessels, prevention of marine pollution from land-based sources, management of hazardous substances, integrated resource management, fisheries conservation and management, as well as biodiversity, conservation and national parks management. It will provide for the implementation of a number of international treaties and agreements in the area of sustainable development.

Gaps in acquisition of baseline information, monitoring and capacity

There is a need for acquisition of baseline data on coral reefs and fisheries resources especially the relative abundance and distribution of the different coral species and fisheries resources for Kiribati which are needed for proper management of the resources. Information available on coral reefs is too general. In addition, the Fisheries Division is currently conducting stock assessment surveys of the coral reef resources, mainly finfish on one or two outer islands. There is also a need to extend this survey to other outer islands but these surveys have not been possible due to the lack of funding. Information collected from these surveys is useful for proper management of coral reef resources, especially in creating marine protected areas.

Coral reef monitoring programs are also lacking in Kiribati. There is also a need to assess coral bleaching and whether this is due to natural or anthropogenic causes.

There is also a need to develop capacity building and training of Government and non-Government personnel in activities (available software on coral surveys and monitoring) that would lead to the protection of coral reefs.

For the live fish ornamental trade, there is an urgent need to assess the impact of this trade on the resources and to have regulatory measures in place for the protection of these resources.

Recommendations for reef conservation

Fisheries division survey program

Provide support for the Ministry of Fisheries coral reef resource and survey program. Access to and support for coral reef surveys has always been impeded by the lack of financial support. The Republic is comprised of three island groups which are separated by substantial distances.

Rapid ecological assessments

Senior reef scientists working with Pacific Islander counterparts to assess large reef areas quickly prior to major development or conservation initiatives.

Capacity building

Develop capacity building and training of Fisheries and Environment Department personnel (survey, monitoring, EIA, education, enforcement) that lead to the protection of coral reefs. Provide facilities and training for the use of email and access to the Internet for information.

Information systems

Support given to ReefBase, an encyclopedic resource to catalogue the grey literature and other information for use in an interactive form by scientists, educators, and managers. Support for the PIMRIS system of bibliographic cataloguing.

Catalogue of reefs and organisms

Need to establish a database of coral reefs and marine organisms.

Coral reef monitoring

Develop a program of coral reef survey and long-term monitoring. This is particularly for areas of high anthropomorphic stress such as urban centers.

Coastal zone management

Establish a cogent policy for integrated coastal zone management and environmental impact assessment to control land-based influences such as construction, agriculture and pollution. Emphasis needs to be placed on community-based approaches. Legislate and formulate plans and regulatory controls over development and resource exploitation.

Community resource management

Empowering local communities with the support and concurrence of Fisheries Division to manage development and levels of resource exploitation on their "home" reefs. Improve co-operation between traditional and government authorities concerned with coral reef stewardship. Re-establish some form of marine tenure to reinforce the concept of community-based management of the coastal resources.

Marine environmental education

Increase community education of environmental and conservation issues, particularly at the school level. Traditional practices and values should be integrated into conservation measures. Encouragement of active public participation in coral reef issues. Media should participate more. Village and church group and NGO are important in education and management. Participation of fishermen is important.

Environmental impact assessments (EIA)

Require an EIA for proposed development with the potential to cause adverse impacts. Evaluation of alternatives, mitigation and monitoring are necessary components.

Subsistence fisheries resources

Develop attitudes and measures to regulate fishing both in terms of over-fishing and the use of destructive methods. Regulate commercial fishing on coral reefs where they are likely to deplete subsistence resources.

Marine protected areas

Develop policies to establish coral reef protected areas particularly in areas of anthropogenic stress such as urban areas.

Table of acronyms

COT	Crown of thorns starfish (*Acanthaster planci*)
FSP	Foundation for the Peoples of the South Pacific
IUCN	International Union for the Conservation of Nature
NOAA	National Oceanographic and Atmospheric Agency
SPC	Secretariat for the Pacific Community
SPREP	South Pacific Regional Environment Program
USP	The University of the South Pacific, Suva.
WWF	World Wide Fund for Nature

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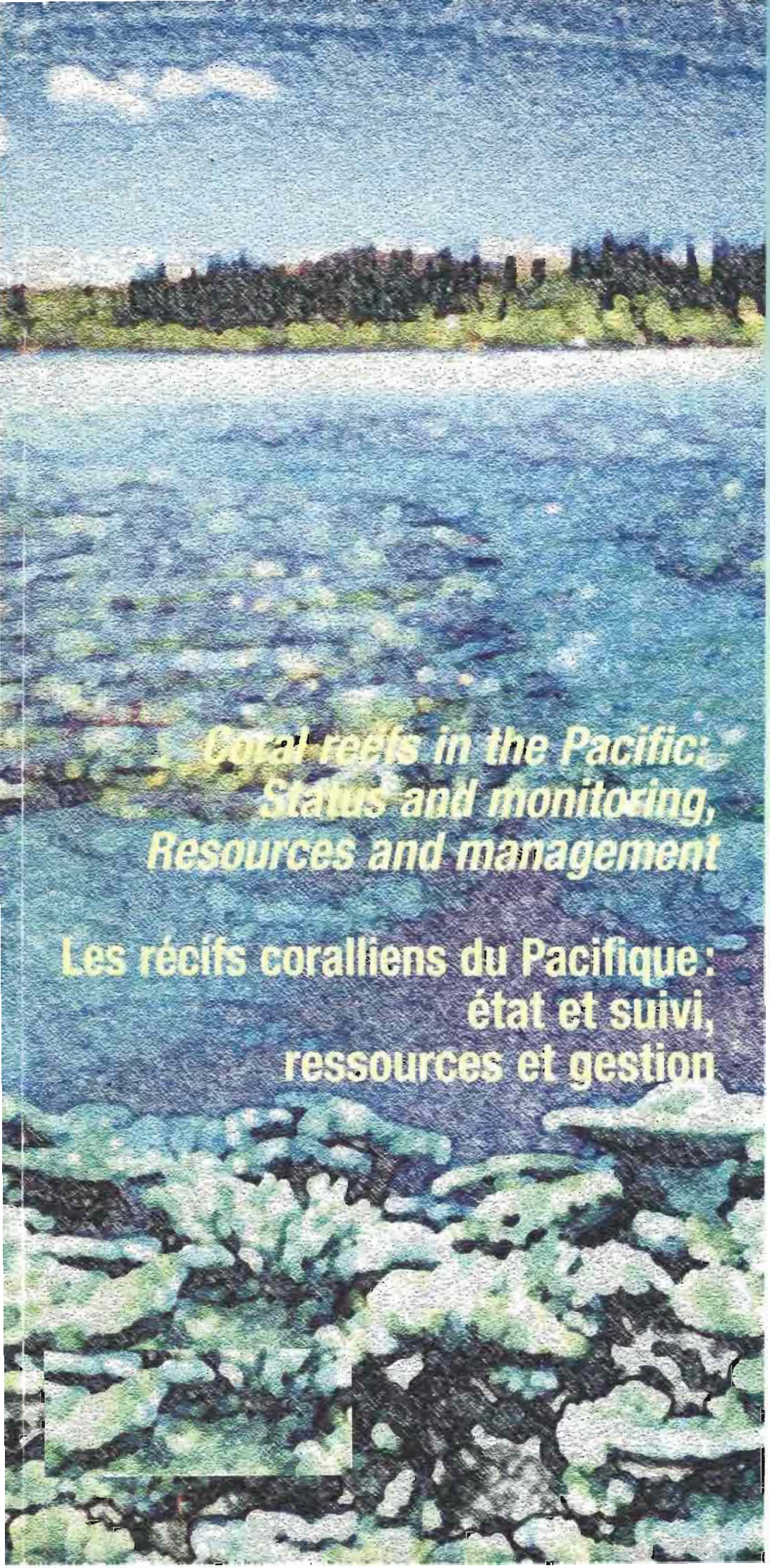

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Centre IRD de Nouméa
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Modèle de référence bibliographique à cette revue :
Adjeroud M. *et al.*, 2000. Premiers résultats concernant le benthos et les poissons au cours des missions TYPATOLL.
Nouméa : IRD. *Doc. Sci. Tech.* II 3, 125 p.

ISSN 1297-9635
Numéro **II** 5 - **Septembre 2002**

Distribué pour le Pacifique par le Centre de Nouméa

A regional symposium
International Coral Reef Initiative (ICRI)
Symposium régional

International Coral Reef Initiative (ICRI)
22-24 Mai 2000
Noumea IRD Centre - New Caledonia

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