Technical Paper No. 179

SOUTH PACIFIC COMMISSION

INTERNATIONAL UNION
FOR CONSERVATION OF NATURE
AND NATURAL RESOURCES

REGIONAL ECOSYSTEMS SURVEY OF THE SOUTH PACIFIC AREA

by

Arthur L. Dahl
Regional Ecological Adviser
South Pacific Commission

55/81

South Pacific Commission
Noumea, New Caledonia
June 1980

TABLE OF CONTENTS

A. INTRODUCTION

This survey of the ecosystems of the Pacific Islands included within the area of the South Pacific Commission (Fig. 1) has been undertaken to summarise the available information on the need for and present progress towards the conservation of nature in the region and to provide an indication of the environmental framework within which sound development must take place. The study was recommended by the South Pacific Conference on National Parks and Reserves (Wellington, New Zealand, February 1975) which called for a survey of existing and potential protected areas in the South Pacific. This recommendation (No. 7) invited the United Nations Environment Programme (UNEP) and the International Union for Conservation of Nature and Natural Resources (IUCN) to work with the South Pacific Commission (SPC) to support a project to:

(a) identify the various characteristic ecosystems and habitats of the region, including marine areas, and determine the extent to which they are currently protected and/or endangered by exploitation;

(b) make proposals for the setting aside of additional areas so as to cover the range of characteristic ecosystems and habitats; and

(c) following consultations with the countries concerned, design projects for technical assistance to implement these findings.

The resolution proposed that this study should be reviewed at the Second Regional Symposium on Conservation of Nature (Apia, Western Samoa, June 1976) where an earlier version was presented as a working paper, and recommended that special attention be given to areas to be designated as Biosphere Reserves under UNESCO's MAB Project 8. It is hoped that this present report will lead to projects for technical assistance necessary to implement its findings.

The survey has been undertaken primarily by the author with travel and secretarial support provided by IUCN as part of a major UNEP-funded programme. Field visits were made as part of this study to American Samoa, the Caroline, Mariana and Marshall Islands, Fiji, French Polynesia, the Gilbert Islands[1], Guam, Nauru, New Caledonia, the New Hebrides, Papua New Guinea and Solomon Islands. Data was also available from other visits to these countries as well as to Western Samoa, the Cook Islands, Niue and Tonga. Large numbers of local and outside specialists also contributed essential information; their contributions are listed as appropriate in the country reports or in the Acknowledgements at the end of this report. The draft report has been reviewed by many specialists and government authorities, and has, as far as possible, been updated to January 1980.

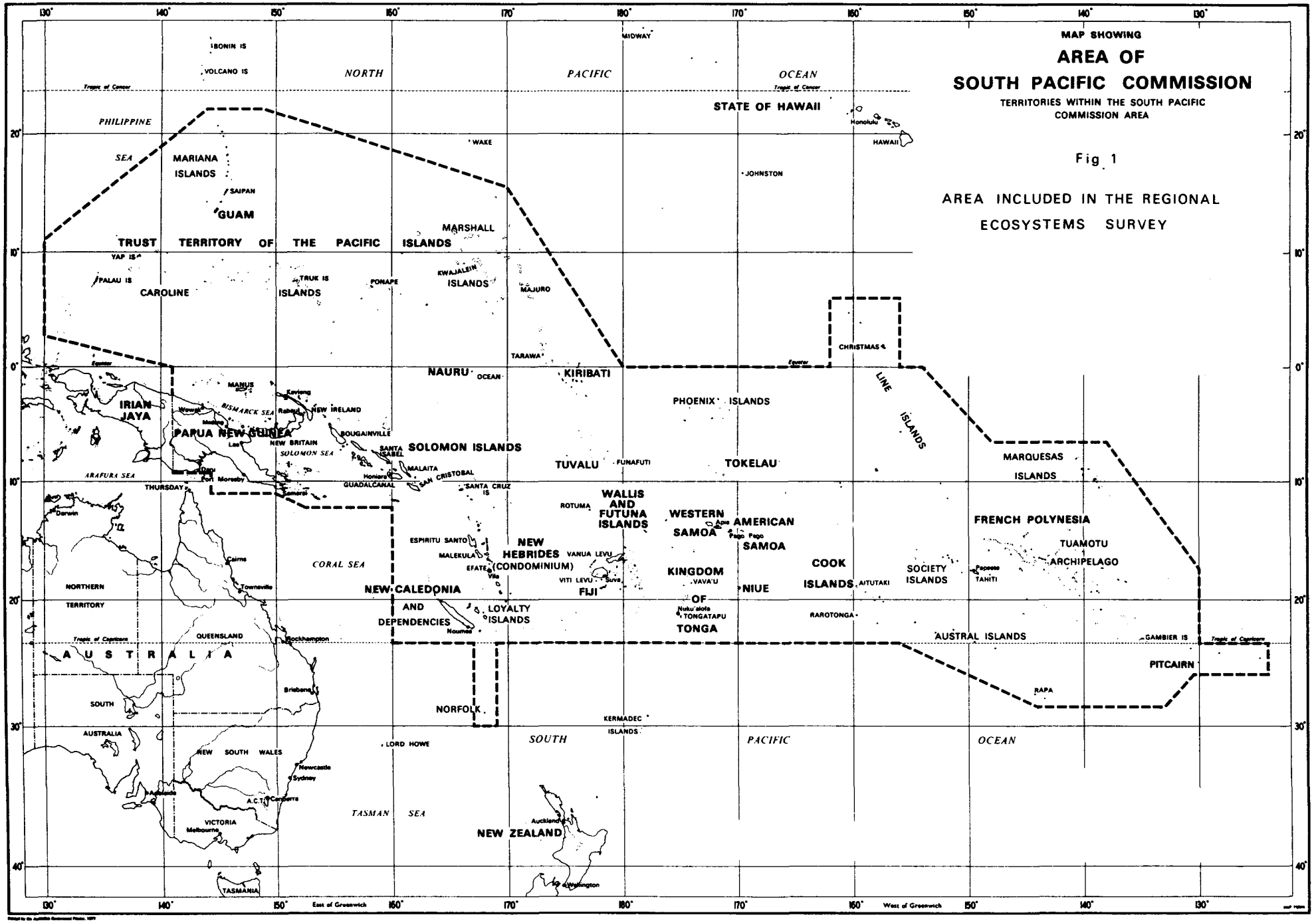
Any survey of this scope is subject to many limitations, including the lack of scientific knowledge of many parts of the Pacific, the difficulty of collecting and reviewing what information exists on such a vast area, the lack of ready access in the islands to much of the scientific literature and the failure of some recently-published reports and solicited contributions to reach Noumea in time for inclusion.

The South Pacific Commission would appreciate learning of errors or omissions in this survey. Opinions and interpretations expressed are those of the author and not necessarily those of the South Pacific Commission or its member governments.

WHAT IS CONSERVATION?

Conservation is the management of environmental resources (plants, animals, air, water, soil, minerals and even man) to achieve the highest sustainable quality of human life. It thus includes the protection of nature, particularly natural systems of plants and animals, from change or destruction so that they can continue to be of service to man into the future. This can be done in many ways which will be discussed in more detail below.

1. Now the Republic of Kiribati.


MAP SHOWING
AREA OF
SOUTH PACIFIC COMMISSION
TERRITORIES WITHIN THE SOUTH PACIFIC COMMISSION AREA
Fig 1
AREA INCLUDED IN THE REGIONAL ECOSYSTEMS SURVEY
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
PHILIPPINE SEA
TASMAN SEA
CORAL SEA
ARAFURA SEA
SOLOMON SEA
BISMARCK SEA
BONIN IS
VOLCANO IS
MIDWAY
STATE OF HAWAII
Honolulu
HAWAII
WAKE
JOHNSTON
MARIANA ISLANDS
SAIPAN
GUAM
TRUST TERRITORY OF THE PACIFIC ISLANDS
MARSHALL ISLANDS
YAP IS
PALAU IS
CAROLINE ISLANDS
TRUK IS
PONAPE
KWAJALEIN
MAJURO
TARAWA
NAURU
KIRIBATI
CHRISTMAS
LINE ISLANDS
PHOENIX ISLANDS
MANUS
Kavieng
NEW IRELAND
Rabaul
IRIAN JAYA
PAPUA NEW GUINEA
Wewak
Madang
Lae
NEW BRITAIN
BOUGAINVILLE
SANTA ISABEL
SOLOMON ISLANDS
MALAITA
Honiara
GUADALCANAL
SAN CRISTOBAL
SANTA CRUZ IS
Port Moresby
THURSDAY
Samarai
TUVALU
FUNAFUTI
TOKELAU
MARQUESAS ISLANDS
WALLIS AND FUTUNA ISLANDS
ROTUMA
WESTERN SAMOA
Apia
AMERICAN SAMOA
Pago Pago
FRENCH POLYNESIA
TUAMOTU ARCHIPELAGO
Papeete
TAHITI
SOCIETY ISLANDS
COOK ISLANDS
AITUTAKI
RAROTONGA
NIUE
KINGDOM OF TONGA
Nuku'alofa
TONGATAPU
VAVA'U
AUSTRAL ISLANDS
GAMBIER IS
PITCAIRN
RAPA
NEW HEBRIDES (CONDOMINIUM)
ESPIRITU SANTO
MALEKULA
EFATE
Vila
VANUA LEVU
VITI LEVU
Suva
FIJI
NEW CALEDONIA AND DEPENDENCIES
Noumea
LOYALTY ISLANDS
NORFOLK
KERMADEC ISLANDS
LORD HOWE
NEW ZEALAND
Auckland
Wellington
AUSTRALIA
Darwin
Cairns
Townsville
Rockhampton
Brisbane
Newcastle
Sydney
Canberra
A.C.T.
Adelaide
Melbourne
TASMANIA
NORTHERN TERRITORY
QUEENSLAND
NEW SOUTH WALES
VICTORIA
SOUTH AUSTRALIA
Tropic of Cancer
Tropic of Capricorn
Equator
East of Greenwich
West of Greenwich

Why is conservation of nature so important? Man depends on nature for much of what he needs to live, and indeed lives within a natural system, the biosphere of the planet. While many modern needs are met from agriculture or manufacturing, agriculture itself is based on natural systems, on plants and animals originally found in nature which were adapted to man's need. As the world runs out of nonrenewable resources such as oil and minerals, it will need to turn more and more to natural systems to find alternative materials and processes on which to base civilization. It is to natural systems that scientists frequently look for new medicines and chemicals, new biological controls for pests and diseases, new sources of food or materials for industry, and many other things. Natural systems are like genetic banks from which new biological materials are withdrawn when they are needed. This is particularly true in islands where, because of their geographical isolation, evolution has produced many unique kinds of plants and animals found nowhere else in the world. It is therefore in the long-term interests of island governments to ensure that appropriate viable samples of all their natural systems are protected or conserved in some way to keep them available for future generations.

It is not possible to put a monetary value on each unusual or endemic species (a species found only on one island or territory). We do not know in advance what use, if any, might be found for each of these species. However there are many examples of rare or endemic species which have had very great economic importance. The Monterey pine (*Pinus radiata*) is an endemic species of the California coast with little local economic value; however, it has been introduced to New Zealand and other countries where it is now the basis for much of the forest industry. An obscure insect in one country may be found to be the ideal biological control for an important agricultural pest somewhere else. Allowing our natural environments, habitats, and species to be destroyed is rather like throwing away a box of rocks because we cannot tell which ones are worthless and which ones are uncut jewels of great value.

There are more immediate reasons for conserving nature. Many developing countries have found that conservation areas such as national parks can provide the basis for tourism, one of the important money-earners in many economies. Many Pacific Islands have been trying to develop tourism, but few have taken the necessary steps to develop attractions for tourists, such as areas of scenic beauty and natural interest appropriately protected in parks so that they will not be destroyed by the very visitors they are meant to attract. Conservation can therefore mean new jobs in the tourist industry as well as in the management and protection of reserve areas. Conservation also contributes to the quality of life of the local inhabitants by providing them with areas for rest and recreation where they can go to learn about the environment within which their traditional culture and island way of life evolved. Indeed, conservation in the broadest sense is the continuation into the future of the same wise management of natural resources that was an important part of most island cultures in the past.

Conservation is also essential to science. Reserve areas can provide natural laboratories in which biologists and other scientists can study the processes of evolution and the maintenance of natural ecosystems. Many great biological discoveries on which modern progress in medicine, agriculture and other fields has been based have been made in island areas.

Governments should therefore, as a matter of policy, decide to set aside, in some kind of appropriate reserve or conservation area, viable samples (i.e. samples able to maintain themselves) of each of the natural communities or ecosystems found in their country or territory. The purpose of this report is to provide a practical guide to conservation needs in the Pacific Islands. It should be regarded as an interim step in conservation planning.

It is not possible in a survey of this scope to go into great detail in describing the natural systems of each island. Defined here are the *regional* needs for conservation. Each government should take this foundation and build upon it a detailed plan for national conservation areas. The steps necessary to develop a national conservation plan are included in the recommendations at the end of this report.

It should be emphasised that any system of classification such as this depends on scientific judgments that are constantly subject to modification and change in the light of new information. The conclusions of this report are preliminary and will need to be modified as more detailed surveys are undertaken of the natural resources of the Pacific Islands.

PREVIOUS WORK

This is not the first attempt to review the need for, and progress of, conservation in the Pacific Islands. More than 40 years ago, the Standing Committee for the Protection of Nature of the Pacific Science Association began collecting information on the conservation needs of the Pacific Islands. Then, as now, conservation in the islands concerned the protection of island cultures and peoples as well as nature (Skottsberg, 1940). More recently the International Biological Programme conducted studies of Pacific Islands (Mueller-Dombois, 1973), producing a check list of Pacific Oceanic Islands (Douglas, 1969) and recommending certain remote islands for designation as Islands for Science (Nicholson and Douglas, 1970; Elliott, 1973). The Regional Symposium on Conservation of Nature - Reefs and Lagoons organised by SPC and IUCN in Noumea in August 1971 also reviewed conservation needs and status for the Pacific (South Pacific Commission, 1973) and the South Pacific Conference on National Parks and Reserves in Wellington, New Zealand, in February 1975 provided the opportunity for conservation reports by many countries and territories of the region (National Parks Authority, 1975). Further materials were presented at the Second Regional Symposium on Conservation of Nature in Apia, Western Samoa in June 1976. At the same time, a Plenipotentiary Meeting concluded a Convention on Conservation of Nature in the South Pacific which is now undergoing ratification. The situation reports given at the Second South Pacific Conference on National Parks and Reserves (Sydney, Australia, April 1979) provided the most recent update of the conservation situation in the region. This information has been drawn upon freely in this present report.

B. CLASSIFICATION AND CHARACTERISATION OF ECOSYSTEMS

WHAT IS AN ECOSYSTEM?

An ecosystem consists of all the organisms - plants, animals and micro-organisms - that occur in a given area, together with the non-living elements of the environment. The term *ecosystem* is used because the living and non-living elements are closely interrelated in a functioning system with producing, consuming, decomposing and non-living components. An ecosystem has therefore a spatial definition (it occurs in a definable area) and a functional definition (the parts of the system are interdependent and maintain at least temporary stability).

Both of these ecosystem characteristics are essential for conservation. Parks and reserves are geographical units containing one or more ecosystems, but to be effective they must include enough of the ecosystem components to maintain the stability and continuity of the system over time.

Because of the great interdependence of organisms within an ecosystem many species can only survive as part of the system within which they evolved. Conservation of species therefore generally means conservation of the ecosystems of which they form a part.

In islands, because of their small size and isolation, many unique ecosystems have evolved that are often limited in total size. Such ecosystems are particularly easy to destroy, and their conservation is therefore most urgent.

It may be helpful in picturing an ecosystem to make a comparison with an organism, perhaps some kind of animal. An animal is made up of many cells which depend on their relationship with other cells in the animal for their survival. In an ecosystem each individual organism would be like a cell. In an organism, the cells have different forms and different functions (bone, muscle and skin cells, for example); an ecosystem has many kinds of organisms with different roles (plants producing food, trees producing shelter, insects pollinating plants, etc.). If part of an animal, say its stomach, is taken out it will probably die; if part of an ecosystem is destroyed (cutting the trees in a forest), the rest of the system will be degraded or lost. The different species of plants and animals and micro-organisms are as important to an ecosystem as the various organs are to an animal.

Defining specific ecosystems is never easy since no natural system is ever totally independent of the others that surround it, and one almost always intergrades gradually into the next. It is only where there is a sharp distinction between physical environments, such as water and land, that the boundaries can sometimes be clearly defined. Definitions of ecosystems can also be based on various criteria, such as structural similarities or species composition. A coral atoll in the Caribbean may have the same structure and functional organisation as one in the Pacific, even though the species that make it up are almost completely different. This problem of defining distinct ecosystems becomes particularly acute in islands where each biological community has its own unique characteristics varying slightly (or greatly) from those on neighbouring islands, and where isolation has frequently led to the evolution of endemic species (species found nowhere else). Each government must decide for itself how much of this variability and uniqueness can be conserved in the light of present and future social, political and scientific needs.

ELEMENTS OF ECOSYSTEM DEFINITION

This survey is part of a world-wide project by IUCN to define the needs for the conservation of all the principal types of ecosystems in the biosphere. In developing this project, IUCN has prepared papers defining and classifying the biogeographic provinces of the world (Dassman, 1973; IUCN, 1974; Udvardy, 1975), and has produced a working

system for the classification of world vegetation (IUCN, 1973). These terrestrial projects are now being parallelled by efforts to characterise marine ecosystems (Ray, 1975). These global studies have provided the basis for the approach to ecosystem definition used here.

Geography

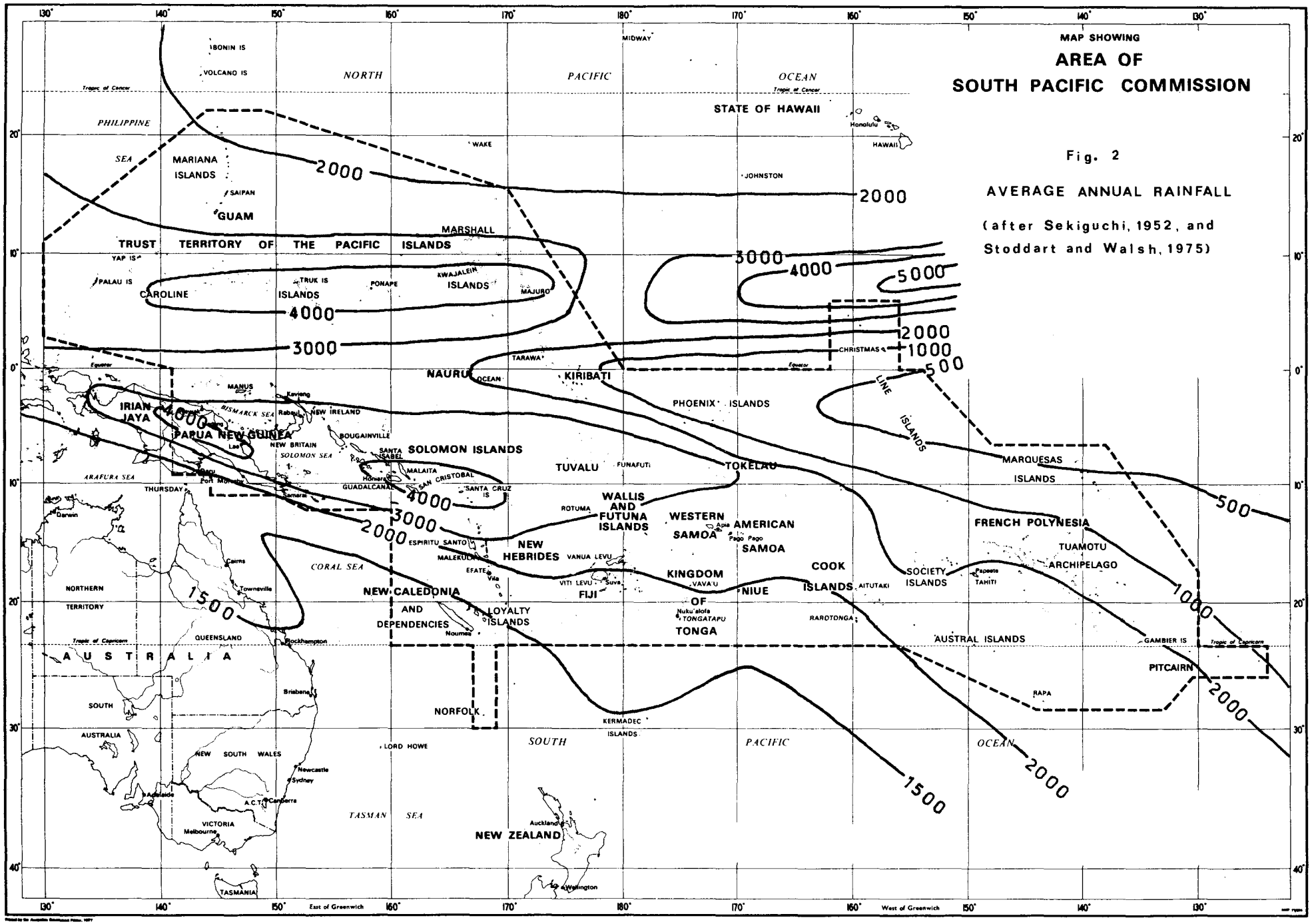
There are several different elements that contribute to the distinctiveness of ecosystems. The *biogeographic dimension* determines which organisms could colonise an island in the first place. The closer an island is to major centres of evolution and distribution such as Southeast Asia, the Indo-Malay Archipelago, Australia, or America, the greater the chance that species from those areas will have been able to colonise it. The amount of present and past isolation of the island is also important. During the changes in sea level and continental position that have occurred over geological time, certain islands have been joined by land bridges to other islands or to continents, permitting the migration and establishment of many more species than could fly, swim or drift or be flown to more isolated areas. Once a plant or animal is established, its subsequent isolation may permit it to evolve into new and unique forms, or may allow it to survive long after it has been out-competed and become extinct elsewhere. These facts help to explain the great diversity of island ecosystems and the uniqueness and scientific interest of their faunas and floras.

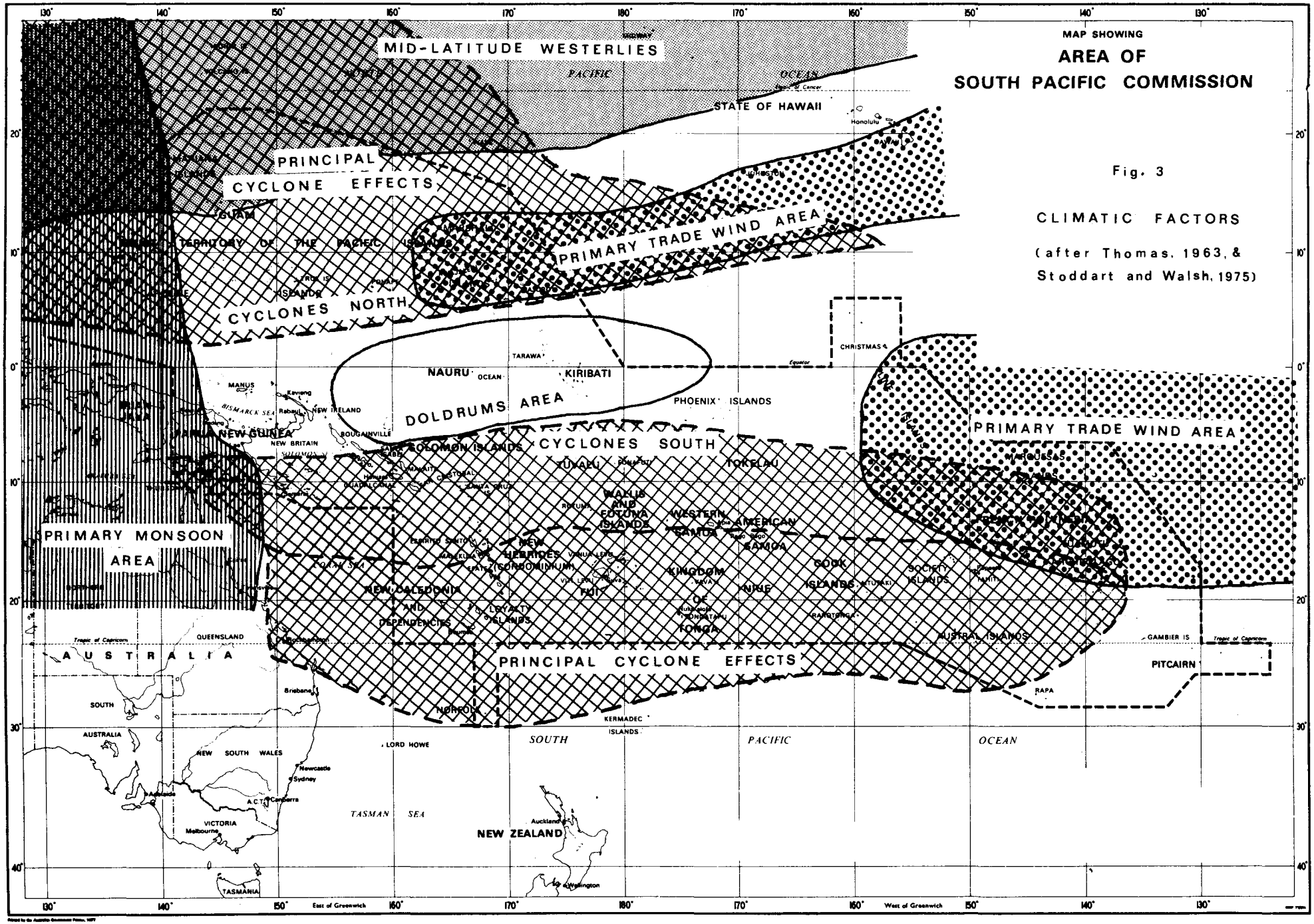
It is possible to recognise various biogeographic groupings on the basis of similarities or differences between the organisms of adjacent islands, such as those proposed by Curry-Lindahl (1975) for terrestrial animals or the biogeographic provinces proposed by IUCN (1974).

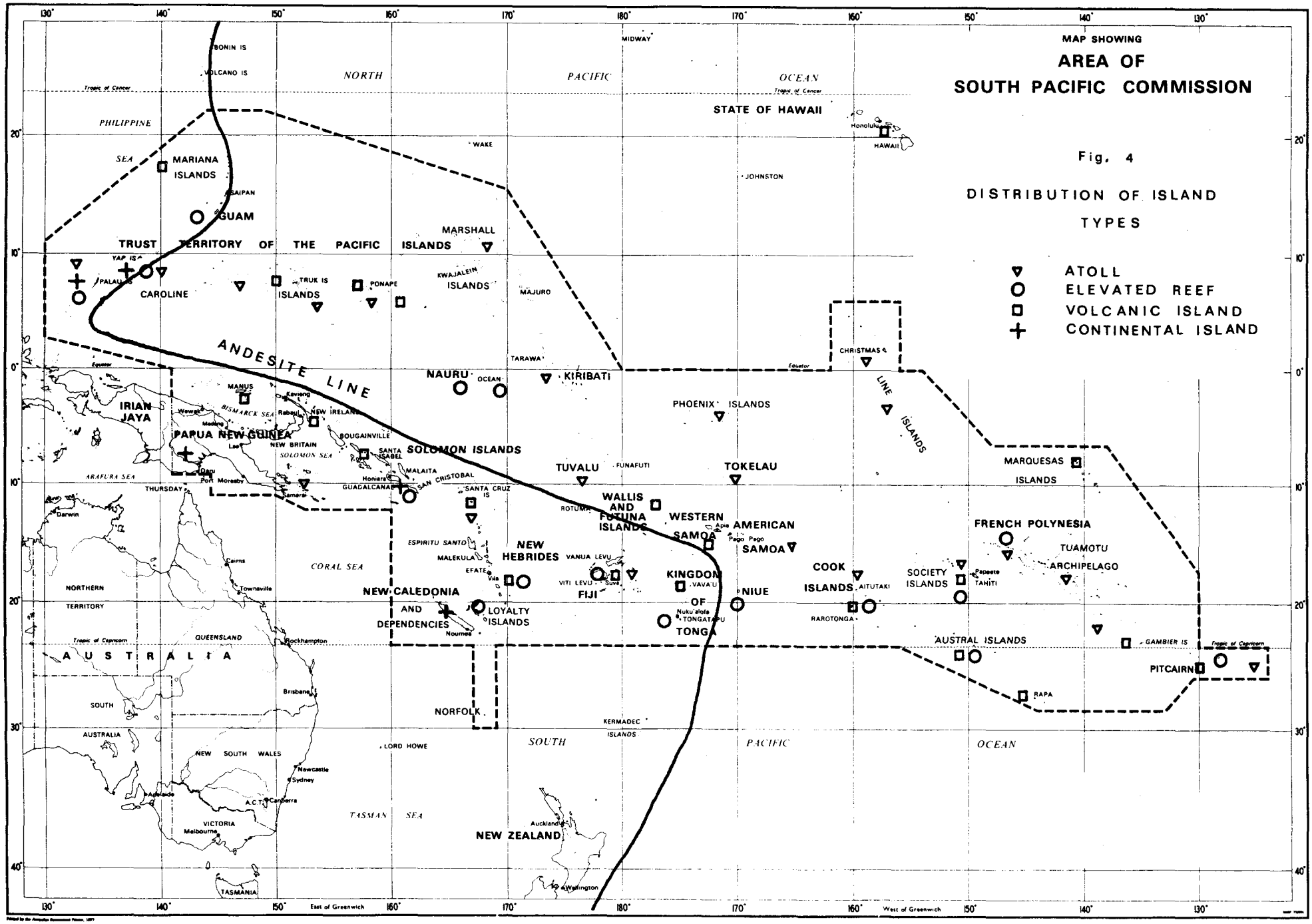
A second geographic element defining ecosystems is *climate,* particularly temperature (air and ocean) and rainfall. Almost all the SPC area lies within the tropics, a region noted for its warm and relatively constant temperatures. Tropical organisms tend to be sensitive to temperatures below their normal range, and hence are limited in their distribution by the temperature gradients north and south of the equator. Ocean water temperatures are determined both by climate and by the patterns of ocean currents which are also important in determining marine organism distributions. Rainfall is one of the critical parameters for terrestrial ecosystems, and varies widely throughout the Pacific Islands (Fig. 2). While average amounts of rain are very important, its distribution over time is also critical. Long dry spells interrupted by heavy downpours may provide the same total rainfall as frequent light showers, but will support a very different biological community. Even very rare extreme events can be significant (Stoddart and Walsh, 1975). A severe drought occurring once a century can permanently alter an island's population composition, as can a cyclone which flattens forests, smashes corals and floods low-lying areas. Some significant climatic factors in the Pacific are mapped in Fig. 3.

Island structure

The *physical structure* of the island itself is also a major determinant of the ecosystems present. High volcanic islands will provide many more habitat types than low coral islands. Continental islands occurring west of the Andesite Line will tend to be larger and to have a greater variety of soil types and landforms than oceanic islands. Elevated atolls or coral platforms can support more varied populations than reef islands just at sea level. The islands of the Pacific represent a complex mix of all of these forms (Fig. 4) and even a single island may be composed of several structural types. These island forms also respond differently to climatic and geographic factors. Low islands are more likely to be flooded and their terrestrial populations exterminated at times of rising sea level. High islands produce their own climatic differences, such as increased rainfall in mountain areas, wet and dry sides of the island and temperature gradients with altitude, each of which can lead to distinctive ecosystem components. Marine habitats are similarly affected, with the many reef forms and lagoon types determined by the structure and history of the island substrate (Thomas, 1963; Dahl, Macintyre and Antonius, 1974).


MAP SHOWING
AREA OF
SOUTH PACIFIC COMMISSION
Fig. 2
AVERAGE ANNUAL RAINFALL
(after Sekiguchi, 1952, and
Stoddart and Walsh, 1975)
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
PHILIPPINE SEA
TASMAN SEA
CORAL SEA
ARAFURA SEA
BISMARCK SEA
SOLOMON SEA
STATE OF HAWAII
Honolulu
HAWAII
MIDWAY
WAKE
JOHNSTON
IBONIN IS
VOLCANO IS
MARIANA ISLANDS
SAIPAN
GUAM
MARSHALL ISLANDS
TRUST TERRITORY OF THE PACIFIC ISLANDS
YAP IS
PALAU IS
CAROLINE ISLANDS
TRUK IS
PONAPE
KWAJALEIN
MAJURO
TARAWA
NAURU
KIRIBATI
CHRISTMAS
LINE ISLANDS
PHOENIX ISLANDS
MARQUESAS ISLANDS
TUVALU
FUNAFUTI
TOKELAU
MANUS
Kavieng
NEW IRELAND
Rabaul
IRIAN JAYA
PAPUA NEW GUINEA
Lae
NEW BRITAIN
BOUGAINVILLE
SOLOMON ISLANDS
SANTA ISABEL
MALAITA
Honiara
GUADALCANAL
SAN CRISTOBAL
SANTA CRUZ IS
Port Moresby
Samarai
THURSDAY
ROTUMA
WALLIS AND FUTUNA ISLANDS
WESTERN SAMOA
Apia
AMERICAN SAMOA
Pago Pago
FRENCH POLYNESIA
TUAMOTU ARCHIPELAGO
ESPIRITU SANTO
MALEKULA
NEW HEBRIDES
VANUA LEVU
EFATE
Vila
VITI LEVU
Suva
FIJI
KINGDOM OF TONGA
VAVA'U
Nuku'alofa
TONGATAPU
NIUE
COOK ISLANDS
AITUTAKI
RAROTONGA
SOCIETY ISLANDS
Papeete
TAHITI
NEW CALEDONIA AND DEPENDENCIES
Noumea
LOYALTY ISLANDS
AUSTRAL ISLANDS
GAMBIER IS
PITCAIRN
RAPA
NORFOLK
KERMADEC ISLANDS
LORD HOWE
Darwin
Cairns
Townsville
Rockhampton
Brisbane
NORTHERN TERRITORY
QUEENSLAND
AUSTRALIA
SOUTH AUSTRALIA
NEW SOUTH WALES
Newcastle
Sydney
Adelaide
A.C.T.
Canberra
VICTORIA
Melbourne
TASMANIA
NEW ZEALAND
Auckland
Wellington
Tropic of Cancer
Tropic of Capricorn
Equator
East of Greenwich
West of Greenwich
2000
3000
4000
5000
1000
500
1500


MAP SHOWING
AREA OF
SOUTH PACIFIC COMMISSION
Fig. 3
CLIMATIC FACTORS
(after Thomas, 1963, & Stoddart and Walsh, 1975)
MID-LATITUDE WESTERLIES
PRINCIPAL CYCLONE EFFECTS
PRIMARY TRADE WIND AREA
CYCLONES NORTH
DOLDRUMS AREA
CYCLONES SOUTH
PRIMARY TRADE WIND AREA
PRIMARY MONSOON AREA
PRINCIPAL CYCLONE EFFECTS
PACIFIC OCEAN
STATE OF HAWAII
Honolulu
GUAM
TERRITORY OF THE PACIFIC ISLANDS
JOHNSTON
CHRISTMAS
NAURU
KIRIBATI
TARAWA
PHOENIX ISLANDS
MANUS
Kavieng
NEW IRELAND
Rabaul
BISMARCK SEA
PAPUA NEW GUINEA
NEW BRITAIN
BOUGAINVILLE
SOLOMON ISLANDS
TUVALU
TOKELAU
MARQUESAS
WALLIS AND FUTUNA ISLANDS
WESTERN SAMOA
AMERICAN SAMOA
NEW HEBRIDES (VANUATU)
FIJI
NEW CALEDONIA AND DEPENDENCIES
LOYALTY ISLANDS
KINGDOM OF TONGA
NIUE
COOK ISLANDS
SOCIETY ISLANDS
AUSTRAL ISLANDS
GAMBIER IS
PITCAIRN
RAPA
Tropic of Capricorn
AUSTRALIA
QUEENSLAND
Brisbane
SOUTH AUSTRALIA
NEW SOUTH WALES
Newcastle
Sydney
Adelaide
A.C.T.
Canberra
VICTORIA
Melbourne
TASMANIA
LORD HOWE
NORFOLK
KERMADEC ISLANDS
TASMAN SEA
NEW ZEALAND
Auckland
Wellington
SOUTH PACIFIC OCEAN
East of Greenwich
West of Greenwich


MAP SHOWING
AREA OF
SOUTH PACIFIC COMMISSION
Fig. 4
DISTRIBUTION OF ISLAND TYPES
ATOLL
ELEVATED REEF
VOLCANIC ISLAND
CONTINENTAL ISLAND
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
PHILIPPINE SEA
CORAL SEA
TASMAN SEA
ARAFURA SEA
BISMARCK SEA
SOLOMON SEA
ANDESITE LINE
Tropic of Cancer
Tropic of Capricorn
Equator
East of Greenwich
West of Greenwich
BONIN IS
VOLCANO IS
MIDWAY
STATE OF HAWAII
Honolulu
HAWAII
WAKE
JOHNSTON
MARIANA ISLANDS
SAIPAN
GUAM
TRUST TERRITORY OF THE PACIFIC ISLANDS
MARSHALL ISLANDS
YAP IS
PALAU IS
CAROLINE ISLANDS
TRUK IS
PONAPE
KWAJALEIN ISLANDS
MAJURO
TARAWA
CHRISTMAS
NAURU
KIRIBATI
PHOENIX ISLANDS
LINE ISLANDS
MANUS
Kavieng
Rabaul
NEW IRELAND
IRIAN JAYA
Wewak
Madang
PAPUA NEW GUINEA
Lae
NEW BRITAIN
BOUGAINVILLE
SANTA ISABEL
SOLOMON ISLANDS
Dobu
Port Moresby
MALAITA
Honiara
GUADALCANAL
SAN CRISTOBAL
SANTA CRUZ IS
TUVALU
FUNAFUTI
TOKELAU
MARQUESAS ISLANDS
THURSDAY I.
Samarai
ROTUMA
WALLIS AND FUTUNA ISLANDS
WESTERN SAMOA
Apia
AMERICAN SAMOA
Pago Pago
FRENCH POLYNESIA
TUAMOTU ARCHIPELAGO
Darwin
ESPIRITU SANTO
MALEKULA
EFATE
Vila
NEW HEBRIDES
VANUA LEVU
VITI LEVU
Suva
FIJI
KINGDOM OF TONGA
Nuku'alofa
TONGATAPU
VAVA'U
NIUE
COOK ISLANDS
AITUTAKI
RAROTONGA
SOCIETY ISLANDS
Papeete
TAHITI
Cairns
Townsville
NORTHERN TERRITORY
NEW CALEDONIA AND DEPENDENCIES
Noumea
LOYALTY ISLANDS
QUEENSLAND
Rockhampton
AUSTRALIA
AUSTRAL ISLANDS
GAMBIER IS
PITCAIRN
RAPA
Brisbane
SOUTH AUSTRALIA
NORFOLK
KERMADEC ISLANDS
LORD HOWE
NEW SOUTH WALES
Newcastle
Sydney
Adelaide
A.C.T.
Canberra
VICTORIA
Melbourne
TASMANIA
NEW ZEALAND
Auckland
Wellington
130°
140°
150°
160°
170°
180°
10°
20°
30°
40°

Biomes

Finally, as ecosystems evolve, they develop their own structural characteristics based on their physiognomies or life forms, which help to determine their own environments. They may be characterised by certain dominant species or functional types, or by a particular type of habitat with which they are associated. These distinctions of biological structure and habitat provide the principal basis for defining the biomes which constitute the largest scale of functional biological unit, and thus generally correspond to the ecosystem level in any given area.

A survey and classification of Pacific Island ecosystems must be based on all of these approaches, much as Ray (1975) has classified marine environments on the basis of zoogeographic regions, biotic provinces and habitats. This is because a biome such as lowland rain forest may be structurally and functionally similar in two geographically separate areas even though composed of different species of plants, and even in the same area may differ in composition depending on the side of the island or the kind of substrate. The following classification is based on such an approach, combining a biogeographic view embodied in a list of biogeographic provinces, a structural view incorporating the principal island types and a biome view categorising the principal vegetation units and habitats. In principle each biome type occurring on each island type or structural unit in each biogeographic province should be considered as a distinctive ecosystem. Some critical habitats such as breeding areas have also been added because of their conservation importance.

C. REGIONAL ECOSYSTEMS SURVEY

Biogeographic Provinces of the Pacific Islands

IUCN (1974) has proposed 19 terrestrial biotic (biogeographic) provinces for the SPC area, as follows: New Guinea, Bismarck Archipelago, Solomon Islands, New Caledonia - Loyalty, New Hebrides, Lord Howe - Norfolk, Fiji Islands, Tonga - Kermadec, Samoa - Ellice, Tokelau - Phoenix - Manihiki, Kiribati - Nauru, Mariana Islands, Caroline Islands, Marshall Islands, Johnston - Palmyra - Christmas, Cook - Austral, Society Islands, Tuamotus and Marquesas. For the marine fauna, Ray (1975) placed the entire area within the Central Pacific Islands Subprovince of the Indo-West Pacific Tropical Warm Water Shelf Province. Ray comments that, in relation to the very rich Indo-Malayan centre, the subprovince is somewhat impoverished in biota, becoming more so to the east. While there may be many marine species in common throughout the region, the biotic gradient is such that the resulting ecosystems may be quite distinctive in different areas. It would probably therefore be wise, pending further research, to treat both coastal marine and terrestrial ecosystems in accordance with the same series of biogeographic provinces. A modified list of biogeographic provinces is therefore proposed below and mapped in Fig. 5. Some alterations have been made in the IUCN (1974) proposals to provide more logical groupings by island structural types and climatic situations, both of which are principal biotic determinants. The Santa Cruz Islands (Solomon Islands) have been regrouped with the New Hebrides with which they have closer affinities. Tuvalu (former Ellice Is.) and Tokelau are similarly regrouped, as are the Northern Cook (Manihiki), Phoenix and Line Islands. An additional province has been created for the eastern, more temperate volcanic islands of Pitcairn, Rapa and the Gambier Islands. There may be some value in separating the Eastern and Western Caroline Islands, and in combining some of the strictly atoll provinces, but this should await further studies, particularly of the marine fauna and flora.

Biogeographic provinces can be most useful in suggesting the general species composition to be expected in an area. However, the high levels of endemism in certain islands greatly complicate matters, and require that even within biogeographic provinces, each island must be considered as a somewhat distinct entity. Furthermore, distinctions between provinces are not always clear-cut, with some islands (Loyalty Islands for example) representing intermediates between adjacent areas. This matter will be treated in more detail in the discussions of each island group.

BIOGEOGRAPHIC PROVINCES OF THE SOUTH PACIFIC COMMISSION AREA (Australian Region)

Code No.	Biogeographic Province	IUCN Code No.
I	New Guinea	6.12. 2
II	Bismarck Archipelago	6.12. 3
III	Solomon Islands	6.12. 4 (Modified)
IV	New Caledonia - Loyalty Islands	6.12. 5
V	New Hebrides - Santa Cruz Islands	6.12. 6 (Modified)
VI	Norfolk - Lord Howe - Kermadec	6.12. 7 (Modified)
VII	Fiji	6.12.10
VIII	Tonga - Niue	6.12.11 (Modified)
IX	Samoa - Wallis and Futuna	6.12.12 (Modified)
X	Tuvalu - Tokelau	6.12.13 (Modified)
XI	Kiribati - Nauru	6.12.14
XII	Mariana Islands	6.12.15
XIII	Caroline Islands	6.12.16
XIV	Marshall Islands	6.12.17
XV	Phoenix - Line - Northern Cook Islands	6.12.18 (Modified)

Code No.	Biogeographic Province	IUCN Code No.
XVI	Cook - Austral Islands	6.12.19
XVII	Society Islands	6.12.20 (Modified)
XVIII	Tuamotu Archipelago	6.12.21
XIX	Marquesas Islands	6.12.22
XX	Pitcairn - Gambier Islands - Rapa	None

STRUCTURAL TYPES

The type of island on which a biological community occurs can have a major effect on the community composition, largely as a result of landform and substrate characteristics. There are four principal island types: continental, volcanic, elevated reef and sea level reef (Thomas, 1963), each of which provides certain special structural characteristics. Islands are often composed of more than one type (such as an elevated coral platform or sea-level beach deposit on a volcanic island), in which case each type should generally be considered as distinctive for purposes of ecosystem classification. The following list of structural characteristics is intended to be neither complete nor mutually exclusive, but merely to suggest certain factors which may delineate distinctive ecosystems.

Continental type

Composed of sedimentary, metamorphic, igneous or other rocks of continental origin (occurring west of the Andesite Line), and of soils derived therefrom, generally islands of large size with complex landforms.

Serpentine or metalliferous soils occurring on such islands may have highly distinctive plant communities.

Slope-limited vegetation may be found in geologically active areas, where the steepness and instability of mountain sides result in specially-adapted communities.

Orographic rainfall (produced by clouds rising over mountains) may be *high* or *low*, depending on the situation, producing wet and dry areas.

Volcanic type

Islands built by volcanic activity and therefore with substrates derived from lava (usually basalt) and volcanic ash.

Recent volcanic substrates may have specialised pioneer communities, and there may be many gradations between these and the mature ecosystems of *weathered volcanic* soils. Again there may be *slope-limited* communities as well as zones of *high* and *low orographic* rainfall (the wet and dry sides of many volcanic islands).

Elevated reefs

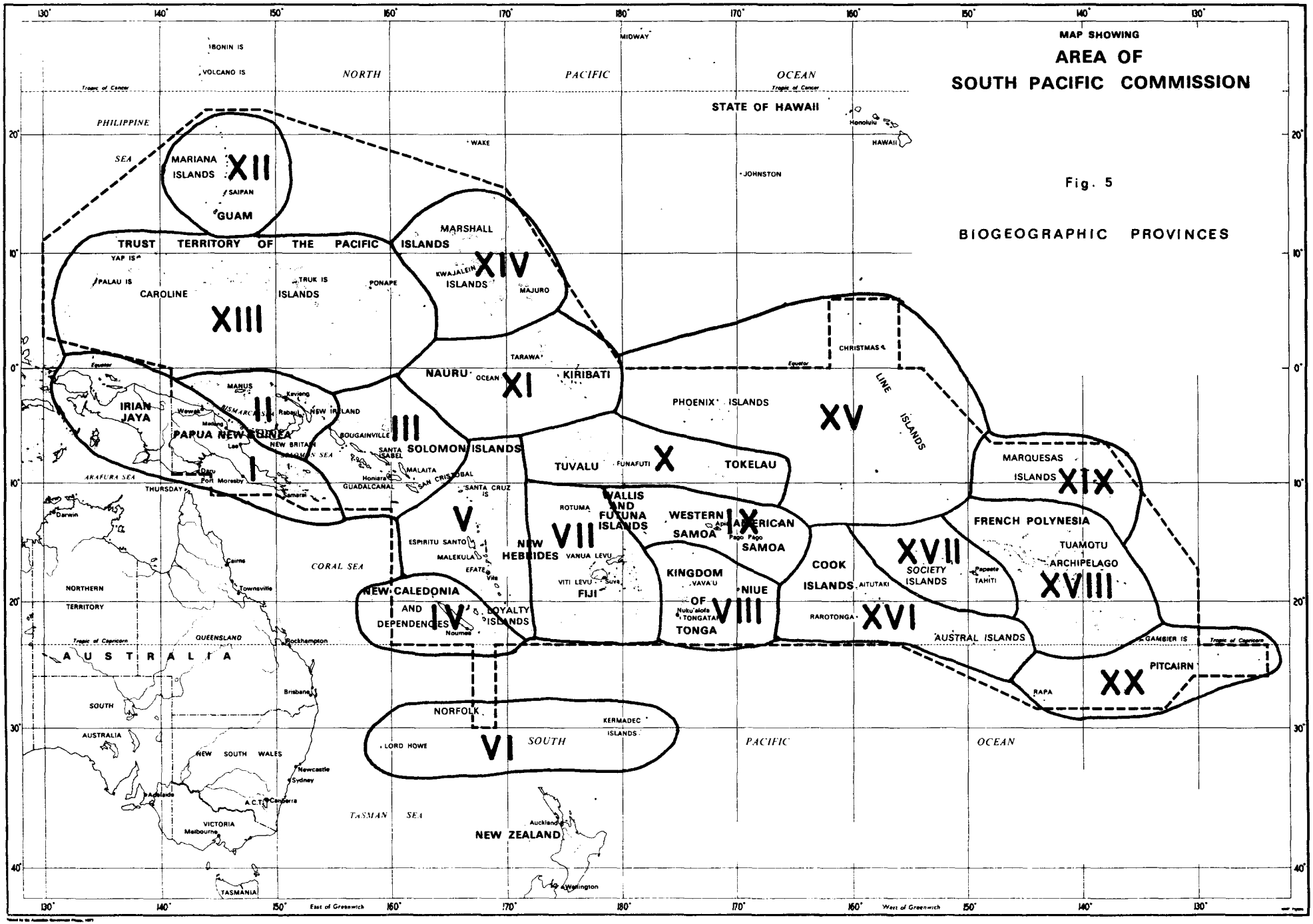
Islands or parts of islands composed of raised coral platforms or limestone. Two significant types may be distinguished as having:

overlying non-calcareous soil derived from volcanic ash or alluvial deposits, or

little or no overlying soil, frequently with exposed rock in rugged karst or pinnacle formations.

Low islands

Composed of sand and coral rubble accumulated on a reef platform at or near sea-level. This is the typical type on atolls and barrier reefs, and also frequently as coastal or beach areas on other island types.


MAP SHOWING
AREA OF
SOUTH PACIFIC COMMISSION
Fig. 5
BIOGEOGRAPHIC PROVINCES
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
PHILIPPINE SEA
TASMAN SEA
CORAL SEA
ARAFURA SEA
STATE OF HAWAII
MIDWAY
WAKE
JOHNSTON
MARIANA ISLANDS
XII
SAIPAN
GUAM
TRUST TERRITORY OF THE PACIFIC ISLANDS
YAP IS
PALAU IS
CAROLINE ISLANDS
XIII
TRUK IS
PONAPE
MARSHALL ISLANDS
KWAJALEIN
MAJURO
XIV
NAURU
TARAWA
KIRIBATI
XI
CHRISTMAS
LINE ISLANDS
PHOENIX ISLANDS
XV
IRIAN JAYA
II
MANUS
Kavieng
Rabaul
NEW IRELAND
PAPUA NEW GUINEA
Wewak
Madang
Lae
NEW BRITAIN
BOUGAINVILLE
III
SOLOMON ISLANDS
SANTA ISABEL
MALAITA
Honiara
GUADALCANAL
SAN CRISTOBAL
I
Daru
Port Moresby
Samarai
THURSDAY
SANTA CRUZ IS
TUVALU
FUNAFUTI
X
TOKELAU
MARQUESAS ISLANDS
XIX
FRENCH POLYNESIA
TUAMOTU ARCHIPELAGO
XVIII
SOCIETY ISLANDS
Papeete
TAHITI
XVII
V
ESPIRITU SANTO
MALEKULA
EFATE
Vila
NEW HEBRIDES
VANUA LEVU
VITI LEVU
Suva
FIJI
ROTUMA
WALLIS AND FUTUNA ISLANDS
WESTERN SAMOA
IX
AMERICAN SAMOA
Apia
Pago Pago
NEW CALEDONIA AND DEPENDENCIES
IV
Noumea
LOYALTY ISLANDS
KINGDOM OF TONGA
VAVA'U
Nuku'alofa
TONGATAPU
VIII
NIUE
COOK ISLANDS
AITUTAKI
RAROTONGA
XVI
AUSTRAL ISLANDS
GAMBIER IS
PITCAIRN
RAPA
XX
NORFOLK
LORD HOWE
KERMADEC ISLANDS
VI
NEW ZEALAND
Auckland
Wellington
AUSTRALIA
Darwin
Cairns
Townsville
Rockhampton
Brisbane
NORTHERN TERRITORY
QUEENSLAND
SOUTH AUSTRALIA
NEW SOUTH WALES
Newcastle
Sydney
Canberra
A.C.T.
Adelaide
VICTORIA
Melbourne
TASMANIA
Tropic of Cancer
Tropic of Capricorn
Equator
East of Greenwich
West of Greenwich

Similar structural criteria apply in the marine environment, particularly with respect to the nature of the substrate. The following categories can be identified:

Rocky substrate

calcareous
non-calcareous

Sedimentary substrate (unconsolidated)

gravels
sands
silts
clays
high organic content

Additionally, reef community structure can be significantly different if, over recent geological time, the island is: *submerging, emerging,* or *apparently stationary* relative to sea level. Exposure to waves and storms also alters ecosystem form, so distinctions between *exposed* and *protected* marine environments are appropriate in many instances.

The above categories will generally be useful to subdivide the biome types described below when it is apparent that there is considerable ecosystem diversity within the biome. It is not, however, practical to introduce most of these distinctions at the level of the present study.

PACIFIC ISLAND BIOMES AND HABITATS

A biome is the largest biological community unit and generally, either singly or in some combination, corresponds to an ecosystem type. Biomes are usually defined by major habitat distinctions, by dominant species or by aspects of the community structure. On land, most biomes are distinguished by the principal type of vegetation; in the sea, environmental or substrate factors may be as important as dominant plants or benthic (bottom dwelling) animals in determining a biome and habitat classification. The following list for the tropical Pacific Islands is based on the vegetation classification prepared by IUCN (1973) for terrestrial environments, and the habitat list for marine areas proposed by Ray (1975), with major modifications and additions as appropriate to integrate the two and to adapt them to the regional situation. The vegetation classification, drawn largely from that for the humid tropics, has been simplified by the elimination of certain categories; it may be that others can be deleted as well, or that some will need to be added for particular local situations (such as the barren desert category for recent volcanic deposits).

In classifying marine biomes and habitats, it is important to recognise that biological communities may exist in the water mass as well as on the bottom. These can sometimes be considered together as single ecosystems; in other situations it is more convenient to separate them. Certain coastal biomes such as mangroves and salt marshes have both terrestrial and marine components. A few organisms, such as sea birds, sea turtles and migrating fish populations, move between biomes and thus must be given special treatment by distinguishing their critical habitats.

There are an increasing number of man-made biomes such as planted forest areas, mine spoil and tailings areas, man-made lakes, areas of dredge spoil, artificial reefs, etc., but these have been largely excluded from the present survey.

Forests *IUCN Number*

Formed by trees at least 5 m tall with crowns usually interlocking.

Tropical rain forests

Consisting mainly of evergreen trees, many with little or no bud protection, neither cold nor drought resistant. Truly evergreen, i.e. the forest canopy

IUCN Number

remains green throughout the year, but individual trees may stand leafless for a few weeks only and not at the same time with all others.

Lowland rain forest 1.1.1.1.
Composed usually of numerous species of fast-growing trees, many of them exceeding 40 m in height, generally with smooth, often thick bark, some with plank buttresses. Emergent trees often present or at least a very uneven canopy. Very sparse undergrowth, and this composed mainly of young trees. Palms and other tuft trees usually rare. Crustose lichens and green algae are the only constantly present epiphytic life forms; vascular epiphytes are usually not abundant except in excessively humid situations.

Montane/submontane rain forest 1.1.1.2.
Emergent trees largely absent and canopy relatively even. Vascular epiphytes and pseudo-lianas abundant. Tree heights usually less than 50 m; crowns extending relatively far down the stem. Bark often more or less rough. Undergrowth abundant, often represented by tree ferns or small palms or bamboos. May be dominated by trees which are broad-leaved (commonest form), needle-leaved or small-leaved.

Bamboo forest 1.1.1.3.
Dominated by bamboo. Common in tropical mountains but may occur also in lowlands.

Cloud forest 1.1.1.4.
Tree crowns, branches and trunks as well as lianas burdened with epiphytes, mainly bryophytes or lichens. Ground covered with club mosses and ferns. Trees often gnarled, with rough bark, rarely exceeding 20 m in height. Most commonly broad-leaved but may be needle-leaved or small-leaved.

Riverine forest 1.1.1.5.
Similar to submontane forest, but richer in palms and in undergrowth life-forms, particularly tall forbs (e.g. Musaceae); plank-buttresses frequent. Characteristic of areas which are: (1) riparian (on the lowest forested river banks, frequently flooded); (2) occasionally flooded (on relatively dry terraces accompanying active rivers); or (3) seasonally waterlogged (along the lower river courses, where the water accumulates on large flats for several months).

Swamp and bog forest 1.1.1.6.
Not along rivers, but on wet soils, which may be supplied with either fresh or brackish water. Similar to riverine forest, but relatively poor in tree species. Many trees with buttresses, stilt roots or pneumatophores; mostly taller than 20 m, dominated by broad leaved trees or palms. Where organic surface deposits occur, poor in tree species and with canopy often forming a pattern of tall trees at the bog fringe and shorter trees near the centre.

Tropical/subtropical seasonal forest 1.1.2.

This is transitional between rain forest and semi-deciduous forest. Consists mainly of evergreen trees with some bud protection. Foliage reduction during dry season is noticeable, often as partial shedding.

	IUCN Number
Tropical/subtropical semi-deciduous forest Most of upper canopy trees drought deciduous. Understorey trees and shrubs evergreen, often sclerophyllous. Various mixtures occur (e.g. shrubs may be deciduous and trees evergreen). Trees rough-barked except for bottle trees which may be present.	1.1.3.
Subtropical rain forest Grading into tropical rain forest but marked by more distinct seasonal rhythms. Trees less vigorous than in tropical forest and more shrubs are present in understorey. Subdivisions similar to those of tropical rain forests may be noted.	1.1.4.
Mangrove forest Sclerophyll broad-leaved trees and shrubs with either stilt roots or pneumatophores. Occurs in tidal range along ocean shores and estuaries. Epiphytes, except lichens or algae, are rare.	1.1.5.
Atoll/beach strand forest Species-poor community of trees such as *Pisonia* and *Casuarina* and shrubs occurring on calcareous sand and rubble deposits on islets and on coastal beach strand within a few metres of sea level.	None
Woodland Formed by trees at least 5 m high, with most of their crowns not touching each other, but covering at least 30 per cent of the surface; grass or shrub cover sometimes present. This formation class does not include savannas or parklands.	2.
Scrub Scrublands or thickets. Mainly composed of woody shrubs to 5 m high.	3.
Serpentine vegetation Plant communities adapted to metalliferous serpentine or ultrabasic soils. This substrate condition can also be used as a subdivision of other vegetation types.	None
Dwarf scrub and related communities Woody plants rarely exceeding 50 cm in height (sometimes called heaths or heath-like formations).	None
Dwarf-shrub heath Closed or open cover of mainly evergreen dwarf shrubs, often with moss or lichen understorey. When open, often in clumps, colonies, or cushions and may have forb or grass cover in open areas.	4.1.1.
Bog Often sedges are abundant. Sphagnum or other moss cover; peat accumulation. Some woody shrubs may be present.	4.3.
Herbaceous	
Savanna Tropical or sub-tropical grasslands or parklands with trees and shrubs covering not more than 30 per cent of the ground.	

Alpine meadow — 5.3.2.
Complex meadow and bog communities in high mountains above the tree line.

Woodland savanna — 5.1.1.1.
Dominated by grasses with forest islands or patches of woodland.

Tree savanna — 5.1.1.2. & 5.1.2.1.
Grass cover with isolated trees dispersed regularly over the area.

Shrub savanna — 5.1.1.3. & 5.1.2.2.
Thickets or shrublands in an area dominated by grass.

Grassland — 5.1.1.4. & 5.1.2.3.
Grass with few or no woody plants.

Flood savanna — 5.1.1.5.
Grass periodically flooded, with tree or scrub islands.

Wetlands

Fresh water marsh — 5.5.1.
Herbaceous formations on constantly or periodically flooded and waterlogged ground without or with few woody plants (*Carex, Juncus, Cyperus, Scirpus* are characteristic genera).

Salt marsh — 5.5.2.
Salt-tolerant herbaceous or partly woody formations in areas periodically or constantly flooded or waterlogged. Water saline or alkaline.

Tidal salt marsh with marine environment subject to tidal flooding

Non-tidal salt marsh and flats

Barren desert

In the South Pacific area, desert-type conditions are only found naturally on recent volcanic deposits and on small islands lacking water or occasionally affected by sea water. Mining may also produce desert conditions.

Rock desert — 6.1.

Ground surface dominated by bare rocks or screes with occasional plant cover in crevices, fissures, etc.

Sand desert — 6.2.

Ground surface dominated by wind-blown sand, often forming dunes. Vegetation scarce or absent.

Fresh water environments

Aquatic vegetation

Floating meadow — 5.6.1.
Densely interwoven or matted forbs, reeds and/or mosses covering permanent fresh water. Woody plants may be present.

Reed swamp — 5.6.2.
Tall reeds rooting in soil at bottom of shallow lakes, ponds, or slow moving rivers.

Submerged rooted aquatics — 5.6.3.
Water areas dominated by rooted plants which are structurally supported by water and scarcely emergent.

Floating aquatics 5.6.4.
Water areas dominated by non-rooted floating plants.

Bodies of water

Lake and pond
Open areas of standing water.
Permanent - with more or less constant level.
Intermittent - filling during rains, then gradually drying out.
Brackish - standing bodies of somewhat saline water without direct connection with the sea.

Mountain stream
Fast-flowing, steeply falling water courses, often with rocky bed.

Lowland river and stream
Slow moving water courses, usually with sedimentary bottoms.

Hot spring
Water heated by geothermal processes.

Animal-dominated terrestrial habitats
Areas which, while technically not ecosystems, are critical habitats for particular species and thus require special conservation action.

Sea bird rookery

Areas predominantly covered by sea bird nesting sites.

Sea turtle nesting area

Sand areas frequently used as nesting sites by sea turtles. Similar categories for other organisms may be developed where locally appropriate.

Cave

Subterranean passages with distinctive terrestrial or aquatic cave faunas.

Shallow coastal environments

Submarine vegetation bed

Plants rooted in sedimentary bottoms, attached to rock pavements, or in loosely-anchored mats.

Algal bed
Dominated by benthic algae or seaweed.

Sea grass bed
Principal components marine vascular plants (*Thalassia, Cymodocea, Syringodium, Halophila,* etc.).

Animals in sediments
Sedimentary bottoms with burrowing animals as predominant life forms.

Algal reef
Calcareous reef structures in which coralline algae are principal contributors to reef construction and surface cover.

Coral reef
Calcareous reef structures being actively constructed by skeletal deposition of hermatypic corals and other organisms.

Atoll reef
Reefs between the ocean and a lagoon unassociated with any major landmass.
Windward - fronting on the ocean in the direction of the predominant winds.
Leeward - on the more sheltered side of the atoll, frequently receiving outflow from the lagoon.

Barrier reef
Offshore from a major land mass and separated from it by a lagoon.

Fringing reef
Growing directly out from the coastline and not separated from it by more than a shallow depression.

Lagoon reef or patch reef
Reef structures developing in the sheltered waters of a lagoon.

'Non-growing' reef

Calcareous reef structures now covered with organisms not contributing significantly to skeletal accumulation or reef growth.

Submerged reef

Reefs submerged by subsidence below depths at which reef growth has been sufficient to regain the surface.

Rocky coast

Non-calcareous or uplifted calcareous shorelines without significant reef development, including both the intertidal zone and the subtidal euphotic region (in which light penetration permits plant growth).

Beach

Shorelines with unstable sand or rubble deposits.

Lagoon

Bodies of water more or less cut off from the sea by reefs or other barriers. Extent isolation best indicated by salinity. Pacific reef areas salinity constant. Lagoon areas cut off by sand with variable salinity during year.

Saline Salinity greater than seawater.	(Hyperhaline, over 40 ‰ salinity)
Open Seawater - good mixing with open sea.	(Euhaline, 30-40 ‰)
Closed Close to seawater in salinity, but little mixing or interchange with the sea.	(Mixoeuhaline)
Dilute Dilute seawater.	(Polyhaline, 18-30 ‰)
Brackish Brackish water.	(Mesohaline, 5-18 ‰)
Fresh water Fresh or slightly salty water.	(Oligohaline, less than 5 ‰)

Estuary

Partly enclosed bodies of water where rivers or other inputs of fresh water flow into and mix with seawater, producing great and often variable salinity gradients.

Marine lake

Inland bodies of seawater with subterranean connections permitting some exchange with the sea.

Marine cave

Caves partly or completely filled with sea water.

Deep offshore environments

Offshore terrace

Horizontal or gently-sloping bottom areas below 20 m depth on the offshore slope.

Offshore slope

Vertical or steeply-sloping bottom areas of island margins below the euphotic zone.

Continental shelf

Submarine extensions of continental land masses.

Submarine canyon

Canyon-like features in the continental shelf margin.

Continental slope

Continental shelf margins.

Offslope environments

Deep ocean bottom features.

Abyssal plain
Submarine trench
Submarine ridge
Seamount

Water circulation bodies

Inshore circulation cell

Biological communities maintained within an inshore current system.

Larger scale circulation cell

Upwelling system

Pelagic communities maintained by upwelling of nutrient-rich water from ocean depths.

ECOSYSTEM OCCURRENCE

A simplified list of over 70 ecosystem types has been prepared from the biome list. This list is presented, together with the four principal island types, in a matrix with the biogeographic provinces of the SPC area to illustrate the distribution and occurrence of ecosystem types (Table 1). The approximately 600 ecosystems so identified are much less than the total probable number of about 2,000, since the biomes occuring on the different island types, and those modified by substrate, slope exposure, rainfall, etc. have not been distinguished.

BIOGEOGRAPHIC PROVINCES

The following sections summarize the conservation situation in each biogeographic province of the South Pacific Commission area. For each province, the following information is given:

Responsible governments; island types and significant climatic factors; a list of biomes and habitats (as presently known) with notes on occurrence, significant features, and conservation status; general conservation interest;

a list of rare or endemic species requiring conservation attention, where known; the status of conservation legislation; lists of existing reserves, proposed reserves (areas already identified locally as warranting some type of protected status), and recommended reserve types; and major published references (see literature cited at end of publication) and sources from which the report was compiled.

An essential companion reference for major parts of the survey area (excluding New Guinea, the Bismarck Archipelago and Solomon Islands), is the Draft Check List of Pacific Oceanic Islands by G. Douglas (1969) based on work by E.H. Bryan. This list provides summary descriptive information on each island,which is therefore not repeated here. Other frequently-consulted references include the reports of regional meetings (SPC, 1973; National Parks Authority, New Zealand, 1975) and the early Pacific Science Association survey (Skottsberg, 1940).

Table 1: Matrix of biome occurrence by biogeographic province

* Present ☐ Absent

Biogeographic Provinces \ Island types Biomes/Habitats	Continental islands	Volcanic islands	Elevated reefs	Low islands	Lowland rain forest	Montane rain forest	Bamboo forest	Cloud forest	Riverine forest	Swamp forest	Seasonal forest	Semi-deciduous forest	Subtropical rain forest	Mangrove forest	Atoll/beach forest	Woodland	Scrub	Serpentine vegetation	Dwarf-shrub heath	Bog	Woodland savanna	Tree savanna	Shrub savanna	Grassland	Flood savanna	Alpine meadow	Freshwater marsh	Tidal salt marsh	Non-tidal salt marsh	Rock desert	Sand desert	Floating meadow	Reed swamp	Submerged aquatics	Floating aquatics	Permanent lake	Intermittent lake	Brackish lake	Mountain stream
I. New Guinea	*	*	*	*	*	*	*	*	*	*	*			*	*	*	*		*			*		*	*	*	*	*	*			*	*	*		*		*
II Bismark Archipelago		*		*	*	*	*	*	*	*				*	*		*						*			*			*						*			*
III Solomon Islands		*	*		*	*		*	*	*				*	*	*	*	*	*					*			*								*		*	*
IV New Caledonia - Loyalty	*	*	*	*	*	*	*	*	*	*				*	*		*	*	*			*		*			*			*					*			*
V New Hebrides - Santa Cruz		*	*	*	*	*		*	*	*		*		*	*	*	*							*			*		*	*	*				*			*
VI Norfolk - Lord Howe - Kermadec		*											*				*							*														*
VII Fiji		*	*	*	*	*	*	*	*	*				*	*	*	*			*	*	*	*	*			*		*			*		*		*		*
VIII Tonga - Niue		*	*		*									*	*		*					*	*	*			*		*	*			*		*			
IX Samoa - Wallis		*		*	*	*		*	*	*				*	*		*							*			*			*					*	*		*
X Tuvalu - Tokelau				*										*	*		*																					
XI Kiribati - Nauru			*	*										*	*		*																		*			
XII Mariana Islands		*	*		*		*	*	*					*	*	*	*		*		*	*	*	*	*	*	*	*		*	*		*	*	*	*	*	*
XIII Caroline Islands	*	*	*	*	*	*	*	*	*	*				*	*	*	*		*		*	*	*	*	*	*	*	*	*				*	*	*	*	*	*
XIV Marshall Islands				*										*	*		*							*				*		*						*			
XV Phoenix - Line - Northern Cook				*								*			*		*			*				*			*								*			
XVI Cook - Austral		*	*	*	*	*									*		*							*			*	*							*			*
XVII Society Islands		*	*	*	*	*	*	*	*						*		*							*			*								*			*
XVIII Tuamotu			*	*	*										*		*							*			*											
XIX Marquesas		*			*	*		*							*		*		*					*						*								*
XX Pitcairn - Gambier - Rapa		*	*	*	*	*		*							*		*					*		*						*								*

Biomes/Habitats (continued) / Biogeographic Provinces	I New Guinea	II Bismark Archipelago	III Solomon Islands	IV New Caledonia - Loyalty	V New Hebrides - Santa Cruz	VI Norfolk - Lord Howe - Kermadec	VII Fiji	VIII Tonga - Niue	IX Samoa - Wallis	X Tuvalu - Tokelau	XI Kiribati - Nauru	XII Mariana Islands	XIII Caroline Islands	XIV Marshall Islands	XV Phoenix - Line - Northern Cook	XVI Cook - Austral	XVII Society Islands	XVIII Tuamotu	XIX Marquesas	XX Pitcairn - Gambier - Rapa
Lowland river	*	*	*	*	*		*		*			*	*				*			
Hot spring	*	*			*															
Seabird rookery	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Sea turtle nesting area	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*		
Cave	*			*	*		*	*	*			*	*		*					
Algal bed	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*		*	*
Sea grass bed	*	*	*	*	*		*	*	*		*	*	*	*						
Animals in sediments	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*
Algal reef	*		*	*			*	*	*	*			*	*	*	*				
Windward atoll reef	*			*	*		*		*	*	*		*	*	*	*	*			
Leeward atoll reef	*			*	*		*		*	*	*		*	*	*	*	*			
Barrier reef	*	*	*	*			*	*	*			*	*							
Fringing reef	*	*	*	*		*	*	*	*			*	*						*	*
Lagoon reef	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*			
Non-growing reef	*								*			*	*							
Submerged reef					*				*	*	*		*							
Rocky coast	*	*	*	*	*	*		*	*			*					*		*	*
Beach	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*		*	*
Saline lagoon															*					
Open lagoon	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*		
Closed lagoon					*		*			*	*			*	*					
Dilute lagoon			*						*											
Brackish lagoon															*					
Freshwater lagoon									*											
Estuary	*	*	*	*			*		*				*				*			
Marine lake							*	*				*	*							
Marine cave					*		*	*				*	*							
Offshore terrace			*						*						*		*			
Offshore slope	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Continental shelf	*						*													
Submarine canyon	*																			
Continental slope	*			*			*													
Abyssal plain	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Submarine trench	*				*	*		*				*	*							
Submarine ridge						*	*			*		*	*							
Seamount	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Inshore circulation cell															*					
Larger circulation cell																				
Upwelling system																				

I. NEW GUINEA

(Only the eastern half of the island is included in the survey area. The Bismarck Archipelago is in Province II and Bougainville Island in Province III).

Government: Papua New Guinea (Independent)

Island types: Large continental island of great complexity; low reef islands and volcanic islands occur in surrounding coastal areas

Biomes/habitats

Note: Because of the great complexity of New Guinea, the following outline cannot be considered complete, but merely a suggestion of the types of ecosystems that occur in great diversity throughout the island. For further detail, see Specht, Roe and Boughton, 1974.

Biomes/habitats	Description	Conservation status
Lowland rain forest	Below 1,200 m	
	1) Valley lowland forest, *Terminalia, Pometia,* etc.	None
	2) Lowland slope forest, *Terminalia, Celtis, Myristica,* etc.	Varirata, Mt. Wilhelm
	3) Mixed *Casuarina cunninghamiana* - fan palm forest: north-east Papua New Guinea	None
	4) *Eucalyptus deglupta/Casuarina* forest: north-west Papua New Guinea.	None
	5) Secondary lowland rainforest, *Ficus, Vitex, Pipturus*	Varirata
Montane rain forest	Generally above 1,200 m	
	1) Mixed submontane forest (climax type), *Castanopsis, Litsea, Schizomeria, Eugenia, Lithocarpus, Neonauclea, Cryptocarya, Canarium,* etc.	None
	2) Submontane *Araucaria* forest, 600 - 1,500 m	McAdam
	3) Submontane *Agathis* forest: Watut Valley	None
	4) Submontane *Castanopsis* forest, 600 - 1,800 m	McAdam
	5) Submontane *Eucalyptopsis* forest, 400 - 500 m: on ridge tops, Morobe Coast; Watut Valley	None
	6) Submontane *Lithocarpus* forest, adjacent to grasslands, 600 - 1,800 m	None
	7) Submontane secondary forest, *Ficus, Evodia,* Urticaceae, etc.	None
	8) Submontane *Gymnostoma* forest, 300 - 1,200 m: Owen Stanley Range	None
	9) Submontane pioneer forest, *Casuarina papuana, Dacrydium, Neonauclea* on rock slides and limestone pinnacles, 300 - 1,000 m	None
	10) *Nothofagus* forest, 1,500 - 2,800 m	None
	11) Mixed montane fern forest, *Syzygium, Cryptocarya, Elaeocarpus, Garcinia, Schizomeria, Dryadodaphne,* 1,200 - 2,500 m	Mt Wilhelm
	12) Montane secondary forest, *Evodia, Pittosporum,* Urticaceae, *Rhododendron,* 1,800 m to tree line	None
	13) Mixed upper montane forest, *Amaracarpus, Elaeocarpus, Podocarpus, Dacrycarpus, Phyllocladus, Papuacedrus,* 2,100 - 2,800 m	Mt Wilhelm
Bamboo forest	Montane areas, *Bambusa, Cyathea*	McAdam
Cloud forest	2,800 m to tree line with *Decaspermum, Syzygium, Xanthomyrtus, Olearia, Pittosporum, Rapanea, Rhododendron, Vaccinium*	Mt. Wilhelm
Riverine forest	1) *Dillenia papuana*	None
	2) *Octomeles/Artocarpus* on banks subject to flooding	None

Biomes/habitats	Description	Conservation status
Swamp forest	Extensive in Sepik, Western and Gulf Provinces	
	1) *Calophyllum, Campnosperma,* etc.	None
	2) Sago swamp, *Metroxylon rumphii*	None
	3) *Pandanus* swamps	None
	4) *Melaleuca* swamp	None
	5) *Dacrydium* swamp forest; western and southern Highlands	None
Seasonal forest	Low hill slopes; slightly deciduous, *Bombax, Erythrina, Tetrameles, Pterygota,* etc.; generally in monsoonal areas	Varirata
Mangrove forest	Extensive areas in Gulf of Papua	
	1) *Rhizophora/Bruguiera*	None
	2) *Avicennia/Ceriops/Rhizophora*	None
	3) *Sonneratia* - freshwater tidal areas	None
Atoll/beach forest	*Cerbera, Calophyllum, Hibiscus, Desmodium, Pandanus, Casuarina equisetifolia, Pemphis acidula*	Cape Wom
Woodland	1) *Eucalyptus* or paperbark *(Melaleuca)* species on dry monsoonal regions of southern and north eastern Papua New Guinea - variable density grading into tree savanna	None
	2) *Timonius* woodland; Port-Moresby, Kairuku area	None
	3) Submontane woodland, *Eucalyptus tereticornis,* 500 - 1,200 m, monsoonal parts of south-east Papua New Guinea	Varirata
Scrub	1) Semideciduous scrub, *Flindersia, Tristania, Mangifera, Syzygium, Acacia* in monsoonal areas	None None
	2) Tidal plains scrub. *Acacia/Myoporum* in monsoonal areas	None
	3) *Lumnitzera* scrub of low inner beach ridges	None
	4) *Batis argillicola* scrub, Morehead-Kiunga area	None
	5) Submontane scrub, *Baeckea frutescens/Rhododendron,* on siliceous soils at Green River, Telefomin and Normanby Island	None
	6) Montane scrub (2,000 - 3,800 m), *Rhododendron, Vaccinium, Pittosporum, Trochocarpa.*	None
Dwarf-shrub heath	1) Myrtaceous - ericaceous heath, local in Morehead, Kiunga and Green River areas of central Papua New Guinea	None
	2) Alpine dwarf-shrub heath, above 2,700 m	None
Tree savanna	1) With *Eucalyptus, Melaleuca;* low monsoonal parts of south-east Papua New Guinea	Varirata
	2) *Pandanus* savanna - Port-Moresby, Kairuku areas	None
Grassland	1) Lowland grassland up to 1,800 m with *Imperata, Ophiurus, Ischaemum,* etc.	None
	2) Montane grassland, 1,000 - 2,500 m, *Miscanthus, Ophiurus, Themeda,* both largely resulting from human activities.	None
	3) Subalpine and alpine grasslands, above 3,000 m	Mt Wilhelm
Flood savanna	In south-west Papua New Guinea	None
Alpine meadow	Meadow, fern meadows, mosses, bogs, above tree line from 3,200 to 4,100 m; mountain peaks all along central range	None
Freshwater marsh	Sepik area and south-west Papua New Guinea	Waigani swamp
Tidal salt marsh	With *Nypa fruticans*	None
Non-tidal salt marsh	With *Sporobolus, Triochloa*	None
Floating meadow	*Leersia, Echinochloa,* in lowland swamps	None
Reed swamp	Lowland swamps with *Saccharum, Phragmites*	Waigani swamp
Submerged aquatics	Present	None
Floating aquatics	*Nymphoea/Azilla* in swamps	None
Permanent lake	Present	None
Mountain stream	Common	In some parts
Lowland river	Common, some very large	None
Hot spring	Presumably present	None

Biomes/habitats	Description	Conservation status
Seabird rookery	Presumably present	None
Sea turtle nesting area	Presumably present	None
Cave	In highlands with distinctive terrestrial aquatic fauna	None
Algal bed	Common	None
Sea grass bed	Common and extensive	None
Animals in sediments	Common	None
Algal reef	Present	None
Windward atoll reef Leeward atoll reef	Conflict group, Torlesse Is., Redlick, Egum, Laughlan, etc.	None
Barrier reef	Extensive in eastern Papua New Guinea, both continental and insular types	None
Fringing reef	Common	None
Lagoon reef	Many types	None
Non-growing reef	Present	None
Rocky coast	Present	None
Beach	Common	None
Open lagoon	Many types in complex of reefs in east Papua New Guinea	None
Estuary	Several, including large areas along Gulf of Papua	None
Offshore environments	No data available	None

Conservation interest

Outstanding interest for fauna and flora, terrestrial and marine environments. Great diversity of biomes and species. Marine environment very little studied, so true conservation interest not yet known.

Rare or endemic species

- Many endemic birds, particularly birds of Paradise and other unusual forms.
- Protected species include:
  Birds of paradise
  Egrets (3 species)
  Most birdwing butterflies, *Orthinoptera allotei, O. alexandrae, O. chimaera, O. goliath, O. meridionalis, O. paradisea, O. victoriae.*
  Zaglossus bruijni (long-nosed echidna)
  Liasis boeleni (Boelen's python).
- Some endangered species are:
  Black sickle-billed bird of paradise, *Epimachus fastosus*
  Prince Rudolph's (or blue) bird of paradise, *Paradisaea rudolphi*
  Parotia spp
  Loria loriae
  Drepanornis spp
  Archboldia papuensis
  Astrapia rothschildi
  Astrapia stephaniae
  Pteridophora alberti.
- There are numerous endemic plants, marsupials, insects and other forms of fauna and flora.
- A species of *Schefflera* (Araliaceae) is known only from Mt Fublian, proposed site of Ok Tedi Copper Mine. The status of many endemic orchids is uncertain.

Conservation legislation

- National Parks Act 1966 (as amended), with parks placed under supervision of a National Parks Board.
- Fauna Protection Act 1966 (as amended) allows establishment of sanctuaries and protected areas for particular species.
- Conservation Areas Act 1978.
- International Trade (Fauna and Flora) Act 1978.
- Wildlife Management Areas can be established under local management committees.
- Papua New Guinea is a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

Existing reserves

DECLARED	
Varirata National Park, near Port-Moresby	About 1,000 ha of lowland slope forest, seasonal forest, secondary lowland forest, submontane woodland, and tree savanna; rich wildlife.
McAdam National Park, near Bulolo	About 200 ha including submontane *Castanopsis* forest, bamboo forest, and submontane *Araucaria* forest with *A. cunninghamii* and *A. hunstteinii;* birds of paradise, marsupials.
Cape Wom International Memorial Park, near Wewak	Historic site of 55 ha with atoll/beach forest.
Baiyer River Wildlife Sanctuary	Captive birds of paradise and wildlife in rain forest.
Mt Susu Provincial Park	
Afore Provincial Park	
Namanatabu Provincial Park	
APPROVED (not yet gazetted)	
Mt Wilhelm National Park, near Goroka	Alpine grassland, cloud forest, montane and lowland forest types; marsupials and birds.
Ramu National Park, Madang Province	90,000 ha.
Kokoda National Walking Track	Spectrum of vegetation types, grassland to cloud forest; wildlife and butterflies.
Mt Gahavisuka Provincial Park	
Waigani Swamp Provincial Park, Port Moresby	Freshwater marsh and swamp.
Vaigana Swamp Provincial Park	
Paga Hill Provincial Park	
Waigani City Park	
WILDLIFE MANAGEMENT AREAS	
Tonda Wildlife Management Area, Western Province	Deer, water birds, wallabies.
Baniara Protected Area, Baniara Island, Milne Bay	Wallabies.
Maza Wildlife Management Area, Western Province	Marine area of 184,230 ha for management and conservation of dugongs; only traditional hunting allowed.
Ranba Wildlife Management Area, Long Island, with Ranba and Crown Island Wildlife Sanctuaries, off Madang	Wildlife and marine turtle breeding areas, megapode volcanic sands, coral reefs.

Balek Wildlife Sanctuary (Asuar Bluffs), near Madang	Lowland rainforest, caves with cave fauna.
Bagiai Wildlife Management Area, Karkar Island	

(This list may not be complete)

There are also Benchmark Reserves of 200 - 300 ha in forest project areas.

Proposed reserves

Mt Bosavi National Park, Western Province	Typical lowland to montane forest types, *Nothofagus* forest, cloud forest.
Mt Karamui National Park, Chimbu Province	Lowland forest to cloud forest, unique birds, kangaroos and other wildlife.
Mt Giluwe National Park, Southern Highlands Province	Alpine biomes. *Nothofagus* and cloud forest.
Rempi Islands Provincial Park, near Madang	Mangrove forest, secondary lowland rain forest, coral reef, migratory birds.
Embi Lakes National Park, Northern Province	Lakes with flood plain, swamp and rainforest, birds and crocodiles.
Kinikini Area Provincial Park, near Port Moresby	Tree savanna.
Mt Kemenagi Provincial Park, Southern Highlands Province	Karstic limestone topography, swamp and montane forest.
Idlers Bay Provincial Park, near Port Moresby	Grassland - woodland, beaches and coral reef.
Huon Peninsula National Park	
Gumbar Wildlife Management Area, Rama, Madang Province	
Igom Wildlife Sanctuary, Bogia, Madang Province	
Ialibu Wildlife Management Area, Mendi, Southern Highlands	
Maprik Bird of Paradise Management Area, East Sepik	
Dilava - Kubuna Management Area	
Wallaby Management Area	
Western District Deer Park	
Motupore Island Marine Reserve, near Port Moresby	
Fly Islands Marine Reserve, Morobe Province	

Recommended reserve types

For bird life, reserves in the following areas are recommended:

Southeastern islands of Papua New Guinea: Goodenough mountains, Goodenough lowlands, Fergusson, Kiriwina and Tagula are major centres; Woodlark, Misima and Rossel, minor ones.

Mountains of Papua New Guinea: The Central Dividing Range includes three portions with somewhat distinct faunas: in the east, the Wharton Range and Owen Stanleys; in the centre, the Highland area from Tari and Wabag to Menyama (the area that includes Mts Hagen, Giluwe, Karimui, Wilhelm, etc.); in the west, the area from 142° E to the border of West Irian. In each area, altitudinal transects from 450 m to the highest elevations should be provided, because each species lives in a characteristic

altitudinal range (e.g., a reserve at 1,200 - 2,400 m, no matter how huge, would not help the many species confined to elevations above 2,400 m or below 1,200 m). Also, in each area such transects should be provided both on the northern and southern watersheds, because of their distinct faunas. Three outlying mountain ranges have distinct montane faunas of their own that also require altitudinal transects: the mountains of the Huon Peninsula, the Adelbert Mountains and the North Coastal Range (especially the Bewani Mountains).

Lowlands of Papua New Guinea: There are five major centres of endemism: the Sepik Basin; the Huon Peninsula, with the Markham and Ramu Valleys; the north slopes of southeast New Guinea, from Huon Gulf to Collingwood Bay; the south slopes of southeast New Guinea, from Samarai to the head of the Gulf of Papua; and the Fly River bulge. The Fly and Sepik regions have large water and swamp faunas, and the Fly and south-slopes-of-southeast-New-Guinea regions have large savanna faunas, that should be considered in addition to their forest faunas.

The following sites have been proposed by various authors:

- A large reserve extending from the Fly lowlands over the central range between Telefomin and Lake Kopiago, to the upper Sepik basin (Diamond and Raga)
- Kerewo - Turama, Gulf Province
- Bensbach River-Moorehead area, Western Province
- Gulf District - mangrove forest
- Mount Victoria
- Rossel Island - unique flora, coral reef habitats
- Morobe Islands - bird and turtle breeding area, marine life
- Lake Murray - lake fauna and bird life
- Lake Yimas and Sepik Plains - forest with orchids *(Dendrobium ostrinoglossum)*
- Murray Pass area, western slopes of Mt Albert Edward, alpine swamps and orchids
- Middle Musa area - savanna; lake site for hydroelectric scheme
- Coastal forest S.E. of Lae opposite Lasanga Is. - botanically interesting liana habitat
- Mt Menawa - endemic birds
- Laba and eastern slopes of Herzog Ranges, to Mt Missim
- Southern Coast of Huon Peninsula, lowland forest types, between Lae and Finschaffen
- Lake Wanum - lowland grassland types
- Bulolo, Lake Triste, Mt Amungwiwa - Mt Salawaket, for *Araucaria, Podocarpus* and *Nothofagus* forests
- Purari River - aquatic habitats
- Coastal West Sepik province - dugong conservation area
- Possible further dugong conservation areas in Siassi Islands and d'Entrecasteaux Group.

The proposals by Haantjens (1975), too numerous to include here, include many biome types presently underrepresented in reserve proposals being considered.

Diamond (unpublished mss.) has recommended a comprehensive series of 22 reserves, including 11 in this biogeographic province:

- Fly-to-Sepik reserve: 52,000 km^2
- Southeastern reserve (Central Province, Owen Stanley Range, Morobe and Northern Provinces): 26,000 km^2
- Huon reserve: 7,800 km^2
- Adelbert reserve: 720 km^2
- Bewani-Torricelli reserve: 2,600 km^2
- D'Entrecasteaux reserve (mountains of Goodenough plus lowlands of either Fergusson, Goodenough or Normanby): 1,040 km^2
- Kiriwina Island: 78 km^2
- Woodlark Island: 390 km^2
- Misima Island: 78 km^2
- Tagula Island: 390 km^2
- Rossel Island: 130 km^2

An attempt should be made to include typical as well as rare biome types in reserve proposals. Many more marine reserve areas will eventually be needed but present information does not permit specific proposals.

References and sources

Visits to Port Moresby and vicinity, Lae, Wau and vicinity
Sylvanus Gorio, National Parks Board
M.A. Hill, National Parks Board
Lance Hill, Office of Environment and Conservation
K. Kisokau, Office of Environment and Conservation
M. Downes, Wildlife Division
A.F. Hutton, Wildlife Division
N. Kwapena, Wildlife Division
L. Gressitt, Director, Wau Ecology Institute
M. Hoyle, University of Papua New Guinea
J. Munro, University of Papua New Guinea
D. Teng, National Parks Board, Education Officer
J.M. Diamond - personal communications
J.M. Diamond and M.N. Raga, 'The lowland avifauna of the Fly River Region' (unpublished ms.)
J.M. Diamond, 'A proposed natural reserve system for Papua New Guinea' (unpublished ms.)
D.G. Frodin, 1977
Gorio, 1978
Haantjens, 1975
M.A. Hoyle, 1977
B. Hudson, 'A survey of the Dugong *(Dugong dugon)* in the waters of Papua New Guinea', unpublished report, 1975
IUCN action programme for South East Asia, *IUCN Bulletin* 8(1): 9-10, January 1977
M. Jacobs and K. Paijmans in WOTRO Report for Year 1974, pp. 35-37.
R.J. Johns, 'Habitat conservation in Papua New Guinea', paper presented at Symposium on Ecology and Conservation, Wau, 1975
P.J. Johns, 'A classification of the montane forests of Papua New Guinea' (unpublished ms.)
P. Kores, 1977
Manser, 1973
Percival and Womersley, 1975
Specht, Roe and Boughton, 1974
R.A. Wilson, 'Wildlife programme for Madang Province' (unpublished report to South Pacific Commission)

II. BISMARCK ARCHIPELAGO

Government: Papua New Guinea (Independent)

Island types: Volcanic high islands and low reef islands

Biomes/habitats	Description	Conservation status
Lowland rain forest	Extensive, also *Eucalyptus deglupta* forest - New Britain	Talele Is., Lake Dakataua
Montane rain forest	1) Submontane *Agathis* forest: New Britain.	None
	2) Mixed montane forest. Parts of central New Britain, eastern New Ireland, 1,500-2,800 m	None
	3) Montane *Nothofagus* forest	None
Bamboo forest	Probably present	None
Cloud forest	Probably present	None
Riverine forest	Present	None
Swamp forest	Coastal north-central New Britain, *Terminalia brassii* and *Campnosperma*	None
Mangrove forest	North New Britain, New Ireland, New Hanover	Talele Is. Lake Dakataua
Atoll/beach forest	Common	Talele Is.
Scrub	Present	None
Grassland	Large areas of coastal, especially north coastal, New Britain	None
Freshwater marsh	Present	None
Non-tidal salt marsh	Presumably present	None
Rock desert	Active volcanic areas	None
Permanent lake	Lake Dakataua (crater lake): Lake Hargy	Proposed Lake Dakataua National Park
Mountain stream	Present	None
Lowland river	Present	None
Hot spring	Presumably present	None
Seabird rookery	Present	Talele Is.
Sea turtle nesting area	Present	Talele Is.
Algal bed	Shallow bottom areas	?
Sea grass bed	Common	?
Animals in sediments	Common	?
Barrier reef	Present	?
Fringing reef	Common	Talele Is.
Lagoon reef	Many types	Talele Is.
Rocky coast	Present	None
Beach	Common	Nanuk Is.
Open lagoon	Present	?
Estuary	Present	None
Offshore environments	No data available	None

Conservation interest

There is little data on these large islands with a considerable diversity of habitats.

Rare or endemic species

○ Considerable bird endemism, and presumably also for other forms. Heinroth's shearwater, *Puffinus heinrothi*, threatened species.

Conservation legislation

See New Guinea

Existing reserves

Talele Islands Provincial Park, East New Britain	Eight islands of 2 to 40 ha, with mangrove, beach forest, coral reefs, seabird and turtle nesting areas. Status: declared.
Nanuk Island Provincial Park, New Britain	4 ha island with marine life and island vegetation, recreation area. Status: declared.
Lake Dakataua National Park, New Britain	Crater lake, hot springs, mangrove, secondary rain forest, crocodiles, megapode. Status: approved.
Pokili Wildlife Management Area, West New Britain	Megapode.

Proposed reserves

Lake Hargy National Park, New Britain	Lake, lowland and slope rain forest, megapode.
St Andrew Islands, south-east of Manus Island	Dugong conservation area.
Garu Wildlife Management Area, West New Britain	Megapode egg grounds.

Recommended reserve types

- Kapiura River area, New Britain: hot springs, megapode.
- Talasea Peninsula: hot springs, megapode.
- Mount Langia, West New Britain: semi-active volcano.
- Central mountain areas of New Britain and New Ireland for montane biomes.
- Swamp forest, marsh, river and grassland examples.
- A selection of coastal, lagoon and reef environments.
- For birds, and probably other forms, New Britain, New Ireland, St Matthias-Mussau, and Manus are the four major centres. New Britain requires a reserve on the Gazelle Peninsula (because of some endemism there) as well as on the main body of the island. New Ireland requires separate reserves at the northern and southern ends, because of significant faunal differences. Like Bougainville and New Caledonia, New Britain and New Ireland have distinct montane and lowland faunas, and both need montane as well as lowland reserves. Dyaul, Lihir, Feni and Tabar are significant minor centres. Long should be a reserve because of the interest of its colonist fauna (it was defaunated by volcanic explosion in the eighteenth century, like Krakatau).

Diamond (unpublished ms.) has recommended 10 reserves in this area as part of a comprehensive proposal for 22 reserves:

- New Britain reserve (Whiteman Range, Nakanai Mountains, or mountains of the Gazelle Peninsula): 2,600 km^2
- New Ireland reserves (southeast end, and Kavieng or New Hanover): 2,600 km
- Manus Island: 780 km^2
- Mussau Island: 230 km^2
- Dyaul Island: 50 km^2
- Tabar Islands (Tabar or Tatau): 100 km^2
- Lihir Island: 80 km^2
- Tanga Islands (Tanga or Boang): 50 km^2
- Feni Island: 50 km^2
- Nissan Islands: 15 km^2

References and sources

See New Guinea
Liem, 1976.

III. SOLOMON ISLANDS

(Santa Cruz Islands included in Province V)

Government: Solomon Islands (Independent), except Bougainville (Papua New Guinea)

Island types: High volcanic islands, both old and recent, and elevated reef islands. Subject to cyclones.

Biomes/habitats	Description	Conservation status
Lowland rain forest	1) Kauri forest	None
	2) *Campnosperma* forest - probably late stage following cyclonic disturbance	None
	3) *Calophyllum kajewskii* forest, mostly logged; Gizo Is. and small patches on Bougainville	None
	4) *Dillenia/Calophyllum/Campnosperma* forest, New Georgia, Kolombangara	Small sample on Kolombangara
	5) *Dillenia* - dominated forest	Small sample on Kolombangara
	6) *Terminalia calamansanai/Campnosperma/ Calophyllum* forest, only northern Kolombangara	Kolombangara controlled forest
	7) *Pometia/Vitex/Calophyllum* forest; coastal areas largely disturbed; inland Guadalcanal	Queen Elizabeth National Park, ? degraded
	8) *Vitex*-dominated forest - rare. Tetepare	None
	9) *Casuarina papuana* forest of high ridges	None
	10) Rennell forest, *Terminalia sepicana, Elaeocarpus, Endospermum*	None
Montane rain forest	1) Mixed species with indistinct zonation, possibly several types on upper slopes of Kolombangara, Vanguna and Bougainville	Small example on Kolombangara
	2) *Neonauclea/Sloanea* forest only Bougainville 450-750 m	None
Cloud forest	Present on mountain peaks	None
Riverine forest	With *Dillenia ingens*	None
Swamp forest	1) Sago swamp forest *(Metroxylon salomonense)*	None
	2) *Terminalia brassii* forest	None
	3) Mixed species swamp forest	None
Mangrove forest	1) Tall *(Rhizophora, Bruguiera, Dolichandrone)*	None
	2) Low *(Rhizophora)*	
Atoll/beach forest	Typical Indo-malesian species	None
Woodland	*Casuarina*-dominated	None
Scrub	San Jorge - variant of *Casuarina* woodland	None
Serpentine vegetation	Open woodland on ultrabasic soils, southern Santa Isabel, San Jorge, southern Choiseul; also Guadalcanal, Florida, San Cristobal	None
Dwarf-shrub heath	Nggatokano and elsewhere	None
Grassland	Large areas of Guadalcanal, fire maintained	Queen Elizabeth National Park, disturbed
Freshwater marsh	Mainly *Phragmites karka* and low shrubs	None
Permanent lake	Guadalcanal	None
Brackish lake	Lake Tegano with highly diverse fauna and flora, including endemic species	None
Mountain stream	Common	None
Lowland river	Common	None
Sea turtle nesting area	Turtles still common	None

Biomes/habitats	Description	Conservation status
Algal bed	Common in lagoon areas and reef flats	None
Sea grass bed	Extensive in lagoons	None
Animals in sediments	Common on lagoon bottoms	None
Algal reef	Present	None
Barrier reef	New Georgia	None
Fringing reef	Common	None
Lagoon reef	Common and variable	None
Rocky coast	Common	None
Beach	Common	None
Open lagoon	Common, especially New Georgia	None
Dilute lagoon	Layering of brackish water over sea water occurs in more enclosed lagoon areas such as Roviana	None
Estuary	Present	None
Offshore environments	No data available Intermittent volcanic island of Kavachi surfaces peridically.	None

Conservation interest

Many endemic species with considerable differentiation between islands; textbook examples of island speciation. Extensive areas of undisturbed rainforest, but increasingly subject to development.

Rare or endemic species

- 72 endemic bird species and 62 endemic subspecies in Solomon Islands, often differentiated between islands; largely in forest habitats.
- White-eye, *Zosterops*, different forms on Gizo (threatened), Vella Lavella, Rendova and Tetepare.
- Porpoises are locally hunted for their teeth which have traditional value.
- Dugong: still common but danger of increased hunting.
- Crocodile: large animals protected, but sometimes become dangerous.
- Endemic sea snake, *Laticauda laticaudata crockeri*, in Lake Tegano, Rennell.
- Endemic freshwater turtle reported from Malaita.

Conservation legislation

Solomon Islands:

- National Parks Ordinance - poorly defined and not well enforced.
- Wild Birds Protection Ordinance - old but extensive coverage.
- Forestry Ordinance provides for controlled forest areas.
- New conservation legislation under discussion.

Bougainville: see New Guinea.

Existing reserves

Queen Elizabeth National Park, Guadalcanal	6,080 ha. Major parts now of low conservation value because of forest clearing for gardens.
Kolombangara forest reserve (controlled forest)	Narrow strip of lowland rain forest along Shoulder Hill from sea level to crater.

Proposed reserves

Kolombangara reserve	*Terminalia calamansanai/Campnosperma/ Calophyllum* forest.
Kolombangara	Ecological survey plots with buffer zones, *Dillenia* forest and *Dillenia/Calophyllum/Campnosperma* forest.

Viru	*Dillenia/Calophyllum/Campnosperma* forest; *Casuarina* forest; *Terminalia brassii* swamp forest, *Dillenia/Calophyllum/Campnosperma* forests.
Santa Cruz	Kauri forest and *Campnosperma* forest.
Tetepare	*Vitex* forest.
Allardyce	*Campnosperma* forest.
Gizo	*Calophyllum* forest.
Vangunu	*Dillenia* forest, *Campnosperma* forest.
Vanikolo	Kauri forest and *Campnosperma* forest.
Guadalcanal	*Pometia/Vitex/Calophyllum* forest in upland area.
Santa Isabel (S.E.)	*Casuarina* woodland.
Santa Isabel or New Georgia	Mangrove forest.
Rennell	Rennell forest and brackish Lake Tegano; endemic fauna, including 5 species and 10 subspecies of birds (plus 4 shared only with Bellona), 3 subspecies of bats, and numerous invertebrates.
Guadalcanal	Grasslands.
San Jorge and Nggatokano	Dwarf-shrub heath.
Serpentine woodland	

Recommended reserve types

- Montane and lowland reserves on Bougainville, endemic birds, *Calophyllum* forest. Diamond has suggested Mt Balbi area, 3,900 km^2
- Large forest reserves on Guadalcanal (perhaps Mt Gallego), San Cristobal and Choiseul or Santa Isabel.
- Reserves on Rennell (lake and adequate area of forest habitat), Kolombangara (central montane forest above 500 m and sample of lowland forest to coast), and Malaita (central forest above 1,000 m and some lowland forest).
- Forest and bird reserves on New Georgia, Rendova, Tetepare, Ranongga, Gizo, Uki Ni Masi.
- Reserve for breeding pigeon colonies on Oema (Shortlands).
- Reef reserve in Manning Strait, and selection of reef and lagoon reserves elsewhere.
- Mangrove reserve and small botanical reserves for other vegetation types (scrub, serpentine).

References and sources

Visits to Guadalcanal, New Georgia, Russell Islands, Kolombangara, and Malaita

Keith Treneman, Chief Forest Officer

Ken Martin, Forest Officer

R. James, Fisheries Officer

Mike Hoyle, University of Papua New Guinea

J.M. Diamond, 'A proposed forest reserve system and conservation strategy for the Solomon Islands' (unpublished report)

J.M. Diamond, 'A proposed natural reserve system for Papua New Guinea' (unpublished report)

J.M. Diamond, 'Recommendations for minimizing environmental costs of mining on Rennell' (unpublished report)

Corner, 1969

Schmid, 1978

Whitmore, 1969

Whitmore, 1974

IV. NEW CALEDONIA - LOYALTY ISLANDS

Government: France

Island types: New Caledonia is a continental high island of complex geology; the Loyalty Islands are elevated reefs with small volcanic areas; low reef islands occur in the lagoon surrounding New Caledonia. Subject to cyclones.

Biomes/habitats	Description	Conservation status
Lowland rain forest	1) Coastal forest - only a few remnants remaining (Bourail, Hienghène)	None
	2) *Araucaria cookii* coastal forest on elevated limestone (Isle of Pines: Kuebeni peninsula	Oro Peninsula reserve
	3) Limestone forest, (dominated by *Intsia, Manilkara, Schefflera* and *Albizzia)* Maré, Lifou, Isle of Pines	None
Montane rain forest	1) Submontane rain forest, principally on slopes 400-1,000 m	Several reserves
	2) Dry coniferous forest - 1,000-1,500 m, various *Araucaria* and other gymnosperms	
Bamboo forest	Scattered examples, largely in disturbed areas	None
Cloud forest	Higher mountain peaks	Mont Mou, Mont Panié etc.
Riverine forest	Present along lower reaches of watercourses; Plaine des Lacs with *Dacrydium guillauminii*	None
Swamp forest	Dominated by *Melaleuca quinquenervia* (niaouli)	None
Mangrove forest	Extensive along south-west coast	None
Atoll/beach forest	Common on coast and islets	None
Scrub	Walpole (raised limestone); Isle of Pines. Most New Caledonia scrub is serpentine vegetation	None
Serpentine vegetation	Highly variable with elevation and in different parts of New Caledonia; nearly 100 per cent of species are endemic, including many localised forms; includes gum oak forest type; occurs also on Isle of Pines	Several reserves but not all types included
Dwarf-shrub heath	Isle of Pines plateau	None
Woodland savanna	*Melaleuca* (niaouli)-dominated with some remnant forest patches, common in areas subject to fire; grades into tree savanna	None
Tree savanna	Large areas of niaouli *(Melaleuca)* savanna, fire-maintained on lower elevations; also Hunter Island	Povila reserve
Grassland	Present in frequently burned areas of south-west New Caledonia - grades into tree savanna	None
Freshwater marsh	Plaine des Lacs and many localised areas characterised by *Xyris pancheri* and *Schoenus brevifolius*. Wabao, Maré, only *Melaleuca* in Loyalty Is.	None
Rock desert	Matthew (active volcano); strip-mined areas of New Caledonia	None
Permanent lake	Plaine des Lacs (with endemic lake species)	None
Mountain stream	Common	In several reserves
Lowland river	Common Freshwater fauna distinctive but poorly known	None
Seabird rookery	Matthew, Walpole, Chesterfield, Hunter, Surprise.	None
Sea turtle nesting area	Islets: Belep, Chesterfield and elsewhere	None
Cave	Poya, Hienghène, with rivers and cave fauna	None
Algal bed	Common, lagoon bottoms and reef flats	None
Sea grass bed	Common in lagoon	None
Animals in sediments	Common	None
Algal reef	Present	None

Biomes/habitats	Description	Conservation status
Windward atoll reef Leeward atoll reef	Conway, Surprise, Fabre/Leleizour, Huon, and Beautemps-Beaupré	None
Barrier reef	Probably windward and leeward types and considerable diversity in local community structure	Yves Merlet Reserve
Fringing reef	Both exposed and lagoon forms	None
Lagoon reef	A variety of types are to be expected within the complex lagoon environment	Yves Merlet Reserve
Non-growing reef	Presumably present	None
Rocky coast	Few areas, north shore	None
Beach	Common	Cap N'Doua reserve
Open lagoon	Encircling much of New Caledonia, also Ouvea	Yves Merlet Reserve
Estuary	Common, including Baie de St Vincent	None
Offshore environments	No data available	None

Conservation interest

One of the world's most distinctive floras, with many relic species of highly localised distribution. Only about 10 per cent of the area is covered by dense forest. Many separate reserves are needed to encompass all the endemic species. Several endemic birds of considerable interest. Largest island barrier reef complex with many diverse marine habitats; again a number of reserves will be needed.

Rare or endemic species

PLANTS

- Eighty per cent of 3,500 species are endemic, including many of great botanical interest. For many of these species, the distribution is limited to a few restricted habitats. There are 44 native species of gymnosperms, all endemic. Nearly all exploited timber species are endemic. The 13 species of *Araucaria* have restricted distributions, mostly in mining areas.
- *Agathis lanceolata* has been exploited to near extinction in the wild in southern New Caledonia.
- *Parasitaxis ustus* is a unique parasitic gymnosperm known from 15 sites including Rivière Bleue and Montagne des Sources.
- Of 31 species of endemic palms, 1 is presumed extinct, 4 are endangered (including *Burretiokentia hapala, Cyphophoenix nucele* and *C. elegans*). Three are vulnerable and 18 are rare (Red Data Book).
- *Captaincookia margareta* (Rubiaceae) known from one small east coast site only.

BIRDS

- Twenty of 68 species are endemic, including

Cagou, *Rhynochaetos jubatus*	Threatened. A 3 ha park to study cagou behaviour and reproduction has been established
Cloven-feathered dove, *Drepanoptila holosericea*	Threatened
Giant imperial pigeon, *Ducula goliath*	Threatened
Ouvea horned parakeet, *Eunymphicus cornutus cornutus*	
Lorikeet, *Charmosyna diadema*	Probably extinct
Cyanorampus novazelandiae saisseti	
White collar, *Columba vitiensis hypoenochroa*	
New Caledonian rail, *Tricholimnas lafresnayanus*	Reported extinct since 1880, but possibly still on western slopes of Mt Panié.

ANIMALS

- Two endemic genera of gekkos, *Rhacodactylus* and *Eurydactylus.*

Conservation legislation

- Revised Park and Reserve Legislation is before the Territorial Assembly. Laws exist establishing complete reserves, botanical reserves, forest reserves and a marine reserve, prohibiting hunting and fishing in certain areas, and prohibiting or restricting mining prospecting in some areas. Reserves are not protected against mining activity unless specifically listed as mining reserves.
- Endangered birds and sea birds are completely protected, and hunting of most others is controlled.
- Marine turtles are protected during November through March; commercialization and collection of eggs are prohibited (1977).
- Classified Sites can be declared for areas of archaeological, historic or touristic interest.

Existing reserves

Montagne des Sources	Complete and mining reserve, 5,870 ha.
Oro Peninsula, Isle of Pines	Complete reserve but subject to customary rights. 848 ha with lowland forest.
Mont Panié	Botanical reserve and temporary mining reserve. 5,080 ha. Rich forest type with many endemics, unique palms.
Mont Humboldt	Botanical reserve. 1,600 ha. *Araucaria humboldtensis* cloud forest, *Araucaria rulei*
Mont Mou	Botanical reserve, 675 ha and Forest reserve, 5,038 ha.
Forêt de la Thy	1,200 ha (1977)
Yves Merlet Marine Reserve	Marine reserve, 16,500 ha. Barrier and lagoon reef.
Ouenarou	Forest reserve, 1,171 ha.
Povila	Forest reserve and temporary mining reserve. 600 ha. Niaouli savanna with forest along streams.
Tiponite	Forest reserve, 1,100 ha.
Col d'Amieu	Forest reserve, 12,368 ha.
Koumac	Forest reserve, 1,016 ha.
Haute Yaté	Hunting and fishing reserve. Mining reserve. 16,300 ha, including Rivière Bleue 9,000 ha. Forest, scrub and freshwater marsh, *Podocarpus, Agathis,* some forest exploitation in past.
Ilot Lepredour	Hunting and fishing reserve, 560 ha. Hunting area for Governor.
Ile Pam	Hunting and fishing reserve, 450 ha.
Yaté	Mining reserve, 546 ha. Lowland forest, serpentine scrub.
Fausse Yaté	Mining reserve, 386 ha. Lowland rain forest and serpentine scrub.
Mont Oungone	Mining reserve, 307 ha. Lowland forest and serpentine scrub.
Forêt Nord	Mining reserve, 282 ha.
Cap N'Doua	Mining reserve, 861 ha. Coastal rain forest, 80 m cliffs, serpentine scrub, beaches, springs.
Pic du Pin	Mining reserve, 1,491 ha. 25 per cent forest, 75 per cent serpentine scrub with many endemics; springs and streams.
Forêt Cachée	Mining reserve, 635 ha. Forest and serpentine scrub.

Duthio	Temporary mining reserve, 7,000 ha.
Nord Côte Est	Temporary mining reserve, 89,400 ha.
Amoa - Tchamba	Temporary mining reserve, 43,000 ha.
Ponérihouen	Temporary mining reserve, 33,880 ha,
Branche Nord Dumbea et Couvelée	Mining and water reserve
Isle of Pines	Was declared a 'National Park', but without government control or protection on customary land; this status is to be withdrawn.

Proposed reserves

Massif de Kouakoue	Part mining reserve and part temporary mining reserve. 17,500 ha, many rare plant species.
Dent St Vincent et Pic Comoui	Mining reserve, 10,100 ha, many rare plants.
Forêt Koum et Comboui	Mining reserve, 2,400 ha, 50 per cent forest, rare plants and large kaori (11 m circ.).
Forêt de Saille	Mining reserve, 1,060 ha, half rain forest, half dry forest of *Casuarina* and *Acacia,* some scrub and riverine forest, sole remaining site of *Pseudosciadium balansae.*
Forêt de Ningua	Mining reserve, 600 ha. Montane rain forest, 1,000-1,250 m.
Forêt de Mt D'O	Mining reserve, 1,300 ha. *Araucaria* forest and serpentine scrub.
Zone Centrale	Part mining reserve and part temporary mining reserve.
Me Maoya	Part temporary mining reserve with summit mining reserve, 9,300 ha, 66 per cent forest.
Boulinda	Mining reserve, 2,600 ha, above 1,000 m, partially burned over by mining prospectors.
Massif des Lèvres	Mining reserve. Low forest with many epiphytes and lianas.
Massif du Panié	Mining reserve and expansion of botanical reserve.
Dôme de la Tiébaghi	Mining reserve. Localised endemic *Araucaria* forest, light scrub and forested stream banks with many endemics, threatened by mining activity.
Presqu'île de Kuebini	Forest reserve. Elevated reef with endemic coastal forest.
Un-named	Reserve for *Oceano papaver* highly localised plant, near Koné.

Recommended reserve types

- Chesterfield, for seabirds and for turtle nesting.
- Atolls of Conway reef, Surprise, Fabre/LeLeizour, Huon and Beautemps-Beaupré.
- Hunter, Matthew and Walpole Islands, for seabirds, small island vegetation.
- For birds, New Caledonia should have both montane and lowland reserves; there should be an appropriate reserve or sanctuary on Lifou and also on Maré and Ouvéa.
- Plaine des Lacs, for lake fauna and marsh flora.
- All areas over 800 m elevation.
- Reserves with good stands of each gymnosperm, particularly *Araucaria, Agathis* and *Podocarpus,* and other significant endemic species in areas where their reproduction is possible.
- Areas of remnant coastal forest (east and west coast types) perhaps at Bourail and Hienghène.
- Parari Pass, for *Burretiokentia* and other palms.

- Valley of Palms along Nehoue River in Panié - Iguambi range.
- Small reserve for palm *Cyphophoenix* on central northeast coast of Lifou.
- Additional reserves for other localised endemic species.
- Reef and lagoon reserves on north, east and west coasts, such as Terrain Bas, La Foa.
- Mangrove and estuarine reserves, perhaps including Baie de St Vincent.
- One or more river systems with well-developed freshwater fauna.

References and sources

Visits to several parts of New Caledonia.
F. Goy, Director, Forest Department.
J.P. Cherrier, Forester.
P. Rancurel.
Inventaire des Ressources Forèstières de la Nouvelle-Calédonie (1974-1975).
Carlquist, 1974.
Douglas, 1969.
IUCN Red Data Book - 5, 1978.
Sarlin, 1954.
Schmid, 1978.
Stokes, 1979.
Virot, 1956.

V. NEW HEBRIDES - SANTA CRUZ

Government: New Hebrides is a condominium of France and the United Kingdom, to become independent in 1980; Santa Cruz Islands are part of Solomon Islands.

Island types: Principally volcanic islands, some still active, with portions of elevated reef and some low reef islands. Cyclones frequent but localized. There is biogeographic discontinuity between the five southern islands below 18°S latitude and the northern islands.

Biomes/habitats	Description	Conservation status
Lowland rain forest	1) Kauri forest, *Agathis obtusa, Calophyllum, Hernandia,* on Erromango and Aneityum	None
	2) Kauri *(Agathis macrophylla)* forest, west Espiritu Santo, Vanikolo and Ndendi (Santa Cruz Is.)	None
	3) *Kleinhovia, Dendrocnide, Dracontomelon, Pterocarpus* forest - widespread, often secondary. Limestone and volcanic types of variable composition	None
	4) Low secondary forest with Euphorbiaceae, *Hibiscus* or *Leucaena* (introduced)	None
	5) Fan palm *(Licuala)* forest, Espiritu Santo	None
	6) Dry hill forest, Malekula and Efate	None
Montane rain forest	With *Metrosideros* and *Weinmannia,* many epiphytes, Above 1,000 m on Espiritu Santo, at lower altitudes in southern islands	None
Cloud forest	Present above 1,500 m on Espiritu Santo, above 500 m on Aneityum, Tanna and Erromango	None
Riverine forest	Present, alluvial soils	None
Swamp forest	Present on Tekopia (Santa Cruz Is.) with *Pandanus;* on Efate around Duck Lake with *Barringtonia;* on Malekula with *Hibiscus, Metroxylon;* on Espiritu Santo with *Hibiscus, Erythrina*	None
Semi-deciduous forest	*Garuga* with *Dracontomelon* and/or *Gyrocarpus* on drier parts of Malekula; also reported in southern islands	None
Mangrove forest	Present; including Lo, east Malekula, and scattered elsewhere	None
Atoll/beach forest	Common, with *Casuarina, Hibiscus, Pandanus*	None
Woodland	With *Acacia spirorbis;* on west Erromango and dry parts of large islands	None
Scrub	With Myrtaceae and *Vaccinium;* north Espiritu Santo and elsewhere	None
Grassland	Generally fire-maintained, with *Themeda, Imperata* and *Miscanthus;* Efate (north of Mele Bay), Tanna plateau, west Erromango.	None
Freshwater marsh	Present on Espiritu Santo, Efate, Erromango, Aneityum and Tanna	None
Non-tidal salt marsh	Lo	None
Rock desert	Active volcano slopes and Fatutaka	None
Sand desert	Active volcano slopes and Fatutaka	None
Permanent lake	Crater lakes, Gaua, Tekopia and Aoba, others including Duck Lake on Efate, Espiritu Santo, Maewo and Tanna	None
Mountain stream	Common	None
Lowland river	Common	None
Hot spring	With algae, north Efate	None
Seabird rookery	Fatutaka. shearwaters nest in interior of Tanna and Aneityum	None
Sea turtle nesting area	Present	None
Cave	Espiritu Santo, Aore, Malo, Malekula, north Efate, Tanna, Aneityum, Erromango	None
Algal bed	Common	None
Sea grass bed	Common	None

Biomes/habitats	Description	Conservation status
Animals in sediments	Common	None
Algal reef	Probable	None
Windward atoll reef	Reef Island	None
Leeward atoll reef	Reef Island	None
Fringing reef	Common	None
Lagoon reef	Present	None
Submerged reef	Utupua, Santa Cruz Is.	None
Rocky coast	Present	None
Beach	Common	None
Open lagoon	Havannah Harbour area	None
Closed lagoon	Efate (disturbed by urban development)	None
Marine cave	Present	None
Offshore environments	No data available	None

Rare or endemic species

PLANTS

- Approximately 15-20 per cent of the flora is endemic (over 150 species) including:
- Kauri *Agathis obtusa* on Erromango and Aneityum - one major unlogged stand remaining on Erromango.
- Kauri *Agathis macrophylla* on Espiritu Santo (New Hebrides) and Vanikolo and Ndendi (Santa Cruz) - being logged.

BIRDS

- Seven endemic species in New Hebrides, three in Santa Cruz, two shared, and many endemic subspecies

Baker's imperial pigeon, *Ducula bakeri*	Hunted
Santa Cruz ground dove, *Gallicolumba sanctaecrucis*	Rare, Tinakula, Utupua (Santa Cruz) and Espiritu Santo
Tanna fruit dove, *Ptilinopus tannensis*	Hunted
Chestnut-bellied kingfisher, *Halcyon farquhari*	Malekula, Malo and Espiritu Santo
Buff-bellied flycatcher, *Neolalage banksiana*	Monotypic genus
Santo mountain starling, *Aplonis santovestris*	Restricted to cloud forest of Espiritu Santo (threatened)
White-bellied honeyeater, *Phylidonyris notabilis*	
Yellow white-eye, *Zosterops flavifrons*	Very common
Green palm lorikeet, *Vini palmarum*	All New Hebrides and Santa Cruz Is.
Thicket warbler, *Cichlornis whitneyi*	Only high mountains of Espiritu Santo and Guadalcanal (Solomon Islands)
Slaty flycatcher, *Mayrornis schistaceus*	Only on Vanikolo (Santa Cruz)
Santa Cruz white-eye, *Zosterops sanctae-crucis*	Santa Cruz Islands only, common
Sanford's white-eye, *Woodfordia lucertosa*	Santa Cruz Islands only

ANIMALS

- About one third of insects are endemic.

White flying fox, *Pteropus anetianus*	Closed season needed, February to October
Skinks, *Emoia speiseri*	Endemic
E. nigromarginata	Endemic on Pentecost, collected only once
E. aneityumensis	Endemic on Aneityum
Saw-tailed gecko, *Perochirus guentheri*	Endemic on Erromango

Conservation legislation

New Hebrides: controls on pigeons, turtles, lobsters, trochus.
Santa Cruz: see Solomon Islands.

Existing reserves

None.

Proposed reserves

Reef Island reserve	92 ha. Only atoll in New Hebrides. Joint Regulation agreed to by Governments but negotiations never completed with owners.
Duck Lake reserve, Rentapao Valley, Efate	Lake with swamp forest, freshwater swamp and lowland forest, excellent bird habitat. Prospects for establishment not good at present.
Kauri forest sanctuary, Erromango	Only high canopy forest in New Hebrides with endemic *Agathis obtusa*. Formerly threatened by logging. No steps taken to establish reserve, but logging will apparently not be permitted.

Recommended reserve types

- Examples of major forest types, grasslands, swamps, lakes and marine habitats.
- Forest reserves on each of main islands for vegetation and birds, such as 2,000 ha of forest in southern Erromango and 2,000-3,000 ha in central Efate.
- Cloud forest reserve on Santo.
- Northwest coast of Malekula or Santo, where reefs elevated over 6 m in 1965.
- Forest *(Agathis macrophylla)* and bird reserves on Ndendi and Vanikoro (Santa Cruz Islands).

References and sources

Visits to Efate.
Martin Bennett, Forestry Officer
Reece Discombe
H. Bregulla
J.M. Diamond, personal communication
A. Marshall, *Biol. Cons.* 5: 67-69 (1973) and personal communication
Lord Medway, personal communication
M. Schmid, 'Note sur un projet de réserve naturelle dans le centre de Vaté'
Corner and Lee, 1975
Diamond and Marshall, 1976
Douglas, 1969
Schmid, 1978

VI. NORFOLK - LORD HOWE - KERMADEC

(Only Norfolk Island and adjacent Philip Island are included in the survey area but other information has been included where available)

Government: Australia (Norfolk, Lord Howe), New Zealand (Kermadec)

Island types: Raised undulating platform of weathered volcanic material surrounded by cliffs.

Biomes/habitats	Description	Conservation status
Subtropical rain forest	Norfolk Island pine: only clumps on ridges and in scattered groves remaining from original forest	Mt Pitt Reserve
Scrub	Probable	None
Grassland	Present, largely man-modified	None
Mountain stream	Common	None
Seabird rookery	Present	None
Fringing reef	Small fringing reef near Kingston	None
Rocky coast	Common	None
Beach	Present	None
Offshore environments	No data available.	None

Rare or endemic species

PLANTS

- Philip Island had 3 endemic species of which 2 are probably extinct.
- Norfolk Island pine *Araucaria heterophylla*
- Norfolk Island cabbage palm
- *Hibiscus insularis* (Malvaceae). Endangered (Red Data Book), endemic to Philip Island, 4 surviving bushes
- *Agropyron kingianum.* Probably extinct, endemic to Philip Island, last seen 1912.
- Lord Howe Island has 57 endemic plants.

BIRDS

Norfolk Island green parrot, *Cyanoramphus novaezelandiae cookii*	Endangered, estimated maximum population of 30 in December 1978
Norfolk Island boobook owl, *Ninox novaeseelandiae royana*	Endangered
Gray-headed blackbird	Threatened
White-breasted silvereye, *Zosterops albogularis*	Endangered, less than 50 remained on Mt Pitt in 1962
Lord Howe woodhen, *Tricholimnas sylvestris*	Endangered, breeding population of 26
Lord Howe currawong, *Strepera graculina crissalis*	Endangered, 30-50 individuals remain
Providence petrel, *Pterodroma solanderi*	Lord Howe, Ball's Pyramid, now eliminated from Norfolk Island

On Lord Howe Island, 4 endemic species and 5 endemic forms are now extinct.

ANIMALS

- Two species of lizard are endemic to Norfolk and Lord Howe Islands.
- The breeding population of marine turtles on Lord Howe Island was exterminated in the last century

Conservation legislation

Australia is a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

Existing reserves

Forest reserve of 120 ha, including Mt Pitt and Mt Bates on Norfolk Island.

Proposed reserves

Philip Island.

Recommended reserve types

Remaining areas of native vegetation.

References and sources

Australian National Parks and Wildlife Service, Endangered Species cards, Birds No. 16 and 18

Recker and Clark, 1974

Turner, Smithers and Hoogland, 1968. *The conservation of Norfolk Island.* Australian Conservation Foundation, Victoria (not seen)

VII. FIJI

Government: Fiji (Independent)

Island types: High volcanic islands, including two very large islands (Viti Levu and Vanua Levu); elevated reef islands and areas, sometimes combined with volcanic island centres; low atolls and reef islands. Distinct wet and dry sides on high islands. Occasional cyclones.

Biomes/habitats	Description	Conservation status
Lowland rain forest	Light undergrowth, few epiphytes or lianas, widespread species. When occuring on limestone islands, consists of one tree layer of pan-Pacific species. Largely selectively logged and cleared for agriculture and settlement.	Small sample on Cave Island, Bay of Islands
Montane rain forest	Not always readily distinguished from lowland rain forest, but with heavier epiphytes and undergrowth, more endemic species. Several types distinguished:	
	1) *Agathis* dominant, 3 tree layers with other species *(Syzygium, Palagium, Cleistocalyx, Calophyllum, Podocarpus,* etc.) in second layer	Samples reserved in Nandarivatu; Nanggararimbuluti
	2) *Dacrydium* dominant, some *Syzygium* in pockets	None
	3) *Agathis* emergent with *Dacrydium* dominant and angiosperms	None
	4) *Agathis* emergent with *Decussocarpus* dominant and angiosperms	None
	5) Mixed species forest, 3 tree layers, may be characterized by emergents such as *Endospermum* or *Canarium*	Mt Tomaniivi
	6) Ridge thicket, a slope-limited form on narrow ridges with one layer of stunted trees	None
Bamboo forest	Low forest with *Bambusa, Bischofia, Parasponia*	None
Cloud forest	Stunted wet forest with tree ferns, *Metrosideros,* abundant epiphytes and mosses	Tomaniivi Nature Reserve; Taveuni (Ravilevu)
Riverine forest	Along rivers, sometimes characterized by distinctive species such as *Neoveitchia storckii*	None
Swamp forest	On wet soils with sago palm *(Metroxylon vitiense), Pandanus,* etc.	None
Mangrove forest	Three types distinguished:	Formerly classed as reserved forest, but dereserved in 1975
	1) *Rhizophora* mangrove	
	2) *Bruguiera* mangrove	
	3) Mixed species mangrove, with composition varying with topography, and including above species, *Xylocarpus, Intsia* and *Excoecaria*	
Atoll/beach forest	One tree layer with pan-Pacific strand species, light undergrowth. May be segregated by type of island; sand cay, small volcanic and large volcanic (with *Metrosideros*).	Small sample (1 ha) on Vuo (Admiralty) Island Nature Reserve
Woodland	*Hernandia, Gyrocarpus* and *Casuarina* on sand dunes at Singatoka River mouth.	None
Scrub	Three forms:	
	1) Limestone island scrub *(Messerschmidia, Scaevola, Desmodium)*	1 ha on Snake Island
	2) *Miscanthus* scub with *Piper aduncum* (tall reeds and shrubs) in wet upper catchment areas	None
	3) Slope-limited scrub in mountain areas where slopes are too steep for forest trees *(Bischofia, Alpinia, Heliconia, Piper, Cyathea)*	None
Bog	Peat swamps with sedges; where *Pandanus* and *Barringtonia aquatica* occur, may grade into swamp forest. Coastal and inland types.	None
Woodland savanna	Areas of mixed grassland and woodland on dryer slopes and valleys. *Bambusa* may occur in pockets.	None
Tree savanna	Open grassland with *Casuarina*	None
Shrub savanna	Grassland with *Cycas*	None

Note: The spelling of Fijian names in this section follows the phonetic version recommended for international use. Some publications and maps may give local Fijian spellings.

Biomes/habitats	Description	Conservation status
Grassland	*Pennisetum*-dominated grassland common on dry side of high islands	None
Freshwater marsh	Fern/sedge swamp with *Athyrium* in inland areas	None
Non-tidal salt marsh	Brackish areas, usually behind mangroves with sedges and ferns *(Acrostichum)* and occasionally *Pandanus*	None
Floating meadow	Floating sedge and reed mats which will support walkers, on Lake Tangimauthia.	None
Submerged aquatics	Pond and river bottoms with *Hydrilla, Potamogeton, Ceratophyllum*	None
Permanent lake	Lake Tangimauthia, crater lake at 800 m elevation	None
Mountain stream	Common in mountain areas, with algae, eels, snails, prawns, river perch	Example in Taveuni (Ravilevu) Nature Reserve
Lowland river and stream	With freshwater mussels, snails, eels, crabs, river perch and sometimes submerged aquatic vegetation	None
Seabird rookery	Mambualau, Nukutolu and Wailangilala Islands	None
Sea turtle nesting area	Makondrongo Island and other areas	None
Cave	Present in Singatoka Valley and at Nasinu (bats and swiftlets)	None
Algal bed	Common in shallow reef and lagoon areas	None
Sea grass bed	Three types reported: *Syringodium isoetifolium* *Halodule uninervis* *Halodule pinifolia*	None
Animals in sediments	Common	None
Algal reef	Probable	None
Windward atoll reef	Present	None
Leeward atoll reef	Present	None
Barrier reef	Great Sea Reef and other examples	None
Fringing reef	Many examples	None
Lagoon reef	Common	None
Beach	Common	None
Open lagoon	North Astrolabe reef and others	None
Closed lagoon	Thakau Lekaleka, near Oneata Island and others	None
Estuary	Several such as Suva Harbour, Lauthala Bay, Nandi Bay, Savusavu Bay, but major areas man-modified	None
Marine lake	Centre of Vuanggava Islands (used as turtle pen by Kambara islanders)	None
Marine cave	Examples in Yasawa Islands and Lau Islands, including Nggaranitoa on Fulanga Island. Red prawn pool-cave on Vatulele Island and red turtle pool-cave on Koro Island of special interest.	None None
Offshore environments	No data available	None

Conservation interest

Fiji has a great variety of ecosystems and a considerable number of endemic species. It will therefore need some large parks providing adequate protection for endemic birds, plants, and marine ecosystems, and many smaller reserves for more restricted ecosystems.

Rare or endemic species

PLANTS

Neoveitchia storckii, endemic genus of palm	Riverine forest at Nanggali, (Waindrandra) Viti Levu. Endangered single population of less than 200 trees, continuing to decline from clearing.

Goniocladus petiolatus	Montane forest, central plateau of Viti Levu. On Nandrau plateau, rare.
Goniosperma (2 species) (Palmae)	Tavauni; Mt Mariko.
Taveunia trichospadix (Palmae)	Taveuni and Nandarivatu
Degeneria vitiensis (Degeneriaceae)	Tall tree of mixed species montane rain forest. Scattered individuals on Viti Levu, Vanua Levu and Taveuni.
Readea (3 species) (Rubiaceae)	Small rain forest trees: Nandarivatu; Mt Vakarongasiu; Viti Levu, Vanua Levu and Taveuni
Sukunia pentagonioides (Rubiaceae)	Small rain forest tree from Vanua Levu and Taveuni
Gillespiea speciosa (Rubiaceae)	Rain forest, Vanua Levu
Hedstromia latifolia (Rubiaceae)	Montane rain forest, Korotasere, Vanua Levu
Pimia rhamnoides	Forest margin, north coast of Vanua Levu. Rare.
Medinella waterhousei (Melastomataceae)	Flower of montane areas. Only found at Mt Seatura, Vanua Levu and Crater Lake, Taveuni
Pullea perryana (Cunoniaceae)	Small tree. Viti Levu, Ovalau and Narngani
Santalum vasi (Santalaceae)	Sandalwood of lowland forest of Vanua Levu. Cut nearly to extinction. Now protected.

BIRDS

- Of 57 Fijian bird species, 13 are endemic and 19 are confined to one or more of the five largest islands (Viti Levu, Vanua Levu, Taveuni, Kandavu, Ovalau). Almost all of these birds occur in forest.
- Viti Levu, Vanua Levu, Taveuni and Kandavu each have numerous distinctive endemic sub-species. Three species are endemic to Viti Levu, three more to Kandavu.
- Viti Levu, Vanua Levu and Taveuni each have some bird species confined to the mountains.
- The golden whistler *(Pachycephala pectoralis)* has several sub-species, including distinctive forms on the eastern and western parts of both Viti Levu and Vanua Levu.
- Only Ngau and Koro, of the other main Fiji islands, have endemic sub-species restricted to one island.
- Three species are confined to the Lau Archipelago, including one found only on Ongea Levu. Seven more species have endemic sub-species in the Lau group, and three of these have different endemic sub-species on the northern and southern islands.
- Rotuma has an endemic honey-eater.
- Endangered birds include:

Barred-wing rail, *Nesoclopeus poecilopterus*	Possibly extinct
Banded-rail, *Rallus philippensis* White-browed rail, *Poliolimnas cinereus* Sooty rail, *Porzana t. tabuensis* Purple swamp-hen, *Porphyrio porphyrio*	Subject to predation by cats and mongoose
Pink-billed parrot finch, *Erythrura kleinschmidti*	Threatened on Viti Levu
Peregrine falcon, *Falco peregrinus nesiotes*	Cliff areas
Red-throated lorikeet, *Charmosyna amabilis*	Rare, montane rain forest
Long-legged warbler, *Trichocichla rufa*	Threatened, rain forest. Sub-species *rufa*, last collected 1894; sub-species *clunei*, recently discovered on Vanua Levu.
Peal's pigeon, *Ducula latrans*	Lowland and montane rain forest
Whistling treeduck, *Dendrocygna arcuata*	Probably extinct.

Petrels, including Macgillivray's petrel, *Bulweria macgillivrayi*	Ground-nesting seabirds subject to mongoose predation
Grass owl, *Tyto longimembris*	Last collected 1860's, probably extinct

ANIMALS

- Endangered animals:

Fiji snake, *Ogmodon vitianus*	Endemic, protected
Pacific boa, *Candoia bibronii*	More common on smaller islands
Banded iguana, *Brachylophus fasciatus*	In forest trees, still common on Kandavu and smaller islands; subject to predation by cats
Crested iguana	Recently discovered on uninhabited island off Vanua Levu
Tree frogs: two endemic species, *Platymantis vitianus* and *P. vitiensis*	More common on smaller islands, still found on Ovalau
Mastiff bat, *Tadarida jobensis bregullae*	Only on Taveuni
Bat, *Pteralopex* sp.	Recently discovered, Taveuni montane forest

- Reports suggest Fiji may be an important humpback whale breeding area.

Conservation legislation

- National Trust of Fiji Ordinance (1970) provides for development of parks and reserves.
- Forestry Ordinance (1953) provides for establishment of Nature Reserves within Reserved Forest areas.

Existing reserves (Nature Reserves established under Forestry Ordinance)

Nandarivatu, Viti Levu	Montane rain forest *(Agathis vitiensis)* 93 ha.
Tomaniivi, Viti Levu (Mt Victoria)	Montane rain forest (mixed), cloud forest including Fiji's highest mountain,1320 m. 1330 ha.
Nanggaranimbuluti, Viti Levu (Mt Lomalangi)	Montane rain forest *(Agathis)*, 280 ha.
Draunimbota (Cave) and Lambiko (Snake) Islands in Bay of Islands, Suva	Limestone island forest and scrub, 2 ha & 0.3 ha.
Vuo (Admiralty) Island in Bay of Islands, Suva	Atoll/beach forest, 1.2 ha.
Ravilevu (Taveuni)	Montane rain forest (mixed), cloud forest, mountain stream, 4,000 ha.
Vunimoli, Vanua Levu	Montane rain forest, 20 ha.
Koroutari, Vanua Levu (part nature reserve)	Montane rain forest *(Agathis)*, 1,074 ha.

Proposed reserves (listed by National Trust)

Malamala Island, Nandi Bay	Fringing reef and sand cay.
Namena Island	Barrier reef, fringing reef and beach forest on small volcanic island.
North Astrolabe Reef near Kandavu	Atoll reef, open lagoon.
Wailangilala, north of Lau Group	Atoll reef, beach forest.
Mt Voma, Namosi	Rain forest with unusual ferns.
Rama-Korombamba, Suva	Rain forest with endangered pink-billed parrot finch, and archaeological remains at Mt Rama.
Nausori Highlands	*Dacrydium* and *Agathis-Dacrydium* rain forest; grassland.
Nandrau Plateau	Rain forest grading to grassland, swamp forest, bamboo forest, includes pink-billed parrot finch and palm *Goniocladus.*

Nakaavandra	Swamp forest.
Dreketi	Gymnosperm-dominated rain forest and *Cycas*.
Ra/Rewa delta	*Rhizophora* and mixed species forest.
Mambualau Island	Lowland single layer rain forest on raised reef; sea bird rookery.
Makongai Island	Fragments of riverine lowland rain forest and birds.
Yambu Island	Lowland rain forest and birds.
Mt Washington	Petrel breeding area.
Nukulau	Marine Park.

Recommended reserve types

- For birds relatively large tracts of undisturbed native forest will be needed to provide adequate habitats.
- Viti Levu and Vanua Levu require both mountain and lowland forest reserves (preferably continuous) and separate eastern and western reserves.
- Taveuni needs both mountain and lowland rain forest reserves.
- A forest reserve on Kandavu is also a high priority.
- Additional forest reserves should be considered on Ongea Levu, Rotuma, and eventually on Ngau, Koro, and one of the larger islands of the northern Lau Group.
- A special mangrove reserve is needed at the mouth of the Samambula River for the unusual *Rhizophora* hybrid 'selala' known only from Fiji.
- The following are the biome examples potentially suitable for protection:
    - Southeast slopes of Mt Tomaniivi (Mt Victoria), *Agathis* rain forest
    - Namosi Hills, *Dacrydium* rain forest
    - Serua Forests, *Agathis-Decacarpus* and *Dacrydium* rain forest
    - Waimanu River catchment, mixed rain forest and pink-billed parrot finch
    - Nandarivatu, slope-limited montane forest (ridge thicket)
    - Upper Wainimala, bamboo forest
    - Lake Tangimauthia, cloud forest, swamp forest and bog, lake floating meadow
    - Makaluva Island, beach forest on sand cay, fringing reef
    - Leleuvia Island, beach forest on sand cay, fringing reef
    - Mbengga Island (in part), beach forest, lowland rain forest, fringing reef
    - Ra Coast (in part), lowland rain forest, beach forest, mangroves, fringing reef
    - Ovalau (in part), lowland rain forest
    - Singatoka River mouth, dune woodlands
    - Sawanika/Waindalithe river mouths, *Bruguiera* mangrove forest
    - Between upper Singatoka Valley and Nandrau, grassland
    - Between Nandi Hills and Nausori highland, grassland
    - Monasavu Falls, montane rain forest and scrub
    - Swamps near Navua, bog
    - Between Singatoka and Nandi, tree savanna *(Casuarina)*
    - Mbua Province, Vanua Levu, shrub savanna
    - Lokia swamps, Navua River flats, *Pandanus* swamp forest and bog
    - Moturiki Island, swamp forest and bog
    - Tailevu (north coast and inland valleys), non-tidal salt marsh, freshwater marsh
    - Deumba - Sawani - Seua Road forests, sago palm swamp forest
    - Waindrandra Agricultural Station, riverine forest *(Neoveitchia storckii)*
    - Naisongothauthau Creek, Vanua Levu mountains, mountain stream
    - Upper Wainimala, mountain stream
    - Wainimbuka River mullet 'hole', lowland stream
    - Singatoka Valley caves, cave
    - Thakau Lekaleka, near Oneata Island, closed lagoon
    - Tai Island, fringing reef
    - Mana Island, fringing reef
    - Sections of Coral Coast, fringing reef
    - Yasawa-i-rara Island, fringing reef
    - Makondronga Island, fringing reef, turtle nesting area

- Part of the Great Sea Reef, barrier reef
- Off Naselai, Rewa delta, *Syringodium* sea grass bed
- Fulanga Islands, *Halodule* sea grass bed; land crab breeding area; marine caves (Nggaranitoa)
- Vuanggava Island, marine lake
- Yasawa Islands, marine caves
- Vatulele Island, red prawn pool-cave
- Koro Island, red turtle pool-cave
- Balolo Point, Ovalau Island, balolo rise area
- Moturiki Island, land crab breeding area

- Additional reserves will also need to be considered, especially for scrub, lowland river, estuarine, mangrove, lagoon and reef habitats.
- Protection will be important for seabird and sea turtle breeding areas, and for significant habitats of rare or endangered species (see list above).
- Breeding areas for the marine worm balolo *(Eunice viridis)* also need protection.

References and sources

Visits to sites near Viti Levu

Graham Baines and Suliana Siwatibau, 'Fiji ecosystem survey' (unpublished list of terrestrial and marine ecosystems and proposed reserves)

Jared M. Diamond (information on bird endemism, species distributions and conservation needs)

Suliana Siwatibau (list of endemic plants in need of protection)

National Trust of Fiji

Department of Forestry, Government of Fiji

Baines, Graham. *Mangroves for national development, a report on the mangrove resources of Fiji.* Report for the Government of Fiji, March 1979.

Douglas, 1969

Gorman and Siwatibau, 1975

Parham, 1964

Pernetta and Watling, 1978

Schmid, 1978

(The Dunlap report to the National Trust with extensive recommendations for conservation in Fiji was not yet available as this paper went to press)

VIII. TONGA - NIUE

Government: Tonga (Independent); Niue (Self-governing, New Zealand)

Island types: Elevated reefs with or without overlying volcanic ash soil; volcanic islands, some still active.

Biomes/habitats	Description	Conservation status
Lowland rain forest	Limestone forest on Niue and several other elevated reefs, mostly destroyed on Tongatapu; *Calophyllum* common. Also forest on some volcanic islands (Tokū, Late, Kao, Tafahi, 'Ata, Tofua. Best examples of forest on 'Eua.	Tabu area on Niue; proposed on 'Eua
Mangrove forest	Present	Fanga'uta lagoon
Atoll/beach forest	Common	Proposed on 'Eua
Scrub	Regrowth on poor soils, Niue; volcanic mountains (Late)	None
Tree savanna	*Casuarina* on new volcanic areas	None
Shrub savanna	Secondary vegetation	None
Grassland	Tongatapu, 'Eua and 'Uta Vava'u with *Sorghum* and *Panicum;* Hunga Ha'apai	Proposed on 'Eua
Freshwater marsh	Near Tu'anuku, 'Uta Vava'u	None
Non-tidal salt marsh	With *Cyperus* on Nomuka, Tongatapu	Perhaps in Fanga'uta lagoon
Rock desert	Lava on Fonualei	None
Reed swamp	*Cyperus* in Niuafo'ou crater lake	None
Permanent lake	Niuafo'ou crater lake with hot springs; crater lake on Kao, brackish lake on 'Uta Vava'u	None
Seabird rookery	'Ata, Nuku	Proposed on 'Ata
Sea turtle nesting area	Common, especially on Maninita, Taula, Fonuā-'one'one, Fangasito, Luahoko, Luanamu, Nukulei, Fonuaika, Nukufaiau, but threatened by over-collecting; nesting populations reported extinct on several islands	Protected but not well enforced
Cave	Common on Niue and probably other limestone islands	Proposed
Algal bed	Present	Fanga'uta lagoon
Sea grass bed	*Halodule uninervis* common at Tongatapu; *Syringodium isoetifolium* dominates at Vava'u; both present at Nomuka Island	Pangaimotu
Animals in sediments	Common	Pangaimotu
Algal reef	Present	Possibly Hakaumama'o
Barrier reef	Niuatoputapu, Ofolanga	Hakaumama'o
Fringing reef	Fonualei, Nomuka, etc	Malinoa, Ha'atafu
Lagoon reef	Common	Pangaimotu, Monuafe
Rocky coast	Vava'u and elsewhere	Proposed 'Eua
Beach	Common	Ha'atafu
Open lagoon	Common	Fanga'uta lagoon (not typical)
Marine lake	Nomuka	None
Marine cave	Several on Niue and at Vava'u; Mariner's Cave of historic significance	Proposed (Niue)
Offshore environments	No data available	None
Submarine trench	Present	None

Conservation interest

Considerable endemism; several distinctive biomes in volcanic and elevated reef habitats.

Rare or endemic species

PLANTS ENDEMIC TO TONGA

Uhiuhi, *Podocarpus pallidus*	Tree
Ponga, *Cyathea rugosula*	Tree fern
Hunivau, *Ixora yunckeri*	Flowering shrub, only on 'Eua
Mo'ota, kula, *Dysoxylum tongense*	Only on 'Eua
Kahikahi, *Freycinetia urvilleana*	Liana
Lauteau, *Pittosporum yunckeri*	'Eua and Tongatapu
Langakali, *Aglia heterotruka*	Now grown as ornamental
Tamanu, *Maniltou amoxium*	Timber tree of 'Eua and Vava'u
Lala Vau, *Wickstroemia rotundifolia*	Shrub, widespread
Dryopteris euanensis and *D. macroptera*	Ferns, only on 'Eua
Many others	

BIRDS

Tonga whistler, *Pachycephala melanops*	
Megapodus pritchardi	Endemic on Niuafo'ou
Three endemic subspecies on Tafahi and Niuatoputapu	
Two endemic subspecies on Niue (protected).	

ANIMALS

Flying fox, *Pteropus tonganus*	Partly protected by custom and by legislation in Tonga; protected on Niue
Tongan iguana, *Brachylophus brevicephalus*	
Leatherback turtle, *Dermochelys coriacea*	Protected in Tonga.

Conservation legislation

Tonga:

- Bird and Fish Preservation Act protects listed birds and sea turtles and provides for reserve areas.
- Preservation of Objects of Archaeological Interest Act of 1969 protects archaeological, cultural and historic resources, controls excavations and export of objects.
- Parks and Reserves Act of 1976 provides for protection of terrestrial and marine natural areas and establishes a Parks and Reserves Authority.

Niue:

- Wildlife Ordinance 1972 protects listed birds and animals (birds and fruit bat) but hunting has recently been allowed.
- Fish Protection Ordinance 1965.
- Environmental Protection Ordinance with conservation provisions under consideration.

Existing reserves

Tonga:

Ha'amonga Trilithon	23 ha on east Tongatapu. Cultural and archaeological reserve, established in 1972.
Mui Hopohoponga	2 km of scenic coastline on east Tongatapu (1972).
Monuafe Island Park and Reef Reserve	33 ha including small sand islet with scrub and rich protected reef area, gazetted 1979.
Malinoa Island Park and Reef Reserve	73 ha with small island of historic interest and fringing reef, gazetted 1979.
Pangaimotu Reef Reserve	49 ha of shallow reef near Nuku'alofa, somewhat degraded by heavy tourist use and fishing (1979).
Ha'atafu Beach Reserve	8 ha on west Tongatapu with spectacular beach and fringing reef (1979).
Hakaumama'o Reef Reserve	126 ha. Isolated and largely undisturbed exposed reef north of Tongatapu (1979).

Fanga'uta and Fangakakau Lagoons	2,830 ha. Shallow, nearly enclosed lagoon with mangroves and important fish-breeding areas in the centre of Tongatapu.
Proposed reserves	
Niue:	
Huvalu Forest, Tapu area	At least 160 ha, undisturbed forest and endemic birds. Unique in composition.
Anapala	Chasm and freshwater pool.
Anatola	Cave with many birds (martins) and traditional importance.
Avaiki	Cave with pools (fish breeding area).
Fatiau Tuai	Deserted village near distinctive coral reef formation.
Hikutavake Reef	Reef with large pools.
Hio	Cave and beach.
Limu	Complex of caves and marine pools - scenic example of coastal erosion.
Makalea Cave	Large domed cave.
Makape Cave	Coastal cave.
Makato chasm	Erosion feature.
Makatutaha	Swimming hole and cave used for storing canoes.
Matapa Chasm	Scenic deep cleft in rock with freshwater stream.
Motu	Reef and caves used as canoe landing.
Omea	Cave with legendary associations.
Opaahi	Historic site (Captain Cook's landing place).
Palaha	Caves with stalactites.
Peniamina's grave	Historic site (first Christian).
Tahileleka	Sink-hole with underground connection to sea.
Talava - The Arches	Complex of caves, beaches and marine pools - good stalactites and stalagmites.
Tepa Point, Tapu area	Coastal karst topography and vegetation, of legendary importance.
Togo	Beach caves and fresh water pool.
Tuo	Reef and cave area of traditional importance.
Ulupaka	Cave with stalactites and stalagmites, also black fungus.
Uluvehi	Early landing spot.
Vaihoko	Caves and reef channels.
Vaikona	Chasm and cave with series of deep brackish pools.
Vaitafe	Broad reef with pool and freshwater springs;.
Tonga:	
'Eua National Park	1,400 ha, including fringing reef, coastal region, eastern ridge and terrace, and ridge summit, with rainforest and important bird habitats. Expected to be gazetted in 1979.
'Ata Island	233 ha. Uninhabited volcanic island with forest and seabird breeding areas, proposed as Biosphere Reserve.
Pouono National Historical Park	Site of proclamation of Code of Vava'u, first written law of Tonga, in 1839.
Kanokupolu National Historical Park	Site of crowning of first Tui Kanokupolu in 1631.

'Alaki	Captain Cook's Landing Place.
Langi Mu'a National Historical Park	Pyramids marking royal tombs in ancient capital of Mu'a.
Luanamu, Nukulei, Fonuaika in Ha'apai, and Maninita in Vava'u	Seasonal turtle sanctuaries.
Mala'ekula, Nuku'alofa	Tombs of Tongan Royal family.
Taunga Peka, Kolovai	Roosting place of sacred flying foxes.

Recommended reserve types

- Forest reserves on Tafahi or Niuatoputapu (endemic birds) and perhaps other volcanic islands (Tofua, Kao, Late, 'Ata or Toku).
- Other areas of 'Eua of botanical interest.
- Samples of other terrestrial biomes not yet protected.
- Marsh, lake and lagoon habitats (Niuafo'ou, Kao, 'Uta Vava'u).
- Further marine areas to include a full range of marine biomes, especially outside Tongatapu.

References and sources

Visits to Niue and Tongatapu.

J. Diamond

T. Hubbard

S.L. Tongilava

W.A. Wilkinson

A.P. Thomson. 'Notes on natural forests of Tonga with particular reference to a proposed 'Eua National Park' (unpublished report)

Map of Niue (NZMS 250 NIUE), Department of Lands and Survey, N.Z. 1970

National Parks Authority, New Zealand, 1975 (Address by Young Vivian)

Second South Pacific Conference on National Parks and Reserves, 1979, keynote address by S.L. Tongilava, 'Development and management of marine parks and reserves in the Kingdom of Tonga', and 'Situation report, Kingdom of Tonga'

K. Wodzicki. 'Survey of some animal problems of Niue Island' (unpublished ms. 1976).

Douglas, 1969.

IX. SAMOA, WALLIS AND FUTUNA

Government: Western Samoa (Independent); United States (American Samoa); France (Wallis and Futuna)

Island types: Volcanic islands (Savai'i still active) and two atolls, Rose and Swains.

Biomes/habitats	Description	Conservation status
Lowland rain forest	Largely disturbed, several types noted:	
	1) *Calophyllum inophyllum* littoral forest, Le Pupū coast, otherwise uncommon	O Le Pupū-Pu'e National Park
	2) *Diospyros* coastal forest, on small offshore tuff islands: Nu'utele (Ofu), Aunu'u, Aleipata islands (Upolu)	None
	3) *Dysoxylum* (mamala) forest, secondary growth alluvium and talus slopes; common but with distinctive secondary species in restricted areas: Ta'u, Aiga Bay (Tutuila), Ofu	None
	4) *Pometia* (tava) forest, with *Planchonella* and *Myristica;* widespread on recent volcanics: Tafua (Savai'i), Le Pupū (Upolu)	O Le Pupū-Pu'e National Park
	5) *Planchonella* (mamalava) forest, with *Syzygium* and *Myristica;* on intermediate age volcanics, now mostly destroyed: Lefaga (Upolu), Tafuna (Tutuila)	O Le Pupū-Pu'e National Park; Tusitala Historic and Nature Reserve
	6) Foothill forest, *Planchonella, Myristica* and *Dysoxylum;* on intermediate age volcanics; scattered on Upolu and Savai'i	O Le Pupū-Pu'e National Park; Tusitala Historic and Nature Reserve
Montane rain forest	1) *Syzygium* ridge forest; on most island ridges	O Le Pupū-Pu'e National Park
	2) *Canarium* ridge forest: *Canarium harveyi* and *Myristica hypargyraea;* restricted to ridges on Fagaloa volcanics, south Upolu	O Le Pupū-Pu'e National Park
	3) *Rhus* secondary forest: *Rhus taitensis* and *Alphitonia zizyphoides;* common at middle elevations, particularly in American Samoa	None
	4) Montane forest with many endemics; on Savai'i and Upolu, *Dysoxylum huntii* and *Hernandia moerenhoutiana* common at 500 - 1,000 m	O Le Pupū-Pu'e National Park
Cloud forest	1) *Reynoldsia* cloud forest, with *Dysoxylum;* most higher elevations on Savai'i	O Le Pupū-Pu'e National Park
	2) *Spiraeanthemum* cloud forest, with *Reynoldsia;* some Savai'i uplands	None
	3) *Cyathea* cloud forest; Ta'ū	None
Riverine forest	Along streams, with *Barringtonia samoensis*	None
Swamp forest	1) Crater swamp forest, *Pandanus turritus;* montane craters of Savai'i and Upolu	O Le Pupū-Pu'e National Park
	2) Montane swamp forest, *Pandanus turritus, Calophyllum samoense,* etc.; possibly restricted to Afulilo area (Upolu)	None
Mangrove forest	*Bruguiera* and *Rhizophora,* sometimes also *Xylocarpus:* Gataivai (Savai'i), Masefau, Aunu'u and Pala lagoon (Tutuila), Apia and several sites on south coast of Upolu	None
Atoll/beach forest	1) *Barringtonia* forest, widespread on undisturbed rocky and sandy shores	None
	2) *Hernandia* forest: Swain's Island (disturbed), uncommon elsewhere	None
	3) *Pisonia* forest: Rose Atoll, uncommon elsewhere	Rose Atoll
Scrub	1) *Pandanus* littoral scrub; uncommon: Le Pupū (Upolu), Aunu'u	O Le Pupū-Pu'e National Park
	2) Littoral scrub, *Scaevola* and *Wedelia;* widespread but limited in extent: Maga Point (Ofa); Swains	None
	3) Fernland, largely secondary, burned-over coastal ridges at Luatuānu'u and Ti'avea (Upolu), Uvea (Futuna)	None

Biomes/habitats	Description	Conservation status
Scrub	4) Montane scrub, restricted to Matafao and Piao mountains (Tutuila); recent lava flows on Savai'i	None
Grassland	1) Crater meadow, *Paspalum* spp: montane craters on Savai'i and Upolu, Siga'ele Crater, Upolu	O Le Pupū-Pu'e National Park
	2) Montane grassland: mid-elevations on Futuna, upland valleys such as Silisili on Savai'i	None
Freshwater marsh	1) Coastal marsh: Apolimahou (Upolu), Aunu'u, and other disturbed coastal sites	None
	2) Crater marsh: montane craters on Savai'i and Upolu, Le Pu'e Crater, Lake Lanoto'o, Lake Olomaga	O Le Pupū-Pu'e National Park
Rock desert	Recent lava flows on Savai'i; also various stages of colonization, grading into scrub	None
Permanent lake	Ponds in Aunu'u crater. Pala (mud) lake 'quicksand' on Aunu'u. Wallis Island.	None
Intermittent lake	Ta'ū crater.	None
Mountain stream	Common	None
Lowland river	Several	None
Seabird rookery	Rose Atoll, Nu'utele islets	Rose Atoll
Sea turtle nesting area	Rose Atoll, Nu'utele and Nu'alua islets	Rose Atoll
Cave	Several on Savai'i, Upolu, Tutuila, with cave fauna	O Le Pupū-Pu'e National Park
Algal bed	Common, reef flats, entrance to Pala lagoon	None
Sea grass bed	*Halophila* and *Syringodium* common on lagoon bottom; near Namu'a Island	None
Animals in sediments	Common	None
Algal reef	Rose Atoll	Rose Atoll
Windward atoll reef	Rose, Swains	Rose Atoll
Leeward atoll reef	Rose, Swains	Rose Atoll
Barrier reef	Uvea (Wallis)	None
Fringing reef	Common, both narrow and wide	Palolo Deep
Lagoon reef	Common	Palolo Deep
Non-growing reef	Pago Pago harbour	None
Submerged reef	Taema bank, off Tutuila	None
Rocky coast	Savai'i, north Tutuila, Alofi	O Le Pupū-Pu'e National Park
Beach	Common	None
Open lagoon	Rose Atoll	Rose Atoll
Dilute lagoon	Pala lagoon, Tutuila	None
Freshwater lagoon	Swains Island	None
Estuary	Leone, Tutuila, mud flat with mangrove	None
Offshore environments	No data available	None

Conservation interest

Considerable plant endemism, in montane and cloud forest; a number of unique birds; several largely undisturbed forest sites.

Rare or endemic species

PLANTS

Blumea milnei (Compositae)	Possibly extinct
Tou, *Cordia aspera* (Boraginaceae)	Endangered
Drypetes sp. nova (Euphorbiaceae)	Known only from Ta'ū Mountain, Tutuila
Elatostema tutuilense (Urticaceae)	Collected once, Tutuila
Acronychia retusa (Rutaceae)	Samoa and Futuna, threatened, rare in Samoa

PLANTS (continued)

Geanthus vignaui (Zingiberaceae)	Samoa, rare
Ifilele tree, *Intsia bijuga* (Leguminosae)	Exploited, now rare in American Samoa
Tamole, *Limnophila fragrans* (Scrophulariaceae)	Threatened
Pani, *Manilkara dissecta* (Sapotaceae)	Rare
Maoutia australis (Urticaceae)	Rare
Pongamia pinnata (Leguminosae)	Collected only once, in 1920
Le'ile'i, *Xylocarpus moluccensis*	In mangrove forest, rare in Samoa
Palacca palm	
Sea tree, *Parinari insularum*	

BIRDS

Australian gray duck, *Anas superciliosia pelewensis*	Endangered
White-browed rail, *Poliolimnas cinereus tannensis*	Rare from habitat destruction
Samoan wood rail, *Pareudiastes pacificus*	Probably extinct, but may persist in upland Savai'i
Sooty rail, *Porzana tabuensis tabuensis*	Not observed in Samoa since nineteenth century
White-throated pigeon, *Columbia vitiensis*	
Purple swamp hen, *Porphyrio porphyrio samoensis*	Samoa, threatened
Many-coloured fruit dove, *Ptilinopus perousii perousii*	Samoa, endangered
Samoan ground dove or friendly quail dove, *Gallicolumba stairi stairi*	Samoa, endangered
Island thrush, *Turdus poliocephalus samoensis*	Western Samoa only, endangered
Ma'o, *Gymnomyza samoensis*	Samoa, endangered
Samoan tooth-billed pigeon, *Didunculus strigirostris*	Western Samoa, rare
Samoan triller, *Lalage sharpei*	Western Samoa, rare
Samoan white-eye, *Zosterops samoensis*	Western Samoa, rare
Red-headed parrot-finch, *Erythrura cyaneovirens*	Savai'i, not recently recorded; declining

- There are 23 endemic species or subspecies of birds in Samoa and 5 in Futuna, 2 shared with Alofi.

Conservation legislation

American Samoa:	Parks and Recreation Bill (1980). Some United States federal legislation applies.
Western Samoa:	Stevenson Memorial Reserve and Mount Vaea Scenic Reserve Ordinance 1958. National Parks and Reserve Act (1974) administered through Forestry Division provides for National Parks, Nature, Recreation and Historic reserves. Forests Act (1967) allows declaration of Protected Land.
Wallis and Futuna:	None.

Existing reserves

American Samoa:

Rose Atoll National Wildlife Refuge (1973)	Atoll with two small islets (8 ha), one with a *Pisonia* grove and 6 other plant species, and 640 ha of reef and lagoon.

Western Samoa:

Robert Louis Stevenson Memorial Reserve and Mount Vaea Reserve (proposed new name: Tusitala Historic and Nature Reserve) (1958)	Lowland rain forest on Upolu with stream and grave of Robert Louis Stevenson. 1,295 ha.

O Le Pupū-Pu'e National Park (1978)	2,800 ha from the highest point on Upolu, Mt Fito (1,100 m), to the rocky coast, including several watersheds on volcanic soils of different ages and a range of forest types (not yet gazetted, awaiting boundary survey).
Togitogiga Recreation Reserve (1978)	Two waterfalls and swimming-hole in area of geological interest, recreation facilities.
Palolo Deep Marine Reserve (1979)	Lagoon and fringing reef, Upolu. Underwater nature trail being established.

Proposed reserves

Western Samoa:

Nu'utele Island Group, off eastern Upolu	Beach and lowland forest, fringing reef.
Lake Lanoto'o, central Upolu	Montane forest and three crater lakes.
Lake Olomaga, southeast Upolu	Lowland and sub-montane forest, two crater lakes, good bird populations.
Mount Silisili, central Savai'i	Sub-montane, montane and cloud forest and recent lava flows (rock desert) with vegetation appropriate to various elevations.
Tafua, southeast Savai'i	Largely undisturbed lowland forest.
Lata Forest, Savai'i	Submontane and montane forest.
Cape Puava Forest, Savai'i	Lowland forest, rocky coast and fringing reef.
Apolimafou, Upolu	Freshwater swamp and fringing reef.
Vaipa, Upolu	Freshwater swamp and swamp forest.
Magaloa, Savai'i	Swamp forest
Taupou's Grave Lava Flow, Savai'i	Lava flow (rock desert) with traditional significance.
Lake Mafane, Savai'i Lake Mautalano, Savai'i	Crater lake with montane and swamp forest.
Tiavi, Upolu Fuipisia/Sopo'aga, Upolu	Riverine forest and birds.
Matautu, Upolu Tufutafoe, Savai'i	Lowland swamp forest.
Vailoa, Savai'i	Coastal swamp forest and mangrove.
Pata, Upolu	Mangrove forest.
Fusi/Tafitoala, Upolu	Mangrove forest and fringing reef.
Sa'anapu, Upolu	Mangrove forest.
Sato'alepai, Savai'i	Mangrove forest.
Aganoa, Upolu	Rocky coast and fringing reef.
Nu'usafe'e Island, Upolu	Coral reef and islet.
Salamumu, Upolu	Fringing reef and palolo breeding area.
Leanamoea, Savai'i	Fringing reef with freshwater spring.
A'opo Cave, Savai'i	With cave fauna.
Satuimalufilufi/Fuailolo'o, Upolu	

Recommended reserve types

Western Samoa:

- While the UNDAT/IUCN survey is quite complete, additional protection may be needed for important palolo (*Eunice viridis*) marine worm breeding areas, as this culturally important food is becoming increasingly rare.

American Samoa:

- Faimulivai Marsh in Aunu'u Crater, only remaining undisturbed coastal marsh in American Samoa and habitat for gray duck - 14 ha.
- Tafuna area, Tutuila, lowland rainforest.
- Montane forest areas on Tutuila.
- Lata Mountain, Ta'ū (only potential National Park in American Samoa); cloud forest, montane forest and montane scrub, important bird area; could extend to Lauania Cove and Ulufala Point (1,260 ha).
- Pioa (Rainmaker) Mountain, Tutuila, montane scrub and bird breeding area.
- Pola Islet - Pola'uta Ridge, Tutuila, bird breeding area and marine reserve.
- Fagatele Point, Tutuila, flying fox roost, bird breeding area and marine reserve.
- Anapeapea Cove, Tutuila, with two swiftlet and bat caves.
- Nu'utele Islet, Ofu, seabird breeding area.
- Coastal forest and lowland rain forest, Ofu, northeast of airport.
- Nu'usetoga Islet, Tutuila, with ifilele trees.
- Pala Lagoon, Tutuila, mangrove forest and dilute lagoon.
- Pala (mud) Lake, Aunu'u, unique habitat with mangrove, gray duck.
- Coastal and reef reserves at Lepisi Point, Ogegasa Point and perhaps other sites on Tutuila.
- The marine and lagoon environments on Swains Island should be surveyed for possible conservation interest.

Wallis and Futuna

- Reserves should be considered for appropriate forest, lake and coral reef areas.

References and sources

Visits and detailed studies in Western and American Samoa.

Environmental Consultants, Inc. 1978. *An inventory of the wildlife and wildlife habitat of the Islands of American Samoa.* Vol. 1, Main Report. 475 p. Vol. II, Technical Appendix, Parts 1 and 2, 813 p. (Prepared for the Fish and Wildlife Service, U.S. Department of the Interior) (Not yet accepted for publication).

C.W. Holloway and C.H. Floyd (UNDAT-IUCN). *A National Parks system for Western Samoa.* January 1975.

C.D. Ollier, W.A. Whistler and A.B. Amerson, Jr. 1979. *O Le Pupū-Pu'e National Park.* Vol. I, Main Report. 79 p. Vol. 2, Annexes I, II, III and Interpretive Material, 84 p. United Nations Development Advisory Team, Suva, Fiji, January 1979.

Rose Atoll National Wildlife Refuge, American Samoa (brochure). United States Department of the Interior, Fish and Wildlife Service, no date.

W. Arthur Whistler - outline of vegetation types in Samoa.

W. Arthur Whistler. *Inventory and mapping of wetland vegetation in the Territory of American Samoa,* Report to U.S. Army Corps of Engineers, April 1976.

W. Arthur Whistler, *A preliminary listing of plant communities found in Samoa.* October 1978.

Whistler, 1978.

X. TUVALU - TOKELAU

Government: Tuvalu (Independent); New Zealand (Tokelau).

Island types: Inhabited atolls; subject to cyclones.

Biomes/habitats	Description	Conservation status
Mangrove forest	*Rhizophora*, central swamp of Funafuti	None
Atoll/beach forest	Small areas on Nukunono	None
Scrub	Present	None
Seabird rookery	Probably present	None
Sea turtle nesting area	Probably present	None
Algal bed	Lagoon bottoms, reef flats	None
Animals in sediments	Lagoon bottoms	None
Algal reef	Common	None
Windward atoll reef	Common	None
Leeward atoll reef	Common	None
Lagoon reef	Common	None
Submerged reef	Nui ?	None
Beach	Common	None
Open lagoon	Common	None
Closed lagoon	Nanumanga	None
Offshore environments	No data available.	None

Conservation legislation

Tuvalu: Birds probably protected under former Gilbert and Ellice Islands Wildlife Ordinances; enforcement difficult.

Tokelau: None.

Existing reserves

None.

Proposed reserves

None.

Recommended reserves

- Small areas of native vegetation.
- Appropriate series of reef and lagoon environments, perhaps including Kosciusko Bank.
- Seabird and turtle breeding areas, if any.

References and sources

Douglas, 1969.

XI. KIRIBATI - NAURU

(For Phoenix and Line Islands see Province XV.)

Government: Kiribati (Independent); Nauru (Independent).

Island types: All atolls except Banaba (Ocean Island) and Nauru which are elevated reefs. Rainfall decreases southward; occasional droughts.

Biomes/habitats	Description	Conservation status
Mangrove forest	On Tarawa, Abemama	None
Atoll/beach forest	Remnants principally on small islets	None
Scrub	Common on small islets, undeveloped areas, and on Nauru and Banaba	None
Permanent lake	Buada lagoon on central plateau of Nauru	None
Seabird rookery	On some small islets, with some human predation	Planned
Sea turtle nesting area	On some small islets and scattered elsewhere,Katangateman sandbank near Makin; sandbank by Nonouti.	Planned
Algal bed	Common in lagoon and on reef flats	None
Sea grass bed	Lagoon bottoms	None
Animals in sediments	Lagoon bottoms	None
Windward atoll reef	Common	None
Leeward atoll reef	Common	None
Fringing reef	Around Nauru and Banaba, and several reef islands without lagoons	None
Lagoon reef	Common	None
Submerged reef	Northwest side of Tarawa	None
Beach	Common	None
Open lagoon	Most atolls	None
Closed lagoon	Central Nikunau, landlocked	None
Offshore environments	No data, seamounts present	None

Conservation interest

Inhabited and thus largely disturbed islands of little terrestrial conservation interest. The few remaining patches of atoll forest are of some value, as are the few small islets used by turtles or seabirds for breeding. Not enough is known of the marine environments to assess their significance, but typical samples of the different types should be conserved. Seabirds are considered a desirable item of diet and hence are subject to human predation, and sometimes wanton destruction, wherever access to rookeries is possible.

Rare or endemic species

None reported.

Conservation legislation

Kiribati: Wildlife Protection Ordinance (1975), establishes Wildlife Sanctuaries and protects all birds throughout the year and turtles when on land.
Plans for improved Fisheries Ordinance.

Nauru: None.

Existing reserves

None.

Proposed reserves

Kotabu and Nabini Islets, Butaritari	Atoll forest *(Pisonia)* and breeding seabirds rookery
Noumantong Islet, Nonouti	*Pisonia*
Teirio Islet, Abaiang	Turtle nesting area

These could be managed by Island Councils, with some exploitation permitted under controlled conditions.

Recommended reserve types

- Any remaining areas of natural atoll vegetation
- Seabird and sea turtle breeding areas
- Examples of marine ecosystems
- Land crab reserves.

References and sources

Visits to Tarawa and Butaritari (Kiribati), and Nauru

R.N. Bryden, Chief Agricultural Officer

Mark Goodwin, Assistant Secretary, Ministry of Local Government and Rural Development and many other government officers and individuals, whose assistance is appreciated.

M.A. Hoyle, 'Conservation in the Gilbert and Ellice Islands Colony' unpublished report, 1975.

Wildlife Conservation Unit, Kiritimati (Christmas Island), *Report No. 4.* Republic of Kiribati, Central Pacific, May-November 1979.

Douglas, 1969.

XII. MARIANA ISLANDS

Government: Guam, United States Territory; Northern Marianas, United Nations Trust Territory administered by United States, in process of becoming United States Commonwealth.

Island types: Northern Mariana Islands, Uracas (Farallon de Pajaros) to Anatahan are a series from an almost barren active volcano to densely colonised young volcanic islands. Islands from Farallon de Medinilla to Guam are largely raised coral platforms. Weathered volcanic soils are found in southern hills and plains of Guam which has a limestone cap on the highest southern volcanic ridge. There are several raised coral islands within the Guam reef and low islets on reefs of Guam and Saipan. Rainfall is somewhat seasonal and cyclones occasional.

Biomes/habitats	Description	Conservation status
Lowland rain forest	Lowland forest of small stature occurring in areas of mostly limestone rock, little soil, humus accumulation from trees. 'Limestone forests' of similar physiognomy and species composition found on both limestone rock in southern Mariana Islands and, with fewer species on lava, in northern Mariana Islands Forests of the southern Mariana Islands, especially Guam, are a rich mixture of broadleaf trees up to about 25 m, sometimes of 2 strata, with little to dense undergrowth. A few of the major species include: *Artocarpus mariannensis, Elaeocarpus sphaericus, Merilliodendron megacarpum, Ficus* spp, *Pandanus fragrans, P. dubius, Cycas circinalis,* the endemic genus *Guamia mariannae* and rare endemics such as *Serianthes nelsonii, Tabernaemontana rotensis, Hernandia ovigera* and *Heritiera longipetiolata.* These forests contain the greatest percentage of endemics and provide habitats for endangered and threatened species of birds as well as the fruitbat, *Pteropus mariannus,* and coconut crabs.	On Guam reserves include: Anao, Y-Piga, an area behind the University of Guam, Ritidian and Pati Point reserves No reserves in Northern Mariana Islands
Bamboo forest	Limited areas of tall bamboo.	None
Cloud forest	Possibly limited area on top of Mt Lamlam, Guam, and Mt Tapachau, Saipan; calderas of Agrihan, Alamagan and Anatahan are generally cloud-covered but forests are unexplored.	None
Riverine forest	Forests of moist ravines are mostly gone on Guam except for areas around Fena dam and some southern rivers and ravines. Trees are generally below 25 m with abundant undergrowth including *Areca catechu, Pandanus fragrans, P. dubius, Cycas circinalis;* some forests of *Heterospathe elata* palms and one *Barringtonia racemosa* swamp along river. In northern Mariana Islands, ravines on outer slopes of at least Anatahan, Alamagan, South Pagan and Agrihan represent little explored forests in which endemic tree ferns, *Cyathea alamagensis,* seeded bananas, and other rare and probably yet to be described species occur.	Some ravine forest included in Cotal reserve Area about Fena Lake, though not declared a natural reserve, is protected as it is in a military area
Mangrove forest	Limited areas of mangrove in southern Mariana Islands including *Rhizophora stylosa, R. apiculata, Lumnitzer littorea, Bruguiera gymnorrhiza, Avicennia alba*	None
Atoll/beach forest	Beach forests occur inland of beach scrub in southern Mariana Islands, especially Guam, and include mostly pan-Pacific species as well as some endemic species including *Piper guahamense* and *Taeniophyllum mariannense.* These forests usually grade into limestone forests. *Leucaena insularum* var. *guamense* (endemic) occurs in scrub and low forest on Cocos Island and a few areas of the southeast coast of Guam	Some forest included in Ritidian and Pati Point reserves. No *Leucaena insularum* areas protected
Woodland	Limited areas of low forests on northern Mariana Islands in lee areas on relatively deep, dry, organic rich soils. Also man-created areas of exotic species, especially on Guam	None
Scrub	1) Beach along coasts of southern Mariana Islands, especially Guam, Saipan, Tinian, made up of pan-Pacific species such as *Scaevola taccada, Messerschmidia argentea,* and in some areas *Leucaena insularum* var. *guamense*	Parts of Ritidian, Anao, Pati Point reserves on Guam

Biomes/habitats	Description	Conservation status
Scrub (cont'd)	2) Scrub occurs on rocky limestone coasts of southern Mariana Islands and small area of west coast of Pagan in northern Mariana area, the predominant species being *Pemphis acidula*	
	3) Scrubland and thickets occur on volcanic rock and soils in coastal areas and shallow ravines of northern Marianas, including a curious low form of *Scaevola taccada,* and *Pandanus tectorius, Ficus* spp. and *Hibiscus tiliaceus*	None
	4) Scrubland and thickets and low forests of introduced *Acacia confusa,* especially on Saipan	None
Serpentine vegetation	Possibly some areas of savanna in southern Guam	Possibly in Cotal reserve
Dwarf-shrub heath	*Pemphis acidula* and other low growth on coastal limestone in southern Marianas	Parts of Ritidian, Pati Point reserves on Guam
Woodland savanna	Dominated by *Miscanthus floridulus, Dimeria chloridiformis* and other grasses and sedges, with forest islands of *Pandanus fragrans* and *Casuarina equisetifolia* and areas of ravine forest in parts of southern Guam	Possibly parts of Cotal reserve
Tree savanna	Dominated by *Miscanthus floridulus* with scattered *Casuarina equisetifolia* and/or *Pandanus fragrans,* and in volcanic northern Marianas, *Trema orientalis* and other small trees. A few upper areas of Guam and northern Marianas with tree ferns of genus *Cyathea*	None
Shrub savanna	Community of mostly native low scrub and bushes in limited areas of southern Guam, including some endemics. Dominant species *Wikstroemia elliptica, Melastoma marianum, Geniostoma micranthum, Timonius nitidus* and *Phyllanthus saffordii,* amid tall *Miscanthus floridulus* grass and lower *Dimeria chloridiformis.* On volcanic northern Mariana Islands, thickets of *Pandanus, Ficus* and *Hibiscus tiliaeceus* amid *Miscanthus* grassland	Cotal reserve, Guam
Grassland	Extensive fire-adapted areas of almost pure *Miscanthus floridulus* in southern Guam and northern Mariana Islands and extensive areas of introduced *Pennisetum purpurem,* especially on Saipan	Perhaps part of Cotal reserve, Guam
Flood savanna	Possibly limited areas in some calderas of northern Mariana Islands	None
Freshwater marsh	Limited areas of freshwater marsh with *Scirpus littoralis* and *Cyperus* spp. and some *Achrosticum aureum* in Guam, Saipan and possibly other Mariana Islands	None
Tidal salt marsh	Limited area of salt marshes with grasses and *Sesuvium portulacastrum,* along coasts and on limestone rock subject to tidal flooding	None
Barren desert	Limited areas of barren limestone rock and sand occur in southern Marianas. Extensive areas of barren recent volcanic rock and sand occur in northern Marianas	Some sand beach in Ritidian, Anao reserves on Guam
Reed swamp	Extensive *Phragmites karka* reed swamps, especially in Agana, Guam, and in smaller patches scattered in low areas of savannas and about Lake Susupe, Saipan	None
Submerged aquatics	Very limited areas in at least Guam including rare native plants and endemic water fern	None, except possibly Agana Springs on Guam which is of uncertain status and portion of Cotal reserve.
Permanent lake	Lake Susupe, Saipan; freshwater lake with hot sulfurous springs on Pagan; and man-made Lake Fena on Guam	None, Fena Lake is protected as water reservoir and by being within a military reservation
Intermittent lake	Scattered temporary small lakes possibly including limited area of caldera of Anatahan	None
Brackish lake	Fairly large brackish lake on Pagan and scattered small areas elsewhere	None

Biomes/habitats	Description	Conservation status
Mountain stream	Few at least in south Guam	None, except part of Cotal reserve which is subject to use as recreation area
Lowland river and stream	Largest include Talafofo, Pago and Umatac rivers on Guam	None
Seabird rookery	At least Anae islet and Orote Point on Guam, Bird Island on Saipan, and most northern Mariana Islands especially Farallon de Medinilla, Guguan, Maug and Uracas	None, Farallon de Medinilla used as bombing range
Sea turtle nesting area	Few recent reports, formerly at least at Ritidian beach, Ceti Bay beach and some southern beaches of Guam; and Tanapag beach, Saipan	None, except part of Ritidian Point beach area which is within military reservation but subject to recreational use and disposal of munitions.
Cave	Dry, freshwater and marine caves at least on Guam and Saipan, with cave adapted biota	None
Algal bed	Common on lagoon bottoms and reef flats in southern Marianas	None
Sea grass bed	Present in southern Marianas	None
Animals in sediments	Common in southern Marianas	None
Barrier reef	Cocos, Guam	None
Fringing reef	Common in southern Marianas, often broad approaching barrier reef	None
Lagoon reef	Present in southern Marianas	None
Non-growing reef	Guam, Saipan, etc. often the result of *Acanthaster* or fishing with explosive	None
Rocky coast	Common	None
Beach	Common	None
Open lagoon	Some examples, Guam, Saipan, Tinian	None
Marine lake Marine cave	Grotto on Saipan	None
Offshore environments	No data available	None

Conservation interest

Limestone forest and scrub savanna areas of Guam contain many uncommon to rare endemic and native species. There is no protection for a number of very limited biomes, including cloud forest, where many uncommon native and endemic species occur, and freshwater habitat which provides habitat for very rare birdlife.

Saipan, Tinian and Aguiguan are much disturbed, Rota less so. Remaining areas of natural vegetation, most of them on cliffs, contain rare native and endemic species of plants and birds.

The islands of the northern Marianas from Farallon de Medinilla to Uracas are less disturbed and are of prime interest for the study of biotic colonization under natural conditions.

Rare or endemic species

PLANTS

Serianthes nelsonii	Endangered (Red Data Book); only 4 trees known on Guam, 2 in limestone forest of Ritidian area and 2 in ravine forest in South, also on Rota. Listed as Endangered Species in Trust Territory of the Pacific Islands.
Tabernaemontana rotensis	Only one tree known on Guam, rare on Rota, in limestone forest.
Hernandia ovigera	Limestone, Guam, Rota.

PLANTS (Cont'd)

Heritiera longipetiolata	Endangered (Red Data Book); in limestone forest, some trees present above Asanite bay, Guam; rare on Rota, possibly on Saipan and Tinian.
Merrilliodendron megacarpum	Limestone forest, known from one unprotected area.
Xylosma nelsonii	Guam, Rota mangrove and coast.
Lysimachia mauritiana	Currently known only from Maug.
Fagraea galilai	Mt Lamlam limestone forest.
Solanum guamense	Few plants known from savanna and along rivers.
Styphelia mariannensis	Known only from forests of Alamagan.
Boeragiodendron mariannense	Known only from forests of Rota.
Ceratopteris gaudichaudii	Freshwater areas, Guam.
Potamogeton mariannensis	Freshwater, Cotal area.

- Even the especially rare plants have no legal status. A list of these and other rare plants is being developed as the endangered and threatened species of Guam under the United States Federal Endangered Species Act.

BIRDS

Marianas crimson-crowned fruit-dove, *Ptilinopus roseicapillus*	Threatened; limestone forest.
Nightingale reed-warbler, *Acrocephalus luscinia luscinia*	Threatened, possibly exinct; marsh and reed swamp. Listed as Endangered Species.
Marianas duck, *Anas oustaleti*	Threatened, possibly extinct; freshwater areas of Marianas. Listed as Endangered Species.
Tinian monarch, *Monarcha takatsukasae*	On Tinian. Listed as Endangered Species.
Marianas crow, *Corvus kubaryi*	Limestone forest on Rota. Listed as Endangered Species.
Micronesian megapode, *Megapodius laperouse*	Northern Mariana Islands and Palau, probably extinct in southern Mariana Islands. Listed as Endangered Species.
Bridled white-eye, *Zosterops conspicillata*	Threatened.
Guam rail, *Rallus owstoni*	
White-browed rail, *Poliolimnas cinereus micronesiae*	

- An official listing of the rare and endangered animals of Guam is being prepared in accordance with the United States Federal Endangered Species Act.

REPTILES

Perochirus aciculatus	Micronesian gecko known from atoll forest of Cocos Island and one specimen from limestone forest.
Emoia slevinii	Known only from Cocos Island, Ritidian (one specimen) and Tinian (one specimen), atoll and possibly upland forest skink.
Green sea turtle, *Chelonia mydas*	Common.
Hawksbill turtle, *Eretmochelys imbricata*	Rare on Guam and northern Mariana Islands. Listed as Endangered Species.

MAMMALS	
Dugong, *Dugong dugon*	Only one ever reported from Cocos Lagoon, Guam
Fruitbats, *Pteropus marianus* and *Pteropus tokudae*	Probably not more than several hundred left on Guam, where they are confined to remote limestone forests but may once have also inhabited ravine forests, savannas and other biomes. Present also in northern Mariana Islands in decreasing numbers due to hunting pressure. Illegal to hunt fruitbats on Guam, where they nevertheless command high prices.
Blue whale and sperm whale	Listed as Endangered Species.
OTHER	
Coconut crab, *Birgus latro*	Becoming less common, especially on Guam and Saipan. Natural populations of other islands including volcanic northern Marianas under constant to sporadic hunting pressure.
Soft coral, *Asterospiculatia randalli*	Apparently endemic to Guam.
Freshwater fish, *Taeniodes limnicola*	Known only from Aghagan River mouth, Guam,
Fish, *Pomachromis guamensis*	Probably endemic to Marianas.

Conservation legislation

Guam:

- United States Federal Endangered Species Act and Coastal Zone Management Act apply on Guam.
- Coastal resources are being mapped, and their use is subject to planning controls and regulations.
- Guam Water Quality Standards designate certain coastal waters as conservation areas in which no discharge of pollutants is allowed.
- Fishing regulations prohibit poisons and explosives, and limit exploitation of live coral, coconut crabs, *Trochus,* and spiny lobsters.
- Hunting permits are required, and regulations limit the species which may be taken, their numbers, and open seasons.

Northern Marianas:

- Trust Territory Endangered Species Act (1975) protects listed species.
- Water Quality Standards, including regulations controlling erosion and siltation, exist for Northern Marianas, but enforcement is weak.

Existing reserves

Guam:

Conservation areas totaling 1,150 ha were established in November 1968. Others have been established or considered since, making the expected area to be devoted to conservation 4.46 per cent. Conservation areas include Cotal, Anao, Y-Piga and an area behind the University of Guam established by the Government of Guam, and Ritidian Point and Pati Point established by the Navy and Air Force. Reserves are largely uninventoried; some are subject to damage or recreational development. Military reserves have uncertain legal conservation status.

Northern Marianas:

Maug and Sariguan are scheduled under the Commonwealth Constitution to be 'maintained as uninhabited places and used only for the preservation of bird, fish,wildlife, and plant species'.

Proposed reserves

Guam:

- Facpi Point, Mt Lamlam, Fouha Point and Puntan dos Amantes are being considered for the National Registry of Natural Landmarks. There is also interest in setting aside the Chalan-Palii, Shroeder-Sasalaguan areas as natural areas. The Guam Science Teachers'Association has had two sites set aside as natural areas for educational purposes. One is George Washington High School Limestone Forest Nature Trail, the other the Agana Springs Nature Preserve. Other natural areas in the vicinity of schools are anticipated.
- A marine reserve in Cocos Lagoon is being considered under the Coastal Zone Management Act.

Mariana Islands:

- The IBP has placed the northern Mariana islands of Uracas, Maug, Gugan and Farallon de Medinilla on 'List A', recommendations for International Scientific Reserves, with the protection of areas of the rest of the chain also recommended
- The Mariana District Planning Office of the Trust Territory Government has suggested that all of the northern Marianas from Anathan to Uracas be protected, except for Pagan on which large areas, including the northern volcano, fresh and brackish lakes and the southern peninsula, would be protected. In the limestone northern Marianas, the District Planning Office has suggested the protection of a number of areas including Bird Island, Forbidden Island, cliff and strand areas of Rota, Tinian and Saipan, the Susupe Lake and a number of coastal areas and reefs of Saipan. This would protect the few areas of natural vegetation and habitat left on these islands.

Recommended reserve types

- There is a need to coordinate conservation efforts and to create an agency to be responsible for conservation in the Mariana Islands. Pristine terrestrial and marine communities of Guam have been mapped and described, and their biota inventoried in 1977 as part of the Coastal Zone Management Program. There is as yet no programme to administer natural reserve areas as protected areas. In the Ritidian Point area, one of the three specimens of *Serianthes nelsonii* known to exist there was recently bulldozed. Part of the reserve behind the University of Guam was also bulldozed and the rubble dumped on the portions of the reserve on the cliff and terrace below. The unique Cotal reserve area is subject to reafforestation with exotic species and development as a recreation-tourist area.
- There is a need to create additional reserves on Guam for unrepresented biomes such as freshwater areas and undisturbed savanna shrub communities. The distinctions between reserves or natural areas, and public recreation areas should be clarified and the areas administered accordingly.
- In addition to those areas proposed, at least three other areas should be considered for protection or limited use as natural areas. These include an additional representative area of savanna shrub community and ravine forest comparable to that found at the Tarzan River area in the Cotal reserve. While the individual species making up this shrub community vary from scattered to rare, areas where they exist as a natural community are rapidly disappearing. The protection of this type of community, which consists almost wholly of native and endemic species, should take priority, as should the maintenance of the Tarzan River portion of the Cotal Reserve as a nature reserve.
- Other areas include the Asiga area which provides spectacular examples of limestone forest, including a portion dominated by *Guamia marianae*, atoll beach forest, coastal shrubland and shallow water marine habitat.
- Cocos Island has good populations of organisms not common in other areas such as large *Leucaena insularum*, coconut crabs and reptiles.
- The uninhabited northern Mariana Islands from Farallon de Medinilla to Uracas are prime areas for natural reserves, and should receive top priority. Recent field visits to the island of Asuncion give grounds for giving it more complete protection than earlier indicated in the IBP listing of islands for science. This recommendation is based on the following points:

    1. A new species of tree has been found on the island.
    2. Much of the summit of Asuncion is covered not with swordgrass as on other islands but predominantly with ferns. This may represent the original upper cover of summits before the advent of human burning activity which encourages swordgrass.
    3. Asuncion is the only uninhabited island with fairly natural vegetation which is large enough to permit the development of a relatively homogeneous forest biome. Other islands in the chain are either too disturbed or too small and exposed to the elements to allow such development.

4. Although the endangered species *Megapodius laperouse* is found on other islands, Asuncion represents the largest area in the world where it is not threatened by man, pig or monitor lizards.
5. Because of its height, Asuncion offers a natural situation which might be compared with the other highest peaks in Micronesia which are much more subject to disturbance.

References and sources

Chapter originally drafted by M.V.C. Falanruw, Yap Institute of Natural Science

Visits to Guam and Saipan

Endangered Species Act of Trust Territory of the Pacific Islands

Anon, 1978. Maug, a wildlife preserve in the Northern Marianas Commonwealth. *Pacific Science Association Information Bulletin* 30 (2): 17-18.

Douglas, 1969

Fosberg, F.R., 1973. On present condition and conservation of forests in Micronesia. *In* Pacific Science Association Standing Committee on Pacific Botany Symposium: Planned utilization of the lowland tropical forests, August 1971. Bogor, Indonesia.

Fosberg, F.R., Falanruw, M.V.C. and Sachet, M.-H., 1975. *Vascular flora of the Northern Mariana Islands.* Smithsonian Contributions to Botany.

Stone, B.C., 1970. The flora of Guam. *Micronesica* (6).

XIII. CAROLINE ISLANDS

Government: Part of United Nations Trust Territory administered by the United States, in process of separating into Palau and Federated States of Micronesia.

Island types: Continental high islands (Yap and Palau), volcanic high Islands (Truk, Ponape and Kosrae), at least Ponape with high orographic rainfall; raised coral (Fais, rock islands of southern Palau), and wide variety of atoll situations. Extremely wide variety of marine types.

Biomes/habitats	Description	Conservation status
Lowland rain forest	Mixed broadleaf forest on old weathered basalt in Palau, Truk and Ponape and metamorphic and volcanic soils on Yap. Forests of Palau and Yap are dense, species - rich (especially on Palau) with trees less than 25 m tall presenting uneven canopy. Undergrowth is limited to abundant in areas where canopy is broken. Epiphytes uncommon to common, especially in Palau. Common trees are *Campnosperma brevi-petiolata, Manilkara, Calophyllum, Eugenia* and *Ficus.* Tree ferns are present in Palau .	None
	Limestone forests are rich mixture of trees, generally below 20 m on raised coral island of Fais and rock islands of southern Palau, growing on recrystalized coralline limestone with very little soil. Endemics include palm *Gulubia palauensis*	Some limestone forest in Ngerukewid reserve
Montane rain forest	Forests on top of Mt Winibot, Tol and other mountain-tops of Truk, and lower and middle elevations of Ponape and Kosrae, are moist, tall, dense mixed broadleaf forests including *Campnosperma, Myristica, Eugenia, Couthovia,* sometimes with palms *Clinostigma* spp, *Metroxylon amicarum* and *Ptychosperma ponapensis,* which also form palm forests at middle elevations	None
Bamboo forest	Some limited areas dominated by bamboo	None
Cloud forest	Moist tops of Ponape and Kosrae. Trees not over 20 m, including endemic *Pandanus patina* and *Lepinia,* many ferns, mosses and orchids	None
Riverine forest	Dense forest along rivers on all high islands. Trees include *Campnosperma, Semicarpus, Barringtonia racemosa, Pandanus, Hibiscus tiliaceus* and *Piper betle*	None
Swamp forest	Inland of mangrove and in other low areas. Species include *Barringtonia racemosa, Terminalia carolinensis, Pandanus* spp, *Hibiscus tiliaceus, Samadera indica* and *Metroxylon*	None
Mangrove forest	Well developed mangroves along coasts and estuaries of all high islands, very limited areas on some low islands (Elato, Pingelap, Woleai and others). Species include *Rhizophora mucronata, R. apiculata, Bruguiera gymnorhiza, Sonneratia alba, Lumnitzera littorea, Nypa fruticans* and *Xylocarpus.*	None
Atoll/beach forest	Mixed broadleaf forests of central portions of atoll and other islets, and level areas behind sand beaches of high islands; made up of common widespread species including *Ochrosia oppositifolia, Guettarda speciosa, Pisonia grandis, Thespesia populnea, Hernandia sonora, Casuarina equiseti-folia, Pandanus tectorius, Cordia subcordata*	None
Woodland	1) Patches of woodland in some savanna areas 2) Man-planted areas with exotics	None
Scrub	1) Tall thickets on outer edges of limestone forests including much *Pandanus, Ficus* spp and *Hibiscus tiliaceus*	Some in Ngerukewid reserve
	2) Coastal shrubland and thickets of mostly pan-Pacific species including *Scaevola taccada* and *Messerschmidia argentea* on sandy beaches and *Pemphis acidula* on rocky coasts	Some in Ngerukewid reserve
	3) Scrub of savanna and shallow ravines including *Myrtella, Decaspermum, Melastoma, Pandanus*	None
	4) Scrubland of laterised and stripmined soils generally consisting of stunted trees	None

Biomes/habitats	Description	Conservation status
Dwarf-shrub heath	1) Along rocky exposed coasts, especially *Pemphis acidula*	None
	2) On laterised and stripmined soils, including *Gleichenia linearis,* prostate *Lycopodium cernuum* and stunted scrub	None
Woodland savanna	Open savanna areas on clay with sometimes extensive areas of tall shrubland and woodland	None
Tree savanna	Low growth of grasses, sedges and ferns on clay soils with isolated trees scattered over area including *Pandanus* and sometimes *Casuarina* and other species	None
Shrub savanna	Shrubs such as *Myrtella, Decaspermum, Melastoma*	None
Grassland	Open areas, predominantly of grasses and sedges, generally resulting from repeated burning	
Flood savanna	Areas of savanna generally dominated by sedges, ferns and grasses which are easily waterlogged and flooded. *Utricularia* spp may often be found in these moist areas.	None
Freshwater marsh	Constant to usually flooded areas often filled with sedges and *Hanguana.* Often utilised for taro patches	None
Non-tidal salt marsh	Low, usually muddy areas near coast or mangroves, often with large woody fern *Achrosticum aureum*	None
Tidal salt marsh	Low, muddy areas near coasts and mangroves, subject to tidal flooding, supporting salt-resistant grasses and species such as *Sesuvium*	None
Rock desert	1) Limited areas of laterised clay rocks and stripmined areas with little vegetation in Palau	None
	2) Some boulder-strewn shores and rock accumulations on reef islets mostly devoid of vegetation	None
Reed swamp	Scattered small to large swamps, generally filled with *Phragmites* reeds	None
Submerged aquatics	Water ferns and other aquatic vegetation in lakes, ponds and taro patches	None
Floating aquatics	Limited areas of mostly introduced species in some lakes, ponds and taro patches	None
Lake and pond	Permanent, intermittent, fresh and brackish natural and man-made impoundments, ponds and lakes	None
Mountain stream	Present in all high islands, especially Ponape. *Macrobrachium* shrimp and eleotrid fish live in some	None
Lowland river	Present on all high islands. *Macrobrachium* shrimp, eleotrid fish *Kuhlia* and freshwater eels are found in some	None
Seabird rookery	Many rookeries on uninhabited outer islands such as Gaferut, East Fayu and cliffs of some high islands	None
Sea turtle nesting area	Most important include Ngulu, Ulithi, West Fayu, Gafrut, Pikelot, Elato, in Yap District, Oroluk in Ponape District, probably similar numbers in other districts	None except traditional practices
Cave	Present in Palau limestone areas, also excavated tunnels	None
Algal bed	Many kinds, lagoon bottoms, reef flats, etc.	None
Sea grass bed	Many varied and extensive sea grass beds, especially on silted sands fringing mangroves around high islands, including *Thalassia, Thalassodendron, Enhalus, Halodule, Halophila, Syringodium, Cymodocea*	None
Animals in sediments	Common	None
Algal reef	Common	None
Windward atoll reef	Many types and examples	None
Leeward atoll reef	Many types and examples	None
Barrier reef	Extensive (Palau, Truk, Ponape)	None
Fringing reef	Yap, Kosrae, Truk, Palau (including submarine cliffs)	None

Biomes/habitats	Description	Conservation status
Lagoon reef	Common	None
Non-growing reef	Probably present	None
Submerged reef	Present	None
Rocky coast	Present, Palau, Fais.	None
Beach	Common	None
Open lagoon	Common	None
Closed lagoon	Namoluk, Eauripik	None
Estuary	Present on high islands	None
Marine lake	Limestone islands of Palau; distinctive limited fauna	None
Marine cave	Present	None
Offshore environments	All present but little data	None

Conservation interest

Very great. Very rich area of Pacific. Limited research which has been conducted reveals rich flora and fauna with many unique forms. This area is under development pressure and many biomes are currently threatened.

Rare or endemic species

○ Floras are incompletely inventoried so it is difficult to list all rare plants at this time. Many endemics are present.

PLANTS

Rock Island palm, *Gulubia palauensis*	Palau; Endangered species
Truk palm, *Clinostigma carolinensis*	Truk; Endangered species
Palau palm, *Ptychosperma palauensis*	Palau; Endangered species
Truk poison tree, *Semecarpus kraemeri*	Truk; Endangered species

BIRDS

Palau grey duck, *Anas superciliosa pelewensis*	Endangered species
Micronesian megapode, *Megapodius laperouse*	Palau; Endangered species
Palau scops owl, *Otus podarginus* or *Pyrroglaux podargina*	Endangered species
Ponape short-eared owl, *Asio flammeus*	Threatened
Palau nicobar pigeon, *Caloenas nicobarica pelewensis*	Endangered species
Palau ground-dove, *Gallicolumba canifrons*	Endangered species
Micronesian crimson-crowned fruit-dove, *Ptilinopus porphyraceus*	Threatened
Truk Micronesian pigeon, *Ducula oceanica teraokai*	Endangered species
Nightingale reed-warbler, *Acrocephalus luscinia*	Truk, Ponape, Kosrae; Endangered species
Truk monarch, *Metabolus rugensis*	Threatened
Palau fantail, *Rhipidura lepida*	Endangered species
Yap greater white-eye, *Rukia oleaginea*	
Truk greater white-eye, *Rukia ruki*	Endangered species
Ponape greater white-eye, *Rukia longirostra*	Endangered species
Bridled white-eye, *Zosterops conspicillata*	Threatened
Palau blue-faced parrot finch, *Erythrura trichroa pelewensis*	Endangered species
Ponape mountain starling, *Aplonis pelzelni*	Endangered species
Palau white-breasted wood-swallow, *Artamus leucorhynchus pelewensis*	Endangered species

ANIMALS

Dugong, *Dugong dugon*	Palau; Endangered species
Hawksbill turtle, *Eretmochelys imbricata*	Endangered species
Leatherback turtle, *Dermochelys coriacea*	Endangered species
Pacific Ridley turtle, *Lepidochelys olivacea*	Endangered species
New Guinea crocodile, *Crocodylus novae-guineae*	Rare in freshwater habitats in Palau
Pandanus skink, *Aulacoplax leptosoma*	Palau, endemic.

Conservation legislation

- Trust Territory-wide law provides complete protection for hawskbill turtles, and prohibits the taking of other sea turtles from 1 June - 31 August, and 1 December - 31 January. It is illegal to take green turtles under 34 inches, or to take any eggs. Little publicity or enforcement of this law.
- Federal Endangered Species Act protects all marine mammals in Trust Territory waters, and prohibits the import of hawksbill shell and products of other listed endangered species into the United States. Little enforcement.
- Trust Territory Endangered Species Act (1975) protects listed species.
- Palau Code: section 202 protects most birds and their eggs, section 203 protects dugongs, section 205 prohibits use of explosives in marine waters, section 206 creates a Fish and Game Commission.
- Yap District Legislature recently established a fruitbat hunting season but research is needed to determine most effective seasons for protection.
- Yap magistrates of some municipalities have prohibited spearfishing at night with flashlights in certain areas.
- Some traditions regulating resource use are observed in Yap district but there is some pressure to change them. They are often transgressed by non-Yapese and not often backed by written legislation.
- Similar legislation probably exists in the rest of the Carolines, but means for enforcement are variable or completely lacking. New conservation legislation is being developed in Ponape.

Existing reserves

The Ngerukewid Islands (Seventy islands) Wildlife reserve	Estabished in Palau by District Order in 1958. Enforcement is variable.

Proposed reserves

- The IBP has proposed Helen's Reef and East Fayu as International 'Island for Science' reserves, and the establishment of a National Marine Park to include the Ngerukewid Reserve, other rock islands, coasts and lagoons from Koror to Peliliu and westward to the barrier reef.
- An acting Fisheries Officer for Ponape proposed that Oroluk be protected as a sea turtle reserve,

Recommended reserve types

- There is an urgent need to inventory the biomes of the Caroline Islands and their indigenous biotic resources as this is a rich area subject to great development pressure in the near future.
- Priorities for resource protection based on our present limited knowledge include at least:
  - Native cloud forests on Ponape and Kosrae.
  - Native forest on top of Mt Winibot (Tol), Mt Teroken (Moen), Mt Tolomen (Dublon), Mt Chukusou (Fefan) and Mt Uroras (Uman), Truk.
  - Native forest areas on Babeldoob (Palau) and Yap.
  - Turtle rookeries and seabird rookeries, including Oroluk, Elato, West Fayu (Pigailoe), Gaferut and Pikelot.
  - Those islets and areas recommended by the IBP.
  - Examples of all biomes present including atoll and reef types.

References and sources

Chapter originally drafted by M.V.C. Falanruw, Yap Institute of Natural Science.

Visits to Palau, Kyangle, Angaur, Yap, Truk, Ponape, Ant, Pakin.

Code of the Palau District, Palau District Legislature, 1971.

Endangered Species Act of Trust Territory of the Pacific Islands, Territorial Register 1 (IZ), October 29, 1976.

Memorandum of April 11, 1974 from Acting District Fisheries Specialist, Ponape to District Administrator, Ponape regarding the establishment of District Law making Oroluk Island a Turtle Sanctuary.

Notice from J.B. Mackenzie, District Administrator, Ponape to all residents and visitors regarding Trust Territory laws for Conservation of Sea Turtles and Black Lip Mother of Pearl Oyster Shell.

Douglas, 1969.

Fosberg, F.R., 1973. On present condition and conservation of forests in Micronesia. *In* Pacific Science Association Standing Committee on Pacific Botany. Symposium: Planned Utilisation of the lowland tropical forests. August 1971. Bogor, Indonesia.

Tsuda, Fosberg and Sachet, 1977.

XIV. MARSHALL ISLANDS

Government: United States Trust Territory

Island types: Large variety and number of atolls

Biomes/habitats	Description	Conservation status
Mangrove forest	Limited, in small depressions in few areas, Jaluit, Ailinglaplap, Mejit. Some *Bruguiera* planted in taro pits	None
Atoll/beach forest	Variety of types of forest in central parts of islets, usually dominated by planted coconuts, breadfruit, etc. Small remnants of natural forest made up of pan-Pacific species persist on some northern atolls such as Wotho. Forests may contain *Ochrosia oppositifolia, Guettarda speciosa, Pisonia grandis, Intsia bijuga, Hernandia sonora, Scaevola taccada, Thespesia populnea, Casuarina equisetifolia, Pandanus tectorius, Cordia subcordata.*	Bikar
	In some forests, one-species stands may develop including *Pisonia grandis, Ochrosia oppositifolia* and, on limestone rock, *Pemphis acidula*.	None
Scrub	Scrublands and thickets of common Pacific strand species including *Scaevola taccada, Tournefortia argentea* and *Pemphis acidula* occur along shores of most islands. In some cases there is scrub forest consisting almost wholly of *Pemphis* or *Messerschmidia*.	Example of *Messerschmidia* scrub forest on northern Marshall Islands reserve area
Grassland	Smaller islets of Ujelang, Rongerik, Ailinginae, Jaluit, Wotje	None
Tidal salt marsh	Some strand species of mainly grasses on coast and in depressions subject to tidal flooding	None
Rock desert	Limited areas of bare rock and sand present on low islets, sometimes awash at high tide	None
Permanent lake	Freshwater pond on Lib, man-made depressions for wells and taro patches	None
Seabird rookery	At least on Ujelang, Pokak (Taongi), Bikar	Pokak, Bikar
Sea turtle nesting area	Bikar, Jemo, formerly Rongerik	Bikar
Algal bed	Present	None
Sea grass bed	Present	None
Animals in sediments	Common in lagoons	None
Algal reef	Common	None
Windward atoll reef	Common	None
Leeward atoll reef	Common	None
Lagoon reef	Common	None
Beach	Common	None
Open lagoon	Common	None
Closed lagoon	Namorik	None
Offshore environments		None

Conservation interest

Turtle and seabird rookeries especially valuable, also examples of relatively undisturbed atoll development.

Rare or endemic species

Endemic species of grass, *Lepturus gassaparicensis*	Present on Pokak
Ratak Micronesian pigeon, *Ducula oceanica*	Endangered species, Wotje and Arno
Many locally developed varieties of *Pandanus*	
Bridled white-eye, *Zosterops conspicillata*	Threatened

Conservation legislation

- Trust Territory-wide law provides complete protection for hawskbill turtles and prohibits taking of sea turtles between 1 June - 31 August and 1 December - 31 January. It is illegal to take green turtles under 34 inches, or to take any eggs. Little enforced.
- Federal Endangered Species Act protects all marine mammals in Trust Territory and prohibits the import of hawksbill shell and products of other listed endangered species into the United States.

Existing reserves

Pokak (Taongi) (bird rookery and location of endemic grass) and Bikar (bird rookery, turtle nesting area and atoll forest) are supposed to be protected by Order of the District Administrator.

Proposed reserves

Wotho	Atoll forest
Taka	Seabird rookery
Jemo	Seabird rookery and turtle nesting area

Recommended reserve types

- The recommended reserves above, and improvement of the status of Pokak and Bikar.
- Appropriate habitat area on Wotje for Micronesian pigeon if it still occurs.
- Samples of undisturbed windward and leeward atoll reefs, mangrove and lagoon environments.
- Inventory of atoll types and biota, especially marine, to determine if additional reserves are needed.

References and sources

Chapter originally drafted by M. V.C. Falanruw, Yap Institute of Natural Science.

Visit to Majuro.

Endangered Species Act of Trust Territory of the Pacific Islands.

Douglas, 1969.

Fosberg, F.R. 1973. On Present Condition and Conservation of Forests in Micronesia. *In* Pacific Science Association Standing Committee on Pacific Botany. Symposium: Planned Utilization of the Lowland Tropical Forests. August 1971, Bogor, Indonesia.

XV. PHOENIX - LINE - NORTHERN COOK ISLANDS*

Government: Kiribati (Phoenix and Line Islands); United States of America (Palmyra, Howland, Baker and Jarvis); Cook Islands (Northern Cooks).

Island types: Atolls. Phoenix Islands receive low rainfall, with periods of drought. Line Islands are wetter to the north.

Biomes/habitats	Description	Conservation status
Semi-deciduous forest	Reported on Pukapuka	None
Atoll/beach forest	Common in small isolated areas, and on wet atolls [Palmyra, Tabuaeran (Washington), Teraina (Fanning)]. Varies in composition with rainfall	None
Scrub	Common and extensive	None
Bog	Tabuaeran, small area on Flint and probably elsewhere	None
Grassland	On drier islands	None
Freshwater marsh	Tabuaeran, around freshwater lake	None
Permanent lake	Freshwater pools on Phoenix. Large lake on Tabuaeran	None
Seabird rookery	Common and extensive. Some of most important in the Pacific	Several sanctuaries
Sea turtle nesting area	Common, especially Flint, Canton, Enderbury	None
Algal bed	Common	None
Animals in sediments	Common	None
Algal reef	Probably common	None
Windward atoll reef	Common	None
Leeward atoll reef	Common	None
Lagoon reef	Various types	None
Beach	Common	None
Saline lagoon	Manra (Sydney), partly modified for aquaculture, Malden, Kiritimati (Christmas)	None
Open lagoon	Orona (Hull), Nikumarora (Gardner), Caroline, Suvarov. Also various intermediates with closed lagoon	None
Closed lagoon	McKean	None
Brackish lagoon	Birnie	None
Offshore environments	No data other than below	None
Offshore terrace	Malden	None
Inshore circulation cell	Kiritimati (Christmas) (eddy southwest side)	None

Conservation interest

These islands contain the principal breeding areas of seabirds (and probably sea turtles) for the central Pacific, with rookeries containing many thousands and sometimes millions of birds. Their protection from undue disturbance is therefore most important.

There is an extreme gradient in rainfall across the province, with some of the wettest and driest atolls included within the group. The resulting range of atoll vegetation types is therefore of some interest, as are the distinctive saline and brackish lagoon biomes, and the freshwater habitats on Tabuaeran (Washington), A number of islands would benefit from control programmes to eliminate introduced predators, especially rats and feral cats.

Rare or endemic species

Christmas Island reed warbler, *Conopoderas aequinoctialis*	Common on Kiritimati and Tabuaeran (may be represented by subspecies on each of the Line Islands).

* Clipperton Atoll, a dependency of France, might well be included in this biotic province, even though much further to the east. Because of its position, it may well have some conservation interest for its marine biomes.

Red-tailed tropic bird, *Phaethon rubricauda*	Not uncommon but subject to heavy human predation.
Sea turtles (especially *Chelonia mydas*)	Population decreasing; more management and protection needed.

Conservation legislation

- See Kiribati for Phoenix and Southern Line Islands (most birds and green turtle, *Chelonia mydas,* fully protected throughout area)
- Cook Islands for Northern Cooks.

Existing reserves

North West Point Reserve, Kiritimati (Christmas Island), Kiribati

Motu Tabu Reserve, Kiritimati (Christmas Island), Kiribati

Cook Island Reserve, Kiritimati (Christmas Island), Kiribati

Ngaon te Taake Islet Reserve (Christmas Island), Kiribati

An IUCN/WWF project based on Christmas Island is developing proper surveillance and enforcement for these reserves.

Birnie	Wildlife Sanctuary, Kiribati; seabird rookery.
McKean	Wildlife Sanctuary, Kiribati; seabird rookery.
Phoenix	Wildlife Sanctuary, Kiribati; seabird rookery.
Kiritimati (Christmas)	Wildlife Sanctuary, Kiribati; seabird rookery.
Malden	Wildlife Sanctuary, Kiribati and closed area.
Starbuck	Wildlife Sanctuary, Kiribati; seabird rookery.
Vostok	Wildlife Sanctuary, Kiribati; seabird rookery.
Canton	Formerly Bird Refuge, while under U.S. control; present status uncertain; seabird rookery.
Suwarrow	Bird Sanctuary, Cook Islands; seabird rookery.
Jarvis	U.S. National Wildlife Refuge (1974); seabird rookery.
Howland	U.S. National Wildlife Refuge (1974); seabird rookery.
Baker	U.S. National Wildlife Refuge (1974); seabird rookery.

Proposed reserves

Phoenix Islands National Park	(Possibly excluding Nikumaroro (Gardner), Manra (Sydney) and Orona (Hull) Islands.)

Recommended reserve types

- National or international reserve in Phoenix Islands (upgraded from wildlife sanctuaries), with Canton Island as communications link and surveillance centre, and including Enderbury, Birnie, McKean, Phoenix and Orona (Hull) Islands, and possibly Manra (Sydney) because of its saline lagoon. Nikumaroro (Gardner) is apparently of little scientific interest, so the decision to include or exclude it should be made on other grounds. Regular enforcement visits (without landing on the island) could be undertaken by government ships going to and from Kiritimati (Christmas Island).
- Most of the Line Islands, especially Vostok, Caroline, Howland, Baker, Jarvis, Malden and Kingman reef are candidates for reserve status, especially if existing predators can be controlled so that seabird populations can recover.
- Flint, Caroline, Canton and Enderbury deserve protection as turtle breeding areas, and other protective measures for turtles are needed.
- On Tabuaeran (Washington), the bogs and perhaps the lake, including adequate areas of Christmas Island warbler habitat, should be protected, as should seabird breeding areas.

- Forest area, and Motu Kotawa and Motu Ko (seabird rookeries) on Pukapuka may deserve protection.
- Appropriate samples of atoll, forest, marine, and lagoon environments should be included in reserves to be established. Further studies of all marine environments are needed to determine areas of significance.

References and sources

Line Islands Expedition, August-October 1974 (Government Report)

D.T. Holyoak, personal communication

David R. Stoddart, unpublished report on scientific importance and conservation on Central Pacific Islands, January 1976

Wildlife Conservation Unit, Kiritimati (Christmas Island) *Report No. 4.* Republic of Kiribati, Central Pacific, May-November 1979.

Balazs, 1975

Chave and Kay, 1974

Douglas, 1969

Stoddart and Walsh, 1975

XVI. COOK - AUSTRAL ISLANDS

(Northern Cook Islands are included in Province XV.)

Government: Cook Islands (Self-governing, New Zealand), for Southern Cook Islands; French Polynesia (Austral Islands)

Island types: High volcanic islands, often with elevated reef surrounding central volcanic area; low islands (atolls)

Biomes/habitats	Description	Conservation status
Lowland rain forest	Raivavae, Tubuai, Mauke; remainder largely disturbed. Limestone forest on Rurutu	None
Montane rain forest	Central Rarotonga, Raivavae	None
Atoll/beach forest	Present, particularly on atoll and reef islets	None
Scrub	Bracken scrub in frequently burned areas, Rarotonga, Tubuai, Rurutu	None
Grassland	Tubuai, upper mountain slopes and Rurutu	None
Freshwater marsh	Mangaia, Rarotonga, Mauke, Mitiaro, Atiu	None
Tidal salt marsh	Ngatangiia Harbour, Rarotonga	None
Permanent lake	Centre of Mitiaro, with endemic eel; lake Tiriara on Mangaia	None
Mountain stream	Rarotonga	None
Seabird rookery	Takutea	None
Sea turtle nesting area	Presumably present	None
Algal bed	Lagoon bottoms and reef flats	None
Animals in sediments	Lagoon bottoms	None
Algal reef	Present	None
Windward atoll reef	Manuae, Palmerston	None
Leeward atoll reef	Manuae, Palmerston	None
Barrier reef	Aitutaki, Raivavae, Tubuai	None
Fringing reef	Common	None
Lagoon reef	Common	None
Beach	Common	None
Open lagoon	Aitutaki, Palmerston	None
Closed lagoon	Manuae	None
Offshore environments	No data available	None
Seamount	Present	None

Rare or endemic species

- Several endemic birds on Rarotonga in montane forest, including:

Fruit dove, *Ptilinopus rarotongensis*	Common
Starling, *Aplonis cinerascens*	Common
Rarotonga flycatcher, *Pomerea dimidiata*	Threatened. Only about 50 pairs reported in 1973.
Mangaia kingfisher, *Halcyon rubicollaris*	On Mangaia
Atiu swiftlet, *Collicalia sawtelli*	On Atiu
Endemic subspecies of warbler, *Acrocephalus vaughani*	
Tahitian lorikeet, *Vini periviana*	Aitukaki forest area
Lorikeet, *Vini kuhlii*	Small population on Rimatara, Austral Islands
Warbler, *Acrocephalus vaughani rimatarae*	Common on Rimatara
Endemic eel in Lake Mitiaro	

Conservation legislation

Cook Islands: Conservation Act recently passed. There are plans to encourage land-owners to create family reserves.
Austral Islands: See Society Islands.

Proposed reserves

Suwarrow Island
(The proposal to make Manuae a world marine park is not being pursued).

Recommended reserve types

- Major mountain and forest reserve in central Rarotonga.
- Takutea for seabirds
- Higher areas of Raivavae
- Limestone forest on Rurutu, and possibly a mountain grassland and ravine site
- Lake on Mitiaro
- Appropriate swamp and marsh biomes, and other terrestrial vegetation types
- Endemic bird habitats on Rarotonga
- Elevated limestone 'makatea' regions on Atiu, Mangaia, Mitiaro and Mauke, with endemic land birds
- Barrier and fringing reef and lagoon examples
- Muri Lagoon and motus of Motutapu, Oneroa, Koromiri and Taakoka, including adjacent reefs
- Black Rock (Tuoro) area on Rarotonga, including adjacent reef
- Aitutaki lagoon and its eastern motus, including adjacent reef
- Banks of major streams, including 10 m on each side
- Areas between Ara Tapu and the lagoon on Rarotonga
- Historical features such as marae, landing and departure points for great canoe voyages, old mission buildings, parts of the Ara Tapu and its roadside springs, etc.

References and sources

Visit to Rarotonga
S. Kingan and other Government officials
D.T. Holyoak, personal communication
N.C. Gare, 'The Cook Islands - a conservation report', unpublished report, 1975
J.C. Thibault, 'Fragilité et protection de l'avifaune en Polynésie française' (unpublished ms.)
Douglas, 1969
Fosberg, 1972
Stoddart, 1972

XVII. SOCIETY ISLANDS

Government: French Polynesia (France)

Island types: High volcanic islands, elevated reefs and five atolls

Biomes/habitats	Description	Conservation status
Lowland rain forest	In coastal areas. Subject to much human disturbance	Good example in Presqu'île, Tahiti
Montane rain forest	Extensive in island interiors, several types may exist	Mt Marau, Tahiti
Bamboo forest	Valley area of Raiatea and probably elsewhere	None
Cloud forest	On mountain peaks, Tahiti, Raiatea	Mt Marau but disturbed by road construction
Riverine forest	In valley bottoms, largely disturbed	Presqu'île
Atoll/beach forest	Common	None
Scrub	Often fern-dominated, on steep or disturbed slopes. Common	None
Grassland	On dry disturbed slopes	None
Freshwater marsh	Two on Maiao	None
Permanent lake	Two on Huahine, with interesting fauna; Lake Vaihiria, Tahiti	None
Mountain stream	Common	Presqu'île
Lowland river	Papenoo, Tahiti	None
Seabird rookery	Islets on Tetiaroa, Tubai, Mopihaa (Mopelia), Fenuaura (Scilly), Motuone (Bellingshausen)	Proposed on Tetiaroa
Sea turtle nesting area	Mopihaa, Fenuaura, Motuone	None
Algal bed	Lagoon bottoms and reef flats	None
Animals in sediments	Lagoon bottoms	None
Windward atoll reef	Present, Tetiaroa, Tubai, Mopihaa, Fenuaura, Motuone	None
Leeward atoll reef	Present, Tetiaroa, Tubai, Mopihaa, Fenuaura, Motuone	None
Barrier reef	Common	None
Fringing reef	Common ? Meetia	None
Lagoon reef	Common	None
Beach	Common	Small example Presqu'île
Rocky coast	Presqu'île of Tahiti	Presqu'île
Open lagoon	Common	None
Estuary	Present	None
Offshore environments	No data available	None
Offshore terrace	Reported off northwest Moorea	None

Rare or endemic species

PLANTS

Apehahia	Endemic to Raiatea plateau
Kadua	Endemic to Raiatea plateau

BIRDS

o 9 out of 22 endemic species and subspecies already extinct.

Society Island pigeon, *Ducula pacifica aurorae*	Threatened (on Tahiti).
Society Island ground dove, *Ptilinopus purpuratus* (3 subspecies)	Reasonably common
Moorea Polynesian warbler, *Acrocephalus caffer longirostris*	Threatened. In Moorea less than 100.
Tahiti lorikeet, *Vini peruviana*	Fenuaura (Scilly) over 600 individuals, Motuone.

Tahiti flycatcher, *Pomaria nigra*	Threatened, Tahiti.
Heron, *Butorides striatus patruelis*	Diminishing population of less than 100, Tahiti
Swiftlet, *Aerodramus leucophaeus*	Small population, Tahiti, Moorea.

Conservation legislation

- Forestry Act (Deliberation of 7 February 1958) deals with protection of soil, flora and wildlife.
- Sites can be legislated as a strict nature reserve (réserve intégrale) but there is no provision for supervision.
- Hunting of birds and introduction of alien bird species are prohibited.
- Natural Monument Site Commission established 1962 to propose sites for classification or protection.

Existing reserve

Fenuaura (Scilly) Atoll	Lagoon completely protected in 1971, but risks of exploitation continue.

Proposed reserves

Mt Marau, Tahiti	Mountain peak and upper slopes with montane rain forest, cloud forest and scrub. Disturbed by road and television transmitter. Proposal in final stages of approval in 1980. (About 1,000 ha).
Pari Coast on Taiarupu presqu'île, Tahiti	Lowland forest and archaeological sites along inacessible coast without reef. Several valleys of about 2,000 ha originally proposed, but land tenure problems may permit reserving only La Vaiote.
Tetiaroa islets	Include 6 motus with seabird rookeries and 400 m protective belts on privately-owned atoll. 1,288 ha.
Valley south of Avera, Raiatea	Forest areas require protection for endemic birds.
Temehani Plateau, Raiatea	Fragile and unique flora including endemic tiare apetahi. Above 450 m.
Opunohu, Moorea	*Inocarpus* forest and endemic birds. Above 150 m.

Recommended reserve types

- Tahiti - montane forest types and cloud forest in such areas as upper Papenoo (perhaps some combination of conservation and recreation areas if dam is constructed, improving access), Lake Vaihiria (also lake biome), Tamanu plateau and other areas of central Tahiti; some marine biomes associated with the Presqu'île reserve might also be protected.
- Moorea - a representative selection of reef and lagoon habitats should be reserved.
- Raiatea - a complete estuary-lagoon-reef sequence in one of the least devastated bays, such as Faatema (with some controls on adjacent terrestrial development to maintain the natural characteristics of the watershed); archaeological sites and sites of traditional cultural significance.
- Maupiti - may deserve protection as a good example of the high volcanic island type.
- Meetia (Mehetia) - mountain areas above 160 m.
- Tubai - seabird rookery, internal lagoons and barrier reef.
- Fenuaura (Scilly) Atoll - land areas should be made bird and marine turtle sanctuary to complement lagoon reserve.
- Motuone (Bellingshausen) } seabird rookeries and turtle nesting areas and a selection of atoll
- Mopihaa (Mopelia) } marine biomes.

References and sources

Visits to Tahiti, Moorea, Tetiaroa, Raiatea, Tahaa.

Denis Capitaine, Service d'aménagement et urbanisation, Government of French Polynesia, and many other government officers and individuals.

D.T. Holyoak, personal communication.

J.C. Thibault, 'Fragilité et protection de l'avifaune en Polynésie française' (unpublished ms.).

Douglas, 1969.

XVIII. TUAMOTU ARCHIPELAGO

Government: French Polynesia (France)

Island types: Atolls and one elevated reef (Makatea)

Biomes/habitats	Description	Conservation status
Lowland rain forest	Formerly on Makatea	None
Atoll/beach forest	Common	Taiaro Atoll reserve
Scrub	South Marutea and presumable elsewhere	None
Grassland	Presumably present	None
Freshwater marsh	Niao	None
Seabird rookery	Pukapuka, Tekokoto, Kauehi, Apataki, Rangiroa, Tikei, Taiaro, Kaukura	None
Sea turtle nesting area	Pukapuka, Napuka, Mataiva	None
Algal bed	Lagoon bottom and reef flats	Taiaro
Animals in sediments	Lagoon bottoms and terraces	Taiaro
Algal reef	Common, especially on windward reefs	None
Windward atoll reef	Common	Taiaro
Leeward atoll reef	Common	Taiaro
Fringing reef	Makatea	None
Lagoon reef	Common	None
Submerged reef	North Marutea	None
Beach	Common	Taiaro
Saline lagoon	Taiaro and probably other closed lagoons	Taiaro
Open lagoon	Common	None
Closed lagoon	Probably common, salinity may vary quite abruptly	None
Offshore environments	No available data	None

(There is an unconfirmed reference to mangroves occurring in lagoons of the northern Tuamotus in Douglas, 1969).

Conservation interest

Many variations on the atoll type, with a variety of distinctive lagoon ecosystems. Important areas for seabird and sea turtle breeding.

Rare or endemic species

Tuamotu sandpiper, *Prosobonia cancellata*	Endangered. Maturei Vavao and south Marutea
Ground dove, *Gallicolumba erythroptera*	Endangered. Maturei Vavao
Lorikeet, *Vini peruviana*	Rangiroa and perhaps a few other atolls
Pigeon, *Ducula pacifica aurorae*	Makatea, several hundred individuals
Kingfisher, *Halcyon gambieri gertrudae*	Endemic on Niau, small population (500)
Fruit-dove, *Ptilinopus chalchurus*	Common, Makatea
Fruit-dove, *Ptilinopus coralensis*	Common, most atolls
Polynesian warbler, *Acrocephalus caffer*	5 endemic subspecies, some on single atolls (Anaa, Niau, Napuka)

Proposed reserves (Thibault)

Some islets on an atoll in the Acteon group, perhaps Maturei Vavao, for endangered birds and atoll vegetation.

Recommended reserve types

- A range of open and closed lagoon types including perhaps Hereheretue, Anuanuraro, Anuanurunga, Nukutipipi or Duke of Gloucester's Islands.
- Makatea lowland forest, if remnants can be found.

- Samples of atoll forest and other vegetation types
- Atoll untouched by ciguatera fish poisoning (perhaps Toau)
- Seabird and turtle breeding areas such as Pukapuka, Tekokota, Kauehi, Apataki, Napuka, Mataiva.

References and sources

M. Delarce, Administrator of Tuamotu Archipelago

D. Capitaine, Service d'Aménagement et Urbanisation, Government of French Polynesia.

'Taiaro Reserve' (privately printed brochure)

D.T. Holyoak, personal communication

J.C. Thibault, 'Fragilité et protection de l'avifaune en Polynésie française' (unpublished ms.)

Douglas, 1969

XIX. MARQUESAS ISLANDS

Government: French Polynesia (France)

Island types: Volcanic islands without reefs

Biomes/habitats:	Description	Conservation status
Lowland rain forest	Up to 500 m elevation, many introduced species; secondary anthropogenic forest with many fruit trees in valleys	None
Montane rain forest	400-900 m, *Hibiscus, Pandanus, Angiopteris* with *Gleichenia* and *Paspalum*	None
Cloud forest	Above 900 m, with endemic birds; Nukuhiva, Uapou, Hivaoa, Tahauta, Fatuhiva	None
Atoll/beach forest	With *Pisonia grandis*	Mohotani reserve
Scrub	Uapou	None
Dwarf-shrub heath	Smaller islands with seabirds	Hatutu reserve
Grassland	Motuoa, Mohotani	Mohotani reserve
Rock desert	Low islets, Motu Iti, Fatuuka	None
Mountain stream	Presumably present	None
Seabird rookery	Smaller islands, Hatutu, Motuoa, Fatuuka, Ilot de Sable and islets around Uahuka and Uapou	Hatutu reserve, Ilot de Sable reserve
Algal bed	Present, sometimes *Halimeda* dominant	None
Animals in sediments	Probably present	None
Fringing reef	Around Ilot de Sable, Motu One, some bays of Nukuhiva, Hivaoa, Tahuata, with few coral species; coralline algae important	None
Rocky coast	Present	None
Beach	Present	None
Offshore environments	No data available	None

Conservation interest

Distinctive flora and fauna; vegetation heavily damaged in places by introduced animals.

Rare or endemic species

PLANTS

- There were 83 endemic species of plants in the Marquesas, of which 3 are now extinct and only 7 are not considered rare or endangered. The following are considered to be immediately endangered; many others are insufficiently known to determine their exact status:

Bidens jardinii (Compositae)	Nukuhiva
Carex feanii (Cyperaceae)	Hivaoa
Cyrtandra nukuhivensis (Gesneriaceae)	Nukuhiva
Cyrtandra ootensis (Gesneriaceae)	Fatuhiva, Hivaoa
Cyrtandra toviana (Gesneriaceae)	Probably extinct, Nukuhiva
Cyrtandroidea jonesii (Gesneriaceae)	Nukuhiva, Uahuka
Scaevola subcapitata (Goodeniaceae)	Hivaoa, Nukuhiva, Uahuka, Uapou
Astelia tovii (Liliaceae)	Nukuhiva
Streblus sp. nov. (Moraceae)	
Pelagodoxa henryana (Palmae)	Endangered (Red Data Book), Nukuhiva, 30 individuals remain on half hectare at Ta'ipiva'i Valley
Alphitonia marquesensis (Rhamnaceae)	Fatuhiva, Hivaoa, Nukuhiva
Ixora marquesensis (Rubiaceae)	Mohotani
Psychotria marchionica (Rubiaceae)	
Psychotria taupotinii (Rubiaceae)	Nukuhiva
Psychotria toviana (Rubiaceae)	Nukuhiva
Trimenia marquesensis	Hivaoa, Nukuhiva

- In addition, the endemic genus and species *Lebronnecia kokioides* (Malvaceae) is considered rare on Mohotani and Tahuata (Red Data Book), and *Gahnia marquisensis*, although not endemic, is now rare throughout its range,

BIRDS

- Twenty five (80 per cent) bird species and subspecies are endemic and 2 are already extinct. Some, such as the parrots, a swallow and cuckoo, are restricted to cloud forest.

Polynesian warbler, *Acrocephalus caffer*	All islands, different subspecies, threatened on Eiao, Hatutu.
Fatuhiva flycatcher, *Pomarea whitneyi*	Fatuhiva (subspecies possibly extinct).
Eiao flycatcher, *Pomarea iphis*	Threatened, Eiao (subspecies possibly extinct), Uahuka.
Nukuhiva flycatcher, *Pomarea mendozae* (various subspecies)	Threatened, Nukuhiva (subspecies possibly extinct), Mohotani, Hivaoa (rare), Uapou.
Marquesan pigeon, *Ducula galeata*	Threatened, Nukuhiva (estimates range from less than 100 to 400 individuals remaining) Hivaoa Oa, illegally hunted.
Fruit-dove, *Ptilinopus dupetithouarsi*	Several islands
Fruit-dove, *Ptilinopus mercierii*	Hivaoa, Nukuhiva?
Marquesan ground dove, *Gallicolumba rubescens*	Threatened, Fatuhuku. Hatutu (225 individuals in 1975).
Ultramarine lorikeet, *Vini ultramarina*	Threatened, Nukuhiva (70), Uapou (600), Uahuka (450 individuals in 1975).
Kingfisher, *Halcyon godeffroyi*	Threatened, Tahuata (800), Hivaoa, Fatuhiva?
Sooty rail, *Porzana tabuensis*	Nukuhiva, Uapou, perhaps others.

Conservation legislation

French Polynesia (see Society Islands)

Existing reserves

Mohotani (Motane, Mohotane)	1,554 ha, central dry forest *(Pisonia)*, grassland to south, undergrowth seriously overgrazed by feral sheep (created 1971)
Ilot de Sable (Motu One)	Sandbank, reportedly *Chelonia mydas* (green turtle) nesting area
Ei'ao	5,180 ha, formerly forest? , vegetation devastated by feral sheep, pigs (created 1971)
Hatutu (Hatutaa)	1,813 ha, seabirds and dwarf-shrub heath of great botanical interest (created 1971)

Proposed reserves (based on Salvat and Thibault reports)

Crêtes de To'ovi'i, Nukuhiva	Montane forest above 850 m with threatened birds
Hakanu, Ha'a'opu or Haka'o'a Valley, Terre Déserte, Nukuhiva	Requires elimination of feral animals and protection from hunting of *Ducula galeata*
Ta'ipiva'i Valley, Nukuhiva	Small (half ha) reserve for Marquesas palm *Pelagodoxa*
Fatuhuku	Islet of 2,000 ha with rare land birds and seabird rookeries
Motu Papa, Uahuka	Seabird rookery
Epeti islet, Uahuka	Seabird rookery
Cirque de Hohoi, Uapou, above 600 m from Kohepu cliff to the summit	Important land and seabird area
Motu Mokohe, Uapou	Two islets with seabird rookery
Motu Oa, Uapou	Seabird rookery
Central summit, Tahuata, above 700 m	Montane forest with many endemics and rare birds

Mt Feani (Temetiu), Hivaoa, including central ridge above 700 m	Distinctive montane and cloud forest flora
Fatuhiva	Forest area on summit.

Recommended reserve types

- Significant areas of cloud forest such as Taipivai or Nukuhiva should be protected as a matter of urgency.
- Examples of lowland rainforest, and other terrestrial biomes.
- Examples of marine biomes, including coral reef and rocky coast types.

References and sources

B. Salvat, 'Mesures en faveur de la protection de la nature aux Iles Marquises' (unpublished report, 1974).

D.T. Holyoak, personal communication.

IUCN Survival Service Commission, Threatened Plants Committee.

J.C. Thibault, 'Fragilité et protection de l'avifaune en Polynésie française' (unpublished ms.).

Douglas, 1969.

Chevalier, 1978.

Hallé, 1978.

Sachet, Schafer and Thibault, 1975.

XX. PITCAIRN - GAMBIER ISLANDS - RAPA

Government: French Polynesia (Gambier Islands and Rapa); United Kingdom (Pitcairn, Oeno, Henderson, Ducie)

Island types: High volcanic, elevated reefs and atolls. Subtropical climate

Biomes/habitats	Description	Conservation status
Lowland rain forest	Presumably present	None
Montane rain forest	Probable on Pitcairn	None
Cloud forest	Rapa (tree ferns and epiphytes)	None
Atoll/beach forest	Ducie, Oeno, Timoe	None
Scrub	Presumably present	None
Tree savanna	Probably present	None
Grassland	Rapa, Pitcairn, *Miscanthus* reed grassland on Mangareva	None
Rock desert	Marotiri (Bass Rocks)	None
Mountain stream	Pitcairn	None
Seabird rookery	Marotiri (Bass Rocks); Rapa, Oeno, Ducie	None
Algal bed	Present	None
Animals in sediments	Present	None
Windward atoll reef	Ducie, Oeno, Timoe	None
Leeward atoll reef	Ducie, Oeno, Timoe	None
Barrier reef	Mangareva (Gambier)	None
Fringing reef	Henderson	None
Lagoon reef	Ducie, Oeno, Timoe	None
Rocky coast	Rapa, Pitcairn	None
Beach	Present	None
Open lagoon	Ducie, Oeno, Timoe	None
Offshore environments	No data available.	None

Conservation interest

Atolls and reefs of interest because of extreme distance from centres of reef distribution; high terrestrial endemism on Henderson and Rapa. Many aspects not well studied. Introduced species and fires a problem on some islands; Gambier Islands 98 per cent devastated.

Rare or endemic species

PLANTS

- Ten endemic plants out of 55 on Henderson, 1 out of 15 on Oeno, a few on the Gambier Islands, many on Rapa (66 per cent of 66 ferns and 86 angiosperms).

Sandalwood, *Santalum hendersonense*	Endemic on Henderson, Oeno, exploited for carving
Bidens hendersonensis (Compositae)	Endemic on Henderson, Oeno, rare or possibly endangered (Red Data Book).
Pandanus feruliferus	Endemic on Oeno
Achyranthes mangarevica (Amaranthaceae)	Extinct or possible endangered (Red Data Book), known only from Mt Mokoto, Mangareva (Gambier Islands)
Gouania mangarevica (Rhamnaceae)	Extinct or possibly endangered, Mangareva.

BIRDS

- One species extinct on Mangareva.
- Four endemic land birds on Henderson.

Fruit-dove, *Ptilinopus huttoni*	Threatened, 200-300 individuals on Rapa with diminishing habitat.
Fregetta grallaria titan	Breeds on islets near Rapa and possibly Marotiri.
Puffinus assimilis myrtae	Breeds only on islets near Rapa and possibly Marotiri.

Conservation legislation

- French Polynesia (see Society Islands) for Gambier Islands and Rapa.
- Pitcairn: unknown.
- United Kingdom is a party on behalf of Pitcairn to Convention on International Trade in Endangered Species of Wild Fauna and Flora.

Existing reserves

None.

Proposed reserves

Ducie atoll	Proposed as island for science
Henderson Island	Proposed as island for science. Elevated reef and endemic species. Recommended as reserve by Threatened Plants Committee of IUCN.
Oeno atoll	Proposed as island for science.
Teiku and Manui islets, Gambier	For seabird rookeries.
Marotiri (Bass Rocks), near Rapa	For seabird rookeries.

Recommended reserve types

- Mts Mota and Poranu and other inaccessible peaks, Rapa Island.
- Precipitous southern slope of Mt Mokota, Mangareva Island (Gambier Islands).
- Islets near Rapa for rookeries of endemic seabirds.

References and sources

Douglas, 1969.

D.T. Holyoak, personal communication.

IUCN Survival Service Commission, Threatened Plants Committee.

Harold St John, 'Floristic needs in the Pacific basin: Polynesia' abstract of paper presented at 13th Pacific Science Congress, 1975.

J.C. Thibault,'Fragilité et protection de l'avifaune en Polynésie française' (unpublished ms.).

D. REGIONAL RESERVE NETWORK

In addition to the conservation requirements of each country or territory of the region, there are certain needs encompassing the whole Pacific region, and indeed the global ecological system or biosphere.

The Pacific is largely an oceanic area, and the marine ecosystems and organisms associated with them, including sea birds and sea turtles, extend beyond any one nation's jurisdiction. The conservation of such systems and species must therefore be planned on a regional basis. In particular, there needs to be coordinated development of a regional network of sea bird sanctuaries and of sea turtle breeding areas. Many appropriate sites for such a network have been identified in the geographical section of this report. Ideally, there should be appropriate reserves in each of the biogeographic provinces, with multiple reserves in areas of particular population concentrations.

Further consideration should be given to means of conserving ecosystems occuring wholly or partially in international waters. This may require the establishment of some new type of international reserve in areas of the open sea that are critical to the maintenance of particular species or ecosystems.

Since many of the areas proposed for conservation in the Pacific Islands are of world significance and their protection will ultimately be of world benefit (often to a greater degree than to the local population), it is appropriate to consider the establishment of an international park and reserve system in the Pacific region. Such a system could perhaps be organized on a regional basis and much of the necessary technical and financial support could be sought from the world community (international organizations, overseas aid agencies, and private groups). Reserves of outstanding conservation significance could be nominated by their governments for inclusion in this system, would be subject to certain standards of legislative protection, and would therefore receive management and enforcement assistance through the international reserve system.

At the world level, Unesco is developing a programme of Biosphere Reserves, areas designated by their governments for inclusion in a world network of base line areas, for monitoring the state of the biosphere. It is expected that governments will organize appropriate research programmes in these areas. There are a number of parks and reserves within the region with potential for biosphere reserves.

E. TYPES OF CONSERVATION APPROACHES

There are many ways of achieving the conservation of a particular ecosystem, habitat or species. In the past, areas of land have usually been set aside in National Parks or reserves of various types, but this approach is not always suitable in the Pacific Islands, where land is scarce and must often be used for multiple purposes. Some governments have developed other approaches to the conservation of ecosystems more suited to Pacific cultures and conditions. In many instances, the type of reserve or conservation control should be adapted to the type of ecosystem or habitat, and should allow for some flexibility. Island ecosystems are often dynamic, with populations invading, changing, or becoming extinct. It might be more useful to define the conservation of certain forest types, for instance, in terms of the percentage of a total area to be protected and the rate at which that protected area is allowed to shift within the region to permit forest reestablishment in abandoned areas. Intermittent forestry or agricultural activities could then be carried out in those parts of the area not required for the conservation cycle. Simply leaving small but frequent patches of biome type may permit its regeneration in a development area and thus effectively achieve the conservation of the biome.

F. NATIONAL CONSERVATION PLANS

It is hoped that this Regional Ecosystems Survey will help the governments and administrations of the Pacific Islands to develop their own more detailed national conservation plans. The ecosystem lists can help in an initial inventory of natural areas. Conservationists sometimes become so concerned with the rare and unusual that they forget the common or typical natural systems that are often more important for the quality of life of the people, but both are important in conservation planning.

Areas with the best combinations of biomes or species of conservation interest can then be identified for priority conservation action along with sites or species where urgent measures are required. Boundaries can be defined if a park or reserve is necessary, or management guidelines if some other approach is envisaged. An educational programme for the local population is generally an essential part of any conservation programme; enforcement itself may be best carried out by local leaders who understand the need for conservation action. This is especially true in the Pacific Islands, where governments cannot often afford to staff a scattered, isolated network of parks and reserves.

The national conservation plan should become an integral part of the development planning process. Conservation and development should move forward together. The plan can help to identify areas of conflicting priorities where choices will have to be made, and can help to direct development along those lines most in harmony with the environmental resources and natural heritage of the region. Conservation areas can then be progressively established without blocking the essential development of the country. Types of development can also be chosen that will be in harmony with environmental and conservation requirements.

The goal of conservation is the same as that of development: the highest possible standard of well being and quality of life for the peoples of the Pacific Islands (and indeed of the world), within the limits defined by the resources and natural systems of the planet.

G. ACKNOWLEDGEMENTS

This survey was only made possible by the considerable financial and technical assistance of the International Union for Conservation of Nature and Natural Resources (IUCN) under a project funded by the United Nations Environment Programme. Thanks are also due to the many who supplied unpublished information for this report; most are acknowledged in the geographic sections, but special mention should be made of the contributions of Jared Diamond, E.H. Bryan, Jr, M. Falanruw, D.T. Holyoak and R.F. Dasmann. The draft version of this report was reviewed by Graham Baines, Margie Falanruw and many participants in the Second Regional Symposium on Conservation of Nature (Apia, 1976) whose comments have been incorporated wherever possible.

LITERATURE CITED

Balazs, George H. (1975). Marine turtles in the Phoenix Islands. *Atoll Research Bulletin,* 184: 1-7.

Carlquist, Sherwin (1974). *Island biology.* New York: Columbia University Press.

Chapman, V.J. (1976). *Mangrove vegetation.* Monticello, New York: Lubrecht and Cramer.

Chave, K.E. and E. Alison Kay, eds. (1974). Fanning Island Expedition, July and August 1972. *Hawaii Institute of Geophysics report,* HIG-73-13.

Chevalier, J.P. (1978). Les coraux des Iles Marquises. *Cahiers du Pacifique,* 21: 243-283.

Corner, E.H.J., ed. (1969). A discussion on the results of the Royal Society Expedition to the British Solomon Islands Protectorate, 1965. *Philosophical Transactions of the Royal Society, London,* Series B, 255: 185-631.

Corner, E.H.J. and K.E. Lee, eds (1975). A discussion on the results of the 1971 Royal Society - Percy Sladen Expedition to the New Hebrides. *Philosophical Transactions of the Royal Society, London,* Series B, 272: 267-486.

Curry-Lindahl, Kai (1975). *Zoogeographic subregions of the Pacific Region as a background for ecological reserves in the Pacific.* Paper presented at 13th Pacific Science Congress, Vancouver, B.C., Canada, 22nd August 1975.

Dahl, Arthur L., Ian G. Macintyre and Arnfried Antonius (1974). A comparative survey of coral reef research sites. *Atoll Research Bulletin,* 172: 37-120.

Dasmann, R.F. (1973). A system for defining and classifying natural regions for purposes of conservation. *International Union for Conservation of Nature Occasional Paper,* 7.

Diamond, J.M. and A.G. Marshall (1976). Origin of the New Hebrides avifauna. *Emu,* 76: 187-200.

Douglas, G. (1969). Draft check list of Pacific 'oceanic' islands. *Micronesica,* 5 (2): 327-463.

Elliot, Sir Hugh (1973). 'Pacific oceanic islands recommended for designation as islands for science'. In *South Pacific Commission Regional Symposium on conservation of nature - reefs and lagoons, 1971, part II: working papers.* Noumea: the Commission, p. 287-305.

Fosberg, F.R. (1972). Morotiri (Bass Rocks) Austral Islands. *Atoll Research Bulletin,* 162: 9-10.

Fosberg, F.R. (1975). *Biogeoclimatic patterns in Micronesia.* Paper presented at 13th Pacific Science Congress, Vancouver, B.C. Canada. August 1975.

Frodin, D.G. (1977). Vegetation and general features of the northern Ok Tedi region, Star Mountains. *Science in New Guinea,* 5 (2): 102-106.

Gorio, Sylvanus (1978). Papua New Guinea involves its people in National Park development. *Parks,* 3 (2): 12-14.

Gorman, Martyn L. and Suliana Siwatibau (1975). The status of *Neoveitchia storckii* (Wendt), a species of palm tree endemic to the Fijian island of Viti Levu. *Biological Conservation,* 8: 73-76.

Haantjens, H.A. (1975). *Papua New Guinea: list of areas of conservation interest.* Paper presented at 9th Waigani Seminar, Port Moresby, 1975.

Hallé, Francis (1978). Arbres et forêts des Iles Marquises. *Cahiers du Pacifique,* 21: 315-357.

Hartog, C. den. (1970). *The sea-grasses of the world.* Amsterdam: North Holland.

Hoyle, M.A. (1977). Forestry and conservation in Papua New Guinea. *Tigerpaper* 4 (4): 10-12.

IUCN (1973). A working system for classification of world vegetation. *International Union for Conservation of Nature Occasional Paper,* 5.

IUCN (1974). Biotic provinces of the world: further development of a system for defining and classifying natural regions for purposes of conservation. *International Union for Conservation of Nature Occasional Paper,* 9.

Kores, Paul (1977). Papua New Guinea's orchids: an exploited resource. *Science in New Guinea,* 5 (2): 51-66.

Liem, D. (1976). Report on the habitat survey and habitat assessment of Garu Wildlife Management Area, West New Britain. *Wildlife in Papua New Guinea, Wildlife Publication,* 46/6: Research Series No.1.

Manser, W. ed. (1973). New Guinea barrier reefs: preliminary results of the 1969 coral reef expedition to the Trobriand Islands and Louisiade Archipelago, Papua New Guinea. *University of Papua New Guinea, Geology Department, Occasional Paper,* 1.

Mayr, Ernst (1945) *Birds of the Southwest Pacific.* New York: Macmillan. Reprinted Monticello, New York: Lubrecht and Cramer, 1968.

Mueller-Dombois, Dieter (1973). Natural area system development for the Pacific region, a concept and symposium. *United States International Biological Programme Technical Report,* 26.

Mueller-Dombois, Dieter (1975). 'Some aspects of island ecosystems analysis'. *In* F.B. Golley and E. Medina, eds. *Tropical ecological systems: trends in terrestrial and aquatic research.* (Ecological Studies v. 11). New York: Springer Verlag. p. 353-366.

National Parks Authority (N.Z.) (1975). *Proceedings of the South Pacific Conference on National Parks and Reserves, Wellington, New Zealand, 24-27 February 1975.* Wellington, Department of Lands and Survey.

Nicholson, E.M. and G.L. Douglas (1970). Conservation of oceanic islands. International Union for Conservation of Nature Eleventh Technical Meeting 1: 200-211. *International Union for Conservation of Nature Publication, new series,* 17.

Parham, J.W. (1964). *Plants of the Fiji Islands.* Fiji: Government Press.

Percival, Margaret and John S. Womersley (1975). Floristics and ecology of the mangrove vegetation of Papua New Guinea. *Papua New Guinea National Herbarium, Department of Forests, Lae, Botany Bulletin,* 8.

Pernetta, John, C. and Dick Watling (1978). The introduced and native terrestrial vertebrates of Fiji. *Pacific Science,* 32 (3): 223-244.

Ray, G. Carleton (1975). A preliminary classification of coastal and marine environments. *International Union for Conservation of Nature Occasional Paper,* 14.

Recher, H.F. and S.S. Clark (1974). A biological survey of Lord Howe Island with recommendations for the conservation of the Island's wildlife. *Biological Conservation,* 6 (4): 263-273.

Sachet, M.H., P.A. Schafer and J.C. Thibault (1975). Mohotani: une ile protégée aux Marquises. *Bulletin de la Société des Etudes Océaniennes,* 16(6): 557-568.

Sarlin, P. (1954). Bois et forêts de la Nouvelle-Calédonie. *Centre Technique Forestier Tropical Publication,* 6.

Schmid, M. (1978). The Melanesian forest ecosystems:New Caledonia, New Hebrides, Fiji Islands and Solomon Islands. *Unesco/UNEP/FAO Tropical Ecosystems Natural Resources Research,* XIV: 654-683.

Sekiguchi, Tekeshi (1952). The rainfall distribution in the Pacific region. *Proceedings of the Seventh Pacific Science Congress,* 3: 101-102.

Skottsberg, C. (1940). Report of the Standing Committee for the Protection of Nature in and around the Pacific for the years, 1933-1938, part I. *Proceedings of the Sixth Pacific Science Congress,* 4: 499-539, and addition by Thor Heyerdahl, p. 543-546.

South Pacific Commission (1973). *Regional Symposium on conservation of nature - reefs and lagoons, Noumea, 5-14 August 1971, part I: proceedings; part II: working papers.* Noumea: the Commission.

Specht, R.L., E.M. Roe, and V.H. Boughton (1974). Conservation of major plant communities in Australia and Papua New Guinea. *Australian Journal of Botany, Supplement,* Series 7.

Stoddart, D.R. (1972). Reef islands of Rarotonga. *Atoll Research Bulletin,* 160: 1-7.

Stoddart, D.R. and R.P.D. Walsh (1975). *Environmental variability and environmental extremes as factors in the island ecosystems.* Paper presented at 13th Pacific Science Congress, Vancouver, B.C., Canada, August, 1975.

Stokes, T. (1979). On the possible existence of the New Caledonian wood rail, *Tricholimnas lafresnayanus. Bulletin of the British Ornithological Club,* 99 (2): 47-54.

Thomas, William L., Jnr. (1963). 'The variety of physical environments among Pacific Islands'. In F.R. Fosberg, ed. *Man's place in the island ecosystem.* Honolulu: Bishop Museum Press, p. 7-37.

Tsuda, R., R. Fosberg and M.H. Sachet (1977). Distribution of seagrasses in Micronesia. *Micronesica* 13 (2): 191-198.

Udvardy, M.D.F. (1975). A classification of the biogeographical provinces of the world. *International Union for Conservation of Nature Occasional Paper,* 18.

Virot, R. (1956). La végétation canaque. *Mémoires du Muséum National d'Histoire Naturelle, nouvelle série, série B, Botanique,* 7: 1-398.

Whistler, W. Arthur (1978). Vegetation of the montane region of Savai'i, Western Samoa. *Pacific Science,* 32: 79-94.

Whitmore, T.C. (1969). 'The vegetation'. In Corner, E.H.J. ed. A discussion on the results of the Royal Society expedition to the British Solomon Islands Protectorate, 1965. *Philosophical Transactions of the Royal Society, London, Series B,* 255: 185-631.

Whitmore, T.C. (1974). Change with time and the role of cyclones in tropical rain forest on Kolombangara, Solomon Islands. *Commonwealth Forestry Institute Paper,* 46.