

**REPORT OF THE NORTHERN MARSHALL ISLANDS
NATURAL DIVERSITY AND PROTECTED AREAS SURVEY**

7-24 SEPTEMBER 1988

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EXECUTIVE SUMMARY

This report has been prepared as a joint project of the South Pacific Regional Environment Programme (SPREP) the East-West Center (EWC) and the government of the Republic of the Marshall Islands (RMI) at the request of the latter. Substantial financial support for the project came from a grant to the East West Center from the John D. and Catherine T. Mac Arthur Foundation. The project is also part of and contributes to the Republic of the Marshall Islands Coastal Resource Inventory and Atlas programme funded by the United States government. The report is based on a field survey of the biological diversity and ecosystems of six atolls and one island in the northern Marshall Islands which was carried out by a multidisciplinary team of scientists and planners, 7-23 September 1988. The atolls and island surveyed were Taongi, (Bok-ak) Bikar, (Pikaar) Taka (Toka), Jemo (island) and Erikub (Adkup) in the Radak (eastern) chain and Rongerik (Rondik) and Wotho (Wotto) in the Ralik (western) chain.

The primary objective of the project was the assessment of the ecological condition of the atolls and island with a view determining their suitability as candidates for a system of protected areas in the Marshall Islands. The goal of the protected area system is the protection of representative examples of important natural ecosystems and their biological diversity. The long term protection of these ecosystems and the conservation of their living resources is considered by the survey team to be essential at this stage of the development of the Marshall Islands, if the natural features which play such an important role in Marshallese lifestyle and culture are to be retained for present and future generations.

In the long term, the successful conservation of the natural and cultural resources of the Marshall Islands depends on the level of environmental consciousness and public support for conservation initiatives such as those recommended in this report. For this reason the important support role local communities and traditional landowners have to play in the successful establishment of protected areas is emphasised throughout the report, as are the benefits such areas have to offer in terms of the development of new opportunities for recreation, tourism, educational and scientific research.

Other objectives of the project are the development of appropriate legislation and a management structure for nature conservation and the protected area programme; the provision of opportunities for local people and traditional leaders to be involved in ecological field assessment and protected area planning and the stimulation of public awareness of the need for nature conservation.

The report consists of three parts:

- Part I Survey Results and Protected Area Recommendations; records and analyses of the results of the field survey for each atoll or island and the team's recommendations for protected areas and species conservation.

- Part II Endangered and Threatened Species Conservation; consists of an inventory of endangered and threatened species in part of the Marshall Islands and recommendations for their conservation.

Part III Institutional Arrangements for Protected Area Management and Nature Conservation; advances proposals for protected area and nature conservation legislation together with organisational changes for the administration of the legislation.

Under Part I Survey Results and Protected Area Recommendations, background information on the natural history of the Marshall Islands is provided and followed by atoll specific accounts of the results of the field survey. These are summarised below:

TAONGI ATOLL (Bok-ak)

Without doubt Taongi atoll has the most outstanding ecological values of the atolls (and island) visited. Although its natural diversity is relatively low it has unique and important natural features which justify its full protection. Foremost of these is Taongi's virtually undisturbed and pristine, natural state. Uninhabited and geographically isolated, it is a rare and possibly the only example of a completely natural, unaltered, semi-arid atoll ecosystem remaining in the world today.

In terms of its natural diversity, the most outstanding feature of the atoll is its birdlife. Its islets comprise a vast rookery for at least twenty species of sea and migratory shore birds. Many of the seabirds breed in great numbers making the atoll a rookery of national, regional and international importance. Other important natural features include its vegetation, unique closed reef formations and the abundance and size of the reef fish populations, smaller giant clams and coral communities.

The greatest threats to the outstanding conservation values of Taongi are the accidental introduction of rats or other alien animals or plants and human 'development' activities. During the survey the study team was most concerned to learn of a waste landfill proposed for the atoll. Subsequent dialogue with the Irooj laplap of the Radak chain, Mr. Meijel Hermeos and his representatives have reassured the team that this proposal is unlikely to proceed and the Irooj laplap's expression of support for the idea of protecting Taongi's unique natural values was most encouraging. Any development proposals for Taongi, particularly those involving reef blasting which would seriously alter the hydrological regime and significantly damage its reef and coral composition, should be prohibited. Such activities (e.g. for a boat harbour) would expose the atoll to human disturbance and exploitation of its marine resources and birdlife. More serious is the potential for accidental rat liberations from support boats, or visiting yachts and fishing craft which could devastate the bird population in a relatively short time.

Any development activities would conflict with the survey team's principal recommendation for Taongi, that it and its surrounding waters be protected in perpetuity as a National Preservation Area with all but officially sanctioned visitation being prohibited. Other key recommendations are aimed at:

- reducing the risk of accidental introductions of rats and alien plants through the control of human access and exclusion of unauthorised vessels from the preserve and

- discouraging proposals for the utilisation or development of the atoll, particularly for waste disposal or projects involving dredging, channel enlargement and reef blasting.

Finally, should Taongi be declared a National Preservation Area, it is recommended consideration be given to its nomination as a World Heritage Site.

BIKAR ATOLL (Pikaar)

Although having similar natural characteristics to Taongi in that it is virtually undisturbed and in pristine natural condition, Bikar's outstanding conservation feature is its importance as a marine turtle nesting site. The quality of the turtle nesting habitat on Bikar coupled with its isolation and the absence of human disturbance combine to make this an outstanding turtle nesting area of national importance. In fact, the survey revealed that turtle breeding activity on Bikar was much greater than on any of the other atolls visited. Bikar has other important natural features e.g. its extensive seabird colonies, unusual reefs, abundant coral communities, and its diversity of fish species, all of which are of outstanding quality. However its importance as a turtle nesting site alone justifies the survey team's principal recommendation, that the atoll and its surrounding waters be declared a National Preservation Area and that access be strictly controlled. As with Taongi, other related recommendations aim to reduce the threat of introduced plants and animals (especially rats), prohibit dredging or blasting activities on the reef, protect and monitor the breeding activity of green turtles, monitor the recovery of *Pisonia grandis* forest and finally, investigate the nomination of Bikar together with Taongi as a World Heritage Site

TAKA ATOLL (Tōkā)

Taka atoll was perhaps the most scenically attractive of the atolls surveyed and is more typical of other atolls of the Marshall Islands having an extensive open reef system, wide passes and safe anchorages. Taka has been inhabited from time to time and is regularly visited by people from nearby Utirik atoll who have traditionally regarded it as a 'pantry' for food resources.

Increased human activity is reflected in the more disturbed condition of the atoll vegetation and in evidence of harvesting pressure on some food resources (giant clams, turtles, fish and birds). The future value of Taka as a 'pantry' will depend on effective sustained yield management of the most preferred food resource species. The need for the conservation and controlled management of these resources, together with the desirability of protecting the natural diversity and character of this atoll, led the survey team to its principal recommendation that Taka atoll be declared a National Park. Under National Park status provision could be made for appropriate habitat and species protection while allowing controlled resource harvesting under a management plan based on a scientific assessment of sustainable exploitation levels.

The diversity of Taka's natural resources and the overall high quality of its environment, together with the presence of an airstrip on nearby Utirik Atoll, also offered considerable potential for national environmental education activities and small scale tourism within the proposed park. Thus it is also recommended that these activities be developed in a manner compatible with the overall conservation objectives of the Park and its management plan. Other recommendations include the establishment of a Taka Atoll Conservation Committee to guide the management of the park, the protection of archaeological sites until they have been investigated and special protection for Eluk and Lojong islets, the most important bird nesting sites, as Wildlife Sanctuaries. The protection of green turtles and the large rare species of giant clams is also recommended.

JEMO ISLAND

The two most significant conservation features of Jemo Island are its importance as a turtle nesting site and the existence of previously unknown cultural/archaeological resources. Turtle nesting evidence suggested that the island is an important nesting site for green turtles migrating through the waters of the central Radak chain and that it should be declared a Wildlife Reserve to provide for their supervised protection.

The archaeological remains of a transient or semi-permanent fishing camp of a type not previously known in the Marshall Island were also discovered. These could, with further investigation, add considerably to our understanding of pre-history Marshallese culture.

The survey team's principal recommendation with respect to Jemo Island is that it be declared a Wildlife Sanctuary for the protection of marine turtles and their nesting habitat. Other recommendations call for research into green turtle nesting activity on the island as part of a broader marine turtle research and conservation programme for the Marshall Islands and for the systematic investigation of the archaeological and cultural sites on the island.

WOTHO ATOLL (Wōtto)

Wotho atoll was the only inhabited atoll visited by the team. Although inhabited, it exhibited a range of largely intact relatively undisturbed, natural habitats representative of many of the central atolls of the Marshall Islands. Natural diversity is relatively high compared to the dryer northern atolls. The beautiful reefs are easily accessible. They contain rich and diverse coral communities and are habitat for a wide variety of reef fish and the rare species of giant clams. Islets with white sand beaches and lush green vegetation contrast with the changing colours of the clear lagoon waters making Wotho a place of great scenic beauty. Added to this is the attraction of a cultural landscape formed around an immaculately tidy traditional village. Also, the village leadership has requested support from the RMI government to assist in small-scale tourist development.

The atoll was ranked highest of those visited for historic preservation. Extensive pre-modern and probably prehistoric cultural remains were discovered which are considered to be of very high archaeological potential and interpretive interest.

These factors, together with the interest of the Wotho people in the development of small scale, nature based tourism, led the study team to formulate its principal recommendation that, with the exception of Wotho islet, Wotho Atoll be declared a National Park. As with Taka, the conservation and sustainable harvesting of important food resources together with the planned management of the proposed park for tourism, recreation and educational purposes could all be accomplished within the framework of a management plan. This would be prepared largely by the community itself in consultation with the appropriate government agencies. Other key recommendations relate to the conservation and investigation of the cultural and archaeological resources of the atoll, special protection for key bird breeding islets (Eirek, Ombelin and Bejin), and research to be undertaken into the status and dynamics of green turtle and coconut crab populations.

RONGERIK ATOLL (Rondik)

This atoll has been uninhabited except when Rongerik was the site of relocation for the displaced Bikini Islanders in 1946-48 and appears to have now recovered from any past disturbances associated with their brief period of habitation. The atoll has impressive natural features and some interesting cultural and archaeological sites, especially those associated with the ordeal of the Bikinians. Species diversity in the marine habitats was considered high, although the giant clam population had been subject to heavy exploitation. The diversity and abundance of avifauna was sufficient to rank this island third in importance of the atolls visited. Judging from the number of species now breeding on the atoll, it is slowly becoming an important bird breeding location in the northern Ralik chain, probably because of the lack of human habitation and limited visitation.

Two islets in particular had outstanding natural values, Enewetak (for the quality of its vegetation associations and turtle nesting habitat) and Biggonattum (bird nesting). The survey team's principal recommendation was for their protection as Nature Reserves. Other key recommendations are for urgent archaeological investigations of the eroding shoreline cultural sites on Enewetak islet; the survey of other sites on Rongerik islet; the erection of a memorial to commemorate the temporary settlement of Bikini Islanders on the site at their old village, and the protection of the remaining giant clam population.

Finally, having been led to understand there was a possibility that Rongerik Atoll may be considered for resettlement or tourism, the survey team has recommended that any such proposal be confined to Rongerik islet and be subject to an evaluation of its environmental impact and human safety requirements, including the possibility of radioactive contamination of food (coconuts, coconut crabs) and other sources.

ERIKUB ATOLL (Ādkup)

Although there was clear evidence of human disturbance and exploitation of the food resources of this atoll, it has specific natural and cultural features which should be protected if its present natural character is to be preserved. These include the possibly unique vegetation associations on Bogengoa islet and the five small islets to the south west of the atoll. These islets also provide good habitat for sea and shorebirds. The atoll was ranked second in its importance for historic preservation due mainly to the discovery of a major pre-modern village site on Erikub islet. It is also thought likely that significant prehistoric sites exist on several of the other islets.

The survey team's principal recommendation for this atoll was for the establishment of a Nature Reserve embracing the islets of Guro, Jeldoni, Bogweido, Bogwella, Jogon and Bogengoa and their surrounding reefs and waters. Other key recommendations were for the designation of Enego islet as a Wildlife Reserve; the systematic archaeological investigation of Erikub, Loj and Aneko islets and the monitoring of turtle, giant and small clams, reef fish and coconut crab populations together with the development and implementation of a plan for the sustained yield harvesting of these resources.

In preparing the above recommendations for each atoll and Jemo island, the survey team was principally concerned with the protection of the natural and cultural values identified during the survey. However, the team also recognised that the adoption of its recommendations may impact on the traditional rights of atoll landowners and other resource users and has therefore emphasised throughout the report that the involvement and concurrence of these groups is essential if the recommendations are to be successfully implemented. Concurrently a regional approach to turtle conservation, involving other nations, must be initiated and this issue is currently being addressed by SPREP.

Under Part II of the report a preliminary list of endangered or threatened species for the Marshall Islands is developed by the survey team. Those which are officially so listed by the U.S. Fish and Wildlife Service or the IUCN Red Data Books are designated by an asterisk in the following list. Official "candidate" species, i.e. species which are to be endangered or threatened by the IUCN but for which more information is required or are awaiting official designation as such by the USFWS are marked with a double asterisk.

Endangered Species

Hawksbill turtle *
Green turtle *
Largest species of giant clam **
Radak Micronesian pigeon **

Threatened Species

Coconut crab
Black-lipped pearl oyster

The inventory is incomplete, particularly with regard to the status of marine mammals, shellfish and precious corals. Where appropriate, recommendations have been made for future conservation action, particularly in respect of the marine turtles for which the development of a comprehensive research and management strategy for the Marshall Islands is recommended. Concurrently a regional approach to turtle conservation, involving other nations, must be initiated and this issue is currently being addressed by SPREP.

Part III of the report deals with the development of policy, legislation and an administrative structure for protected areas management and nature conservation. It proposes that nature conservation and protected areas should be elements of an overall National Conservation Policy to be developed to guide future natural resource conservation and development in the Marshall Islands along sustainable paths. Such a policy would serve as a formal expression of the nation's commitment to the sustainable development of its resources and would provide the government with a mandate and priority for national conservation action. The development of a National Conservation Strategy is also proposed as a way of assessing the nation's conservation goals and objectives and defining a strategy for their achievement.

In the absence of a legal framework for the development of a protected area system and species conservation action, proposals are advanced for comprehensive legislation to enable these programmes to be carried out. The proposed legislation provides for:

- the establishment of an organisational structure for the effective implementation of the proposed legislation.
- the identification and legal establishment of several categories of protected areas which will form the basis of the protected area system in the Marshall Islands.
- management planning for protected areas and public participation in the planning and policy formulation process.
- the conservation of flora and fauna, both terrestrial and marine.
- recognition of the relevance of international conservation treaties and conventions to the conservation programme in the Marshall Islands.
- enforcement and regulatory powers.

Related proposals are advanced for organisational changes to provide for the effective administration of the proposed legislation. These recognise the desirability of adopting the existing administrative structure where appropriate and developing institutional mechanisms which ensure close landowner and community involvement in all aspects of the protected area and species conservation programme. They include:

- the establishment of an ad hoc National Conservation Authority to guide the Minister responsible for the Act, developing and reviewing the protected area and species conservation programme and ensuring co-ordination and consultation between government agencies, the public and landowners on conservation issues.
- the establishment of Atoll Conservation Committees to act as a mechanism for encouraging local commitment and involvement in the conservation of living resources and establishment and management of protected areas.

- the establishment of a Conservation Service, located within the Ministry of Resources and Development, or the Environmental Protection Authority to provide technical and administrative support to the proposed National Conservation Authority and provide for the de-centralised (regional/local) implementation and field management of the protected areas and species conservation programme.

Finally, under Part III comment is made on the need for protected area and species conservation training for staff of the proposed Conservation Service, the role of education in achieving conservation goals, the need for a co-ordinated research policy and on the resources needed to establish the proposed new conservation structure.

**REPORT OF THE NORTHERN MARSHALL ISLANDS
NATURAL DIVERSITY AND PROTECTED AREAS SURVEY**

7 - 24 September 1988

INTRODUCTION

In 1988, following a request for assistance from the government of the Republic of the Marshall Islands (RMI), the East West Center (EWC), and the South Pacific Regional Environment Programme (SPREP) developed a joint project for the initial establishment of a protected area system in the Marshall Islands. The request for assistance was prompted by the government's concern over increasing rates of resource exploitation and the loss of habitat and species resulting from development and other forms of human interference with natural environment.

The natural environment, with its diversity of habitats and species, has always had a profound influence on the Marshallese people and their culture. Until the comparatively recent advent of the cash economy, the Marshallese people relied entirely on the environment and its living resources for their sustenance. Even today, on many of the country's thirty-four atolls and islands largely subsistence lifestyles still predominate. Protection of the environment and control of over-exploitation of key food and cultural resources was therefore vital and was achieved through a system of traditional customary rules and laws and by the physical and practical limitations imposed by traditional technology.

However, contact with Asians and Europeans over the past hundred and fifty years has led to environmental and cultural changes which have sharply increased in the years since World War II. The availability of modern transport and technologically superior equipment, coupled with the exploitation of living and physical resources to meet the demands of a cash economy have placed great pressure on the natural environment. Today, previously undisturbed islands and atolls, once very difficult to access, are within comparatively easy reach of international and local entrepreneurs who possess the ability to rapidly harvest valuable food resources and severely disrupt key populations and habitats.

In the face of these pressures, traditional community controls over environmental disturbance and resource exploitation have become less and less effective and it is now important that the government takes firm and positive action to establish and implement effective policies for environmental protection. This need has been recognised by the RMI government which is concerned to ensure that the natural diversity of the environment and its resources are maintained and protected for the benefit of both present and future generations of Marshallese.

One of the most successful ways that conservation objectives can be achieved is through the establishment and effective management of protected areas. Throughout the world systems of protected areas have been established to meet the multiple objectives of:

- maintaining essential ecological processes and human life support systems;
- preserving natural biological and physical diversity in the human environment;
- ensuring the sustainable utilisation of natural ecosystems and their resources;
- promoting environment stability;
- providing opportunities for scientific research and conservation education;
- providing opportunities for recreation and tourism.

Protected areas range from those maintained as strict reserves in their natural state, to cultural landscapes, national parks and areas where forests, fish and wildlife are harvested on a sustainable basis. The term "protected area" often conjures up images of resources "locked" away but this is not the case. Although the term, by definition, secures resources from un-restricted use it does not exclude their planned and managed use on a sustainable basis. Different categories of protected areas allow for different management options to be exercised and flexibility in the application of these categories within a system of protected areas will allow for a balance to be struck between resource use and protection.

It is therefore important to choose the right categories according to objectives of management. The appropriate categories of protected areas depend largely on the following considerations:

Those features which the area is designed to protect based on an evaluation of its bio-diversity and other features:

The degree of management needed for compatibility with the protection objectives;

The degree of ecological tolerance/fragility of the ecosystem of species concerned;

The degree to which different types of utilization of the area are compatible with established objectives;

The level of demand for different types of utilization and management practicability of accommodating these (MacKinnon et. al., 1986).

This project and the survey on which this report and its recommendations are based, represents an initial step in the development of a protected area system for the conservation of the natural diversity of the Marshall Islands. The survey focused on five uninhabited and one inhabited atoll and one island in the northern Marshall Islands identified by the Republic of the Marshall Islands (RMI) Government as priority sites for protected area consideration. The survey objective was the assessment of remaining natural diversity of the atolls and identification of significant cultural features. The data collected has been used to formulate recommendations for the beginning of a system of protected areas which when established, will conserve unique, important and representative examples of the atoll ecosystems including important habitat for threatened and endangered species. The survey also aimed to identify species which can be considered to be endangered or threatened as a first step towards the development of an inventory of the endangered or threatened species of the Marshall Islands.

Also investigated, for the first time, were the archaeological and cultural resources of those atolls. A number of sites were identified which have the potential to add significantly the growing understanding of prehistoric Marshallese culture if they are protected and further investigated.

The survey was also the start of the second phase of the RMI Coastal Resource Inventory and Atlas Program (OEA, 1989). The first phase to be completed in 1989 covers the urban centres of the RMI and was jointly sponsored by the US Army Corps of Engineers and the University of Hawaii Sea Grant Program of the National Oceanic and Atmospheric Administration. The second phase, if funded beyond 1989, will cover most of the northern atolls of the RMI surveyed during the 1988 expedition. Hence the 1988 expedition provided a "head start" on the second phase of the coastal program. Additional US and RMI funding support would accommodate production of coastal resource atlases and follow-up studies and reports of the northern Marshall atolls, and would involve continued co-operation among the EWC, SPREP, the RMI and several US agencies (OEA, 1989).

In the long term, the successful conservation of natural and cultural resources in the Marshall Islands depends on the level of environmental consciousness within the community and public support for conservation initiatives. With this in mind and in response to the brief from the Marshallese government, emphasis is given throughout the report to the role of protected areas in fostering community conservation awareness and supporting environmental education activities, particularly amongst the school age population.

Similarly, the role of protected areas in assisting with the development of low impact, small scale tourism and recreational activities through the protection and maintenance of environmental quality is recognised. Finally, to assist the Marshall Islands government with the implementation of the report and its recommendations, the matter of an appropriate legislative and institutional framework is addressed.

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PART I SURVEY RESULTS AND PROTECTED AREA RECOMMENDATIONS

1. SURVEY OBJECTIVES, PERSONNEL AND METHODOLOGY

The broad purpose of the field survey was to gather the data and carry out the necessary field investigations to meet the following project objectives:

1. To assess the ecological conditions on several uninhabited atolls nominated by the Republic of the Marshall Islands as candidates for a system of protected areas which:
 - a) will lead to the conservation and protection of representative examples of important terrestrial and marine ecosystems including rare and endangered plant and wildlife habitat;
 - b) will identify and lead to the protection of sites of particular value for cultural, recreation, education and scientific purposes.
2. To recommend appropriate legislation and a system for the management of the protected areas identified in 1. above.
3. To gather data on endangered terrestrial and marine plants and animals as a preliminary step towards the preparation of an inventory of endangered species for the Marshall Islands.
4. To provide opportunities for local counterparts to become involved in ecological field assessment and protected area planning.
5. To work with and involve local government agencies and communities in the development of a protected area system plan and appropriate legislation and policy.
6. To increase public awareness of the need for nature conservation in the Marshall Islands through the activities of the survey team.

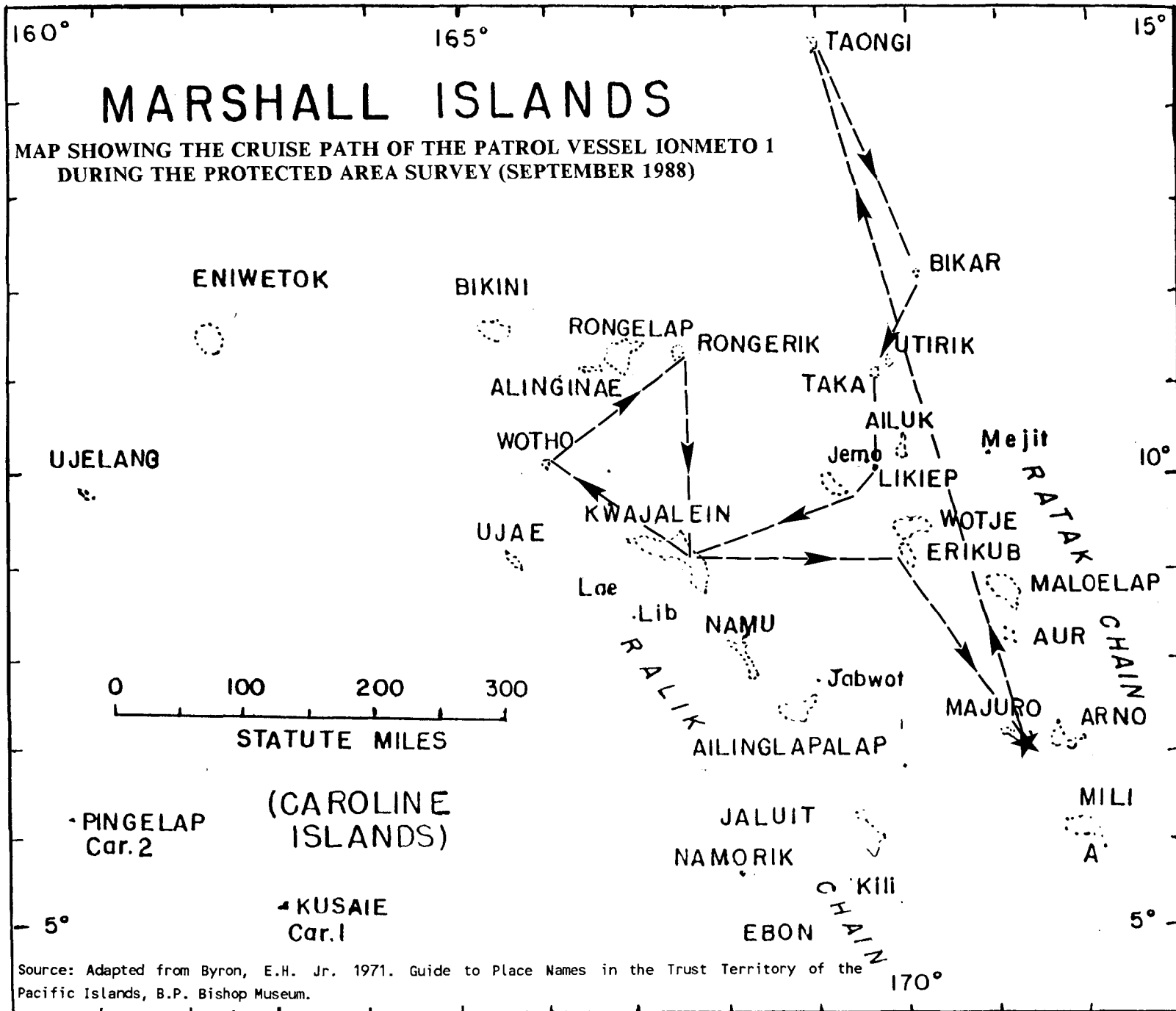
In recognition of the diversity of information to be collected a multi-disciplinary team was assembled. This comprised a biogeographer, protected area management specialist, botanist, fishery biologist, archaeologist, coral reef ecologist together with fishery biologists of the Marshall Islands Marine Resources Authority (MIMRA), cultural resource specialists from the Alele Museum and staff from the Marshall Islands Environmental Protection Authority .

The survey was undertaken on the MIMRA fisheries surveillance vessel *Ionmeto I* which proved excellent for the purpose. Six atolls for which landowner visitation approval had been obtained, and one island were visited over the 18 day period of the survey (7-23 September). These were Taongi, Bikar, Taka, Jemo (Island) and Erikub in the Radak (eastern) chain of the Marshall Islands archipelago and Rongerik and Wotho atolls in the Ralik (western) chain (See Map 1). With the exception of Wotho, all were uninhabited. The atolls visited were chosen in consultation with the Marshall Islands government and represented those on which the ecosystems were likely to be least disturbed due to the absence of humans and which offered the easiest opportunities for establishing protected areas.

The survey team visited a total of 42 islands and surveyed 96 underwater stations during the seventeen days of the survey. Travel between atolls was usually undertaken during the night so the maximum daylight time available was spent on the atolls. Two outboard powered skiffs were utilised for lagoon transport - one for the terrestrial survey team and the other for the marine team (See Appendix 1). Activities of the terrestrial team were co-ordinated so the maximum number of islands, islets and sand cays were visited. The usual survey procedure for the terrestrial team was to walk the perimeter of the islands making several forays into the interior of the larger islands, taking field notes on the fauna, vegetation, soils, geomorphology and cultural sites encountered. Comparisons were made with previous vegetation and avifauna records of the atolls and islands visited where information was available and significant changes noted. Principal references used for this purpose were those of Fosberg (1988) and Amerson (1969).

An excellent checklist of fishes of the Marshall Islands has recently been compiled by Randall and Randall (1987). The authors recorded a total of 817 species in 338 genera and 92 families, including all reef, shore and epipelagic fishes known from the Marshall Islands. With such a large number of species it was impossible to develop complete species lists for each atoll visited during our brief survey. Instead information was recorded on relative abundance of dominant species (particularly in those genera which include important resource species for Marshallese fishermen) found in the major biotypes for each atoll.

The marine team selected survey stations both within the lagoon and on the ocean-side reef. These were chosen to cover as wide a diversity of habitat and reef formations as possible. Field notes on corals, reef characteristics, marine mammals and reptiles, fish, molluscs and other invertebrates were taken at each site by snorkelling and free diving. Where possible sandy beach and shoreline areas were traversed to record sea turtle tracks and nesting pits.



Source: Adapted from Byron, E.H. Jr. 1971. Guide to Place Names in the Trust Territory of the Pacific Islands, B.P. Bishop Museum.

MAP 1

7

2. THE PHYSICAL GEOGRAPHY AND NATURAL HISTORY OF THE MARSHALL ISLANDS

The following information provides a general description of the Marshall Islands and the northern atolls in particular. We are indebted to Dr. F.R. Fosberg for much of the data, made available through his briefing report to the survey team based on unpublished field notes from visits to the atolls in the 1950's and 1960's.

2.1. Geography

The newly founded Republic of the Marshall Islands consists of 29 atolls and 5 small islands or "table reefs," lying in the center of the north-west Pacific Ocean, north of the Equator and west of the 180° meridian (MAP 1). South-west this stretches the Caroline archipelago, and to the south-east the Gilbert Islands (Kiribati).

The Marshall Archipelago is about 800 miles (1,300 km) E-W, 700 miles (1,100 km) N-S, scattered irregularly in two vaguely defined chains, the Ralik, or western, and Radak (Ratak), or eastern, trending somewhat north-west to south-east. The atolls and islands of the two chains are listed in Table 1. Exact areas for some of the atolls and islands are not readily available. The total land area in the Republic is approximately 70 square miles (181 km²), while the total area including lagoon is about 4,507 square miles (11,664 km²).

The atolls are usually characterized by an irregularly ring-shaped reef with one to many "islets," with land areas above high tide level, lying on it. This reef-ring encloses a "lagoon," connected, in most cases, with the sea by one or more deep channels or "passes" and/or by small shallow channels. Water also exchanges between the ocean and the lagoon over the perimeter reefs (with no islands) during high tidal phases.

All the islets are low and made up, geologically speaking, entirely of calcium carbonate in the form of coral sand and gravel, cobbles and boulders, and consolidated limestone - slightly elevated reef in growth position, consolidated limestone debris and beach-rock. The shoreline is formed by coral-sand, gravel, and boulder, beach-rock, and "erosion ramps" - sloping zones of eroded platform rock, often corrugated perpendicular to the edge of the sea. Shorelines of some islets exhibit undercut intertidal cliffs, either in unconsolidated sediment or in platform rock.

Extending outward from the shore for varying distances are "reef-platforms" or flats, of very hard, level and smooth planation (or possibly growth) surfaces, occurring at a depth near mean low water. The seaward terminus of these reef flats end either in an abrupt drop-off on leeward sides of atolls or, on windward sides, in a low trough or moat contained by a definite ridge, which may rise a meter or more above mean sea-level, then a steep drop-off to deep water.

Table 1. Atoll and Island areas of the Marshall Archipelago in square miles, (square Kilometres in Parenthesis).

| | <u>Ralik Chain</u> | | <u>Radak Chain</u> |
|------------------|--------------------|-----------------------|--------------------|
| Enewetak Atoll | 2.22 (5.74) | Pokak (Taongi) Atoll* | 1.45 (3.75) |
| Ujelang Atoll | 0.62 (1.60) | Bikar Atoll* | 0.19 (0.49) |
| Bikini Atoll | 2.82 (7.30) | Utirik Atoll | 1.04 (2.69) |
| Ailinganae Atoll | 1.29 (3.34) | Taka (Takae)Atoll* | 0.22 (0.57) |
| Rongelap Atoll | 3.07 (7.95) | Ailuk Atoll | 2.19 (5.67) |
| Rongerik Atoll* | 0.81 (2.10) | Mejit Island | 1.32 (3.42) |
| Wotho Atoll* | 1.60 (4.14) | Likiep Atoll | 3.9 (10.09) |
| Ujae Atoll | 0.62 (1.60) | Jemo Island* | 0.07 (0.18) |
| Lae Atoll | 0.60 (1.55) | Wotje Atoll | 3.16 (8.18) |
| Kwajalein Atoll | 6.33 (16.38) | Erikub Atoll* | 0.35 (0.91) |
| Lib Island | 0.36 (0.93) | Maloelap Atoll | 3.69 (9.55) |
| Namu Atoll | 2.42 (6.26) | Aur Atoll | 2.17 (5.62) |
| Jabwot Island | 0.22 (0.57) | Majuro Atoll* | 3.54 (9.16) |
| Ailinglapalap | | | |
| Atoll | 4.67 (12.09) | Arno Atoll | 5.00 (12.94) |
| Namorik Atoll | 1.07 (2.77) | Mili Atoll | 5.77 (14.93) |
| Kili Island | 0.36 (0.93) | Knox Atoll | 0.38 (0.98) |
| Jaluit Atoll | 4.38 (11.33) | | |
| Ebon Atoll | 2.22 (5.75) | | |

* visited during the survey.

Source : adapted from Fosberg, F.R. 1988

On most islets just inland from the top of a beach or hard-rock shore, lies a low 3-6 ft (1-2 m) ridge of sand or gravel called a beach ridge. These ridges are much less well-developed, or even absent, on lagoon-sides of islets. Occasional stretches of beach-ridge, have cobbles and even boulders of coral limestone, in some places piled up forming higher ridges to even 16-25 ft (5-8 m), considered to have been thrown up by storms or hurricanes. In some places there are several such concentrically parallel ridges, the older ones inland, the newer ones seaward, representing several storms. Occasional huge blocks or boulders are found well-inland, apparently thrown there by large waves or surges during tropical storms.

The interior of most islets is low, flat and sandy. Seaward the texture may become coarser, and areas of exposed lithified breccia or conglomerate occur, probably formed during a post-glacial warm period with higher sea-level. The material of this structure, reef plus islets, is entirely of calcium carbonate, except for occasional pebbles of pumice, thrown up on the beaches by waves after floating from far-away volcanoes. Occasional bones of turtles and even whales may be found, buried or exposed.

2.2. Climate

A comprehensive account of the Marshall Islands climate is beyond the scope of this summary, which is confined to the tangible or observable results of climatic patterns which have direct influences on the occurrence and behaviour of the organisms that live in and around the islands.

The most striking feature of the regional Marshallese climate is a north-south gradient of increasing rainfall. The northern tier of atolls can be said to have an effectively semi-arid climate. Although no rainfall records are available for Taongi, annual precipitation is likely to be in the range of 30-40 in (750-1000 mm), comparable to that recorded for Wake Island located some 300 m (500 km) to the north. The open, low stature and generally scrubby vegetation structure on Taongi reflect adaptation to severe moisture stress, which in addition to low rainfall is intensified by high evaporation rates, salt spray and poorly developed soils.

Luxuriant forest vegetation, indicating higher and less seasonal rainfall, increases southward in the Radak Chain. Majuro and islands to the south (to Ebon) lie within the equatorial high rainfall belt and receive from 150-200 in (3 700 - 5 000 mm) of annual precipitation.

A second important climatic feature is the position of the archipelago in the north-east trade wind belt. During the greater part of the year the prevailing winds are from the north-east to the east, and are moisture-laden, though there is no high physiographic relief to bring about orographic dumping of this moisture. Trade-wind showers are frequent except in the northernmost atolls. These winds are also strong enough to carry quantities of salt-spray across the flat expanses of the islands from turbulence at the windward reef margin. In the semi-arid Northern Marshall's, surface salinity may be elevated by lack of substantial rain water flushing and high evaporation rates resulting from abundant solar radiation and high average wind speeds.

Finally, tropical storms and hurricanes (locally called typhoons) occur, though not as frequently as farther west. When they occur, most often they sweep up from the south, exerting their force from all directions, and pour down great quantities of rainfall. They are strong enough to uproot or break trees and to defoliate and often kill trees that are left standing. Their effects on animal life has not even been estimated. Among their conspicuous effects are those caused by their generation of powerful waves that may sweep completely across narrow islets and carry tremendous loads of limestone sediments from the ocean margins onto the land, greatly influencing micro-topography and soil textures. Damage to human structures and crops may be complete.

2.3. Soils

Taking as the definition of a soil the "loose or soft materials on the earth's surface capable of supporting plant growth," atoll islets are mostly covered by soils. Even in bare platform surfaces there are crevices and sand-pockets where plants find a foothold.

The simplest soil frequently found on Marshall Islands coral islets apparently has no series name. It is almost pure white or pink coral sand, with no darkened A horizon nor any trace of a B deposition-horizon. This is the youngest of all the atoll soils, deficient in most nutrient elements except calcium. It is found on beach-ridges and dunes.

The Shioya Series is of slightly altered coral sand and small gravel, with a somewhat darkened, thin A horizon, with circum-neutral reaction. This is the most generally distributed and least differentiated soil series in the Marshalls, as well as in most other coral atolls and back-beach flats on high islands. It may be recognised by its generally light brownish-gray color, sandy texture and complete lack of coherence or structure.

The Arno Atoll Series is a comparatively well-developed soil with a friable, usually fine-textured, black A horizon, with a circum-neutral reaction, lacking a B horizon, and with a light brownish-gray to buff colored C horizon not sharply set off from the sand, gravel, or consolidated limestone parent material. This series is found in the interior of larger moist to wet islets. The type locality is on Arno Atoll.

The Jemo Series is a rather localised, remarkable soil found only in association with *Pisonia* forest vegetation. It is characterised by a conspicuous A-0 horizon of pure mor-like raw humus with a definite acid reaction, variable in thickness to as much as 12 in (30 cm), no well-developed A-1 horizon but usually a transition to either a B or a C horizon, a notable but discontinuous B horizon which is either a crumbly, highly phosphatic mixture of humus and coral sand or a hardpan of indurated "atoll phosphate rock," usually 2-8 in (5-20 cm), rarely to 24 in (60 cm) thickness, overlying a C horizon transitional to parent material of coral sand or gravel. The hardpan is found where there are or have been sea-bird rookeries and nesting colonies in *Pisonia* forest. The soil forming process, at least in the Marshall Islands, only takes place under a pure or practically pure stand of the tree *Pisonia grandis*, which produces an acidic raw humus which forms faster than it decomposes, thus accumulates to form an A-0, or humus horizon.

2.4. Hydrology

Standing fresh-water is a rarity in the Marshall Islands. Running water is totally lacking except briefly during heavy rain storms. Fresh ground-water does exist on most islets of any real extent except in the very dry northern region of the archipelago. This water occurs in shallow Ghyben-Herzberg lenses of fresh-water floating on the denser seawater in the porous interiors of atoll islets.

2.5. Vegetation

No record remains of the original Marshall Islands' vegetation. The Marshallese have been in the region for several thousands of years. Although they unquestionably altered the biota and environmental conditions, they probably had reached an equilibrium with the environment and most of the original species likely survived. Change has been more drastic since Europeans, Japanese and Americans have administered the archipelago.

The obvious present day vegetation of the Marshall Islands, as of most other coral atolls, is a forest of coconut palms (*Cocos nucifera*). This is a planted forest and it has replaced most of the original natural vegetation of the islands. In addition to the area now occupied by the coconut plantations, the Marshallese brought other areas under cultivation. Pits for taro cultivation were dug down to below the fresh-water table in the interiors of the larger islets. Filled with muck, created from decomposing vegetable matter, they were planted to *Colocasia* and *Cyrtosperma*, the principal and most edible taro genera, as well as sugar cane and a few marsh plants useful as food and medicines. Still other areas were cleared and occupied by villages and associated human sites.

In the historic period, contact with the modern world (including a century of foreign colonial domination) has led to a dramatic acceleration in the rate of environmental transformation. Contributing factors include importation of technology, newly introduced alien organisms, impacts associated with WWII, urbanization and population growth among others. Areas seriously altered, especially those now occupied or utilised by man are generally characterised by low biodiversity. This is because most of the native plants and animals have been eliminated, replaced by a relatively few planted or naturalised species, most of them not especially well adapted to the saline, highly calcareous atoll environment. Most are pioneer species, widely distributed weeds and "tropical tramps," or domesticated species dependent on the presence and protection of man, and make up a significant fraction of the Marshall Islands' biota. Of the remaining native vegetation the following species and associations are most likely to be encountered in the Marshall Islands:

Mixed broadleaf forest is, as in most tropical areas, the most common and most obvious type of vegetation in undisturbed places in the Marshalls. This is usually a low to medium stature forest with a closed canopy. In the Marshalls, as in other low coral atolls, it is composed of varying proportions of a small number of tree species, a few shrubs and a sparse to dense herb layer, again of a few species. Epiphytes are present in the wetter southern atolls, but there are very few species.

One of the principal situations in which the mixed broad-leaf forest survives is in the "wind-breaks." Crescent shaped strips of forest on the windward sides of islets, especially those on windward parts of the reef, are left more or less intact to protect the coconut plantations and taro-pits from wind-blown salt spray. This cultural practice is a very beneficial one, both as a reservoir of natural diversity and in facilitating food and copra production in the difficult atoll environment.

Where the strip of vegetation left as a wind-break is fairly wide, the inner part may be reasonably typical broad-leaf forest of *Tournefortia argentea*, *Guettarda speciosa*, *Pisonia grandis*, *Pandanus tectorius*, *Allophylus timoriensis*, *Cordia subcordata*, *Hernandia sonora* and a few other less common species. *Lepturus repens*, *Thuarea involuta*, *Fimbristylis cymosa* and *Polypodium scolopendria* are common herb species. The outer fringes of these strips are mostly wind-sheared scrub of *Scaevola sericea*, *Suriana maritima*, *Pemphis acidula* and *Tournefortia*, sloping from the forest down to the top of the beach.

Birds are seen around these areas, especially migrant shorebirds, White terns (*Gygis alba*) and noddies (*Anous* sp.). Birds are more common away from areas of human habitation and activity. The insects and other invertebrates associated with the plant species may survive here as well as their plant hosts.

The relative abundance of the tree species varies a great deal locally and in places single species may dominate or even form pure stands. Such forests which are completely dominated by one species are here treated as distinct vegetation types and described as such. Such monospecific forest types, though common in temperate and colder climates, are not usual in the tropics. In the Marshall Islands they exist probably as a response to stressful environments and to the low numbers of species in the atoll floras. In the case of forests of *Neisosperma oppositifolia*, the pure stands may be final stages in succession. The dense shade created by the *Neisosperma* and the ability of its seedlings to survive in its shade may give the species a crucial advantage, leading to its eventually succeeding the mixed forest in certain habitats.

Neisosperma forest was a fairly frequent type in the interiors of islets, at least in the somewhat moist northern atolls. It may also have existed in wetter southern atolls but has not been observed there. The trees are tall, with clear trunks up to 4-12 in (10-30 cm) diameter, and have dense rounded crowns of large dark green leaves. The ground is commonly covered by a dense stand of seedlings of this species 4-8 in (10-20 cm) tall, apparently in a state of arrested or at least slowed-down development. Here and there in such stands of these trees, spots where the canopy is thin and chlorotic have been observed. Here a few shrubs such as *Allophyllus timoriensis* may gain a foothold.

Pisonia grandis forest is another pure-stand type, formerly very common and widespread in the Marshalls and throughout the Indo-Pacific coral islands. The trees reach enormous size to 100 ft (30 m) tall and with pale, smooth-barked trunks of very soft, brittle wood, up to 6.5 ft (2 m) diameter, and even larger. Little or no undergrowth exists here. The ground is covered by a brown, spongy layer of "raw-humus" or "mor" comprising semi-decomposed leaf-litter which is acidic in reaction. This is indeed an uncommon phenomenon at lowland tropical sites and does not occur under *Pisonia grandis* in mixed forests, where the litter is not pure *Pisonia*. The shade here is almost as dense as in the *Neisosperma forest*. The *Pisonia*, though capable of reproducing from seed, does not produce a layer of seedlings in a *Pisonia* stand. If sufficient moisture is available large fallen branches and trunks strike root where they touch ground and give rise to tree regrowth. This forest is favoured as a roosting and nesting site by several sea-birds species.

Although *Pisonia forest* may have been the most frequent and widespread forest type on Indo-Pacific atolls, ease in clearing and fertile soils made it the most susceptible to alteration to coconut plantation. Now it is one of the more rare types and in most parts of the Marshalls has disappeared, leaving behind traces in the nature of truncated Jemo soils, indicated by weathered bedded phosphate rock.

Tournefortia argentea dominates areas especially on narrow islets in the drier northern atolls. This species is one of the principal pioneers on new sand and gravel bars, denuded islets, and abandoned clearings. The trees reach a large size, and stands of it tend to be of only one generation, replaced by other species of trees and changing to mixed broad-leaf forest. In dry areas there are open stands of *Tournefortia* of scrub-forest stature, with a herb-layer of *Lepturus* and locally, *Sida fallax*, *Portulaca* spp., and *Fimbristylis cymosa*.

On hard limestone platform areas *Pemphis acidula* forms very dense, pure forests of rather low stature. The trees are often close together, tangled and difficult to traverse. Fringes of this species line rocky shores along passes and other places where the sand and gravel may have been washed away.

Stands of *Suriana maritima* scrub line certain sandy shores, forming narrow strips of this one species, resembling *Pemphis* in habit but greener in colour with yellow flowers and more flexible, less rigid branches.

Sandy shores and berms are, however, much more likely to support stands of *Scaevola sericea*. Pure stands of tangled *Scaevola* scrub 3-6 ft (1-2 m) tall, are found on narrow ends of islets and in places where storms may have destroyed former vegetation.

Other species that occasionally form small stands are *Barringtonia asiatica*, *Cordia subcordata*, and *Dodonaea viscosa*.

Mangrove vegetation is not very extensive in the Marshall Islands, but does occur. Poorly developed and impoverished mangrove swamps are known on Jaluit, Arno, and Ailinglapalap atolls in the southern and wettest parts of the group. Northward mangroves, especially *Bruguiera*, are found mostly in inland low wet spots, termed "mangrove basins." These are, at least in some cases, probably the result of planting of the propagules of *Bruguiera* by the Marshallese, who had uses for the trees. They form dense, pure stands, but do not spread where there is no connection with the sea.

Most of the herbaceous species occur principally as components of forest or scrub types, but several may form pure or mixed small stands in openings and in interiors of dry northern islets. *Lepturus repens* is the only one to dominate sizeable areas, especially on Taongi Atoll. It is a bunch-grass that also produces loose tangles of wiry runners. It is one of the earliest pioneers on bare sand and gravel, and its seeds are carried by floating on water, wind, and birds.

Boerhavia, of several poorly distinguished species, is common on both open and shaded ground, and especially where birds are nesting. Similarly, *Tribulus terrestris* is most frequent in sea-bird colonies, its long runners, greyish leaves, bright yellow flowers and "puncture-vine" fruits are characteristic.

Tacca leontopetaloides, a tall herb with dissected leaves, potato-like tubers, and leathery greenish flowers forms occasional open stands both at exposed sites and within coconut plantations.

Small patches of several *Portulaca* (purslane) species are common, especially in openings.

Fimbristylis cymosa is very common forming pure stands in pioneer situations, such as back-beaches, sand flats, and even in coconut plantations.

Sea-grasses are very rare in the Marshalls, only two stands of *Thalassia hemprichii* being known from shallow water in Ujelang and Ailinglapalap Atolls and one *Cymodocea rotundata* bed in Majuro. This seems to be the eastern limit of *Thalassia* in the Pacific. *Halophila* seagrass beds have recently been reported from the lagoon side of several islets at Kwajalein Atoll (University of Hawaii Sea Grant Advisory Program, 1988).

Several cryptogamic formations should be mentioned, three of them terrestrial and three marine, though many more marine algal communities might be defined if serious attention were directed to their study.

The identifiable terrestrial formations are an algal crust. Of several Myxophyta, almost all are universally found on undisturbed loose coral sand; the sand grains, to a few mm depth, stuck together by the gelatinous sheaths of the algal cells and filaments. The crust is grey and friable when dry, soft and flexible greenish gray when wet. This may be a source of fixed nitrogen for the various pioneer ecosystems in which these crusts occur.

On pebbles, cobbles, boulders, and lithified limestone surfaces exposed to light is a layer of the limestone penetrated to up to 2 in (5 cm) or more by endolithic, boring Myxophyta. These appear as a greying or blackening of the limestone surfaces (upper surfaces only, of pebbles, cobbles, and boulders), and a greenish zone on broken edges. This layer seems universal on these coral-limestone surfaces above high tide level.

On coral sand flats, and also on flat exposures of lithified limestone, abundant colonies of *Nostoc* appear after rain or heavy dew, drying black when exposed to the sun. *Nostoc* is known to fix nitrogen, suggesting another nutrient source for pioneer ecosystems on atolls.

The algal ridge on the outer edge of windward fringing and barrier reefs is composed principally of *Porolithon* species. This is the actively growing, wave-resisting part of the reef, and contributes much of the calcium carbonate of a windward reef as well as helping to cement together the carbonate skeletons of coral, mollusks, and other marine invertebrates to form the hard reef framework.

An algal felt (or turf) covers the smooth surface of the reef-flat on the windward side of ocean islets, at or just below mean low-tide level. Algal species include branching filamentous green algae, *Microdictyon okamurae*, *Neomeris vanbosseae*, *Cladophoropsis zollingeri*, and red algae of the genera *Laurencia* and *Jania*. Many other small algae are less common components of this widespread formation. This algal felt is the home of several abundant genera of foraminifera which are principal contributors to the pink sand so abundant on Marshall Islands beaches.

Another recognizable, but poorly studied algal vegetation type is the "meadow" of *Halimeda* spp. on lagoon bottoms. The flake-like segments of this calcareous green alga are the most abundant components of many, if not most, lagoon-bottom sediments, and of some fossil limestone facies. Much work remains to be done on algal communities in the Marshall Islands. The early work of Taylor (1950) has recently been augmented by surveys at Bikini Atoll (Agegian et. al. 1986) and Kwajalein (UH Sea Grant Advisory Programme 1988).

2.6. Fauna

Birds are the most conspicuous group of terrestrial animals in the Marshall Islands fauna. Seventy bird species have been recorded from the Marshall Islands; thirty-one seabird species and thirty-nine land and fresh water birds.

Seventeen seabirds species are resident breeders in the Marshall Islands (including two questionable) (see Appendix 2). Of the two native forest birds the Crimson-crowned fruit dove (*Ptilinopus porphyraceus*) is believed to be extinct and the other, the Radak Micronesian pigeon (*Ducula oecania*) is considered endangered. The remaining avifauna comprises migrant shorebirds and waders and accidental visitors.

The resident (including probable) breeding seabirds in the Marshall Islands all regularly occur at sea within their respective areas. Some are more common than others, mainly due to species feeding habitat preference (also interaction of surface water zonation and abundance of food). The three major feeding habitat categories, for Marshall-Gilbert seabirds, are coastal (beaches, reefs, lagoons), offshore (near islands or atolls), and pelagic. Some species may overlap or their range may vary at different seasons of the year.

A number of species migrate annually through the Marshall Islands area from breeding grounds elsewhere in the Pacific. These migrant species are usually entirely pelagic seabirds and pass through the area quickly or are migrant waders of which some five species are common (see Appendix 2). Occasionally, due to storms, injuries, or sickness, unusual species may appear in the islands and are termed "accidental" visitors.

Other natural terrestrial fauna include a number of species of skinks, geckos and insects, about which little is known. Perhaps the most interesting species is the coconut crab (*Birgos latro*) which occurs on most of the islands where humans cultivate coconuts. Extremely slow growing and relatively easy to catch, populations of these crabs are threatened on most of the inhabited atolls and are easily decimated on the few uninhabited atolls where they occur in abundance. At least two species of marine turtles, the green turtle (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata*) occur in the Marshall Islands. The green turtle nests primarily during the summer months on the many suitable beaches throughout the archipelago and the female and her eggs are a culturally important and sought after food. Unfortunately, as is occurring elsewhere in the Pacific region, hunting pressure on and around the inhabited and more accessible uninhabited atolls is depleting the green turtle population, making the conservation of the species and its nesting habitat of paramount importance. The hawksbill turtle occurs in the lagoon waters but little is known of its breeding habits. This turtle is considered rare and endangered in the Marshall Islands.

The status of fish and shellfish (especially *Tridacna* spp.) populations throughout the Marshalls varies greatly. Generally, populations of reef and lagoon fish near inhabited atolls and the main urban centres of Majuro and Kwajalein are depleted in comparison to those of the remoter uninhabited or lightly inhabited atolls. These do not suffer from over-fishing or the effects of habitat damage from pollution, dredging, sand mining and shoreline infilling. This assessment was supported by this survey which found abundant reef fish and shellfish (except the giant clam, *Tridacna gigas*) populations in remote atolls and a noticeable decline where fishing pressure had been exerted near the inhabited atolls.

Randall and Randall (1987) state that little difference in the fish fauna can be expected from one atoll to the next within the Marshall Islands, particularly those of about the same latitude. They state, however, that there are differences from the northern to the southern Marshalls. They attribute this to greater collecting in the Northern Marshalls (i.e. Eniwetak, Bikini), therefore more species are known from the northern atolls. Results from the 1988 survey indicate an actual difference in the fish fauna with a number of large, conspicuous species missing from the most northern of the Marshall atolls.

3. A PROTECTED AREA SYSTEM FOR THE MARSHALL ISLANDS

3.1 General

The effective conservation or wise use of natural resources is of paramount importance to all countries seeking to achieve a degree of economic and social stability. Together with its human resources the wealth of a country is measured in its natural resources and the way these are managed and utilised on a sustainable basis for the benefit of the population generally, including the maintenance of the flow of benefits provided by healthy natural ecosystems. As we are near the 21st century, the effects of resource mismanagement are sadly becoming obvious in many countries. The demands of development, technology and increasing populations are leading to increased global consumption of resources and the depletion of many basic resources needed for human survival. Natural resource depletion through over-exploitation such as the global destruction of tropical rain forests, has also led to the breakdown of basic ecological processes threatening the maintenance of the life supporting systems of the biosphere and the human environment.

As a region, the equatorial Pacific still enjoys a comparatively high level of environmental quality and mostly has escaped the environmental disasters which have struck the tropical and subtropical continents and large islands in other regions. However, there is ample evidence that "development" activities and increasing populations are leading to the over-exploitation of resources, the destruction of habitats, loss of key species and breakdown of natural systems which have preceded the environmental disasters occurring in other parts of the world. Throughout the region there are examples of severe soil erosion resulting from poor land use practices and forest exploitation, reefs and beaches are destroyed or degraded by siltation, dredging and mining for construction materials; lagoons are being polluted by urban wastes; mangroves and estuaries polluted or lost to "development" and fisheries depleted by over-exploitation and illegal fishing practices.

Species loss in the region is high due partly to the small and isolated nature of the island habitats. In most cases the loss of these species and their habitats represents an irreplaceable loss to national, regional and global biological diversity. Many of these species (e.g. sea turtles, shellfish) have important traditional and cultural significance and their loss to a country further diminishes the national cultural heritage which in most Pacific countries, is already under pressure from western values and consumerism. Their depletion or loss forces greater community dependence on national governments and outside assistance agencies as well as having a detrimental cultural impact.

The Republic of the Marshall Islands has not escaped these trends. It is a country of atolls having a very limited land area and generally low levels of natural diversity. Because the plants and animals of remote atolls have developed in the absence of humans and terrestrial herbivores or predators they are particularly vulnerable to human disturbance and alien introductions. These ecological factors, when coupled with a population growth rate of over 3 per cent, means that the Marshallese must take particular care if the quality of their human environment is to be maintained. Problems are already occurring. Overcrowding on some atolls have led to environmental health concerns and localised pollution of lagoons and fresh water sources. Dredging of reefs and lagoons for construction materials has led to the loss or degradation of these highly productive habitats for fish and shellfish. Intensive urbanisation of the population has led to over-fishing and a scarcity of many marine species once relatively common throughout the atolls. Animals have been introduced accidentally or deliberately on many islands.

Clearly it is imperative that steps be taken to manage and conserve the precious remaining natural resources of the Marshalls. It would indeed be a tragedy if the desire of the present generation of Marshallese to provide their children and future generations with a higher level of material consumption and adoption of "western" habits, denied them knowledge and use of the rich heritage of cultural and natural resources enjoyed by their forefathers. A protected areas system in the Marshall Islands would be a way of ensuring this does not happen and would represent an investment in the social, cultural and economic future of the country.

Such a system would have as its goal the protection of representative examples of the full range of ecosystems, habitats and species communities found in the country. It would be achieved through the careful selection of the best remaining examples of these natural features and the establishment of specific protected areas.

3.2 Categories of Protected Areas

The above factors were taken into consideration by the survey team when deciding on an appropriate range of protected area categories to achieve the multiple conservation objectives thought desirable for the atolls surveyed. The categories generally abide by the current international definitions defined by the International Union for the Conservation (IUCN) but with some adaptations to meet the needs of the Marshall Islands.

The categories recommended as a basis for a protected area system for the Marshall Islands are:

3.2.1. National Preservation Areas (Strict Reserves)

This category is designed to protect entire natural systems and the diversity represented in habitats, species, and physical features of an area of national and or international conservation significance. The objective is to ensure the area is protected, in perpetuity, to a level which allows its dynamic and evolutionary/ecological processes to take place in an undisturbed state. A National Preservation Area would be available for low impact scientific study, monitoring and educational use, but all exploitative resource uses are prohibited. Access to the Area is closely controlled and regular surveillance is required.

3.2.2 National Parks

The principal objectives of this category are the active management of an area with outstanding, largely unmodified and highly scenic features primarily for the protection of those features and for recreation, tourism, education and scientific purposes. However, the category recognises traditional uses of the park for subsistence resource gathering and provides for continued traditional uses of non-critical resources within the framework of a management plan. Controls on harvesting would be exercised on the basis resource monitoring and estimate of sustainable yield. Within the park specially designated areas are to set aside for development, specific habitat and species protection, controlled traditional resource harvesting and for recreation and tourist activities.

3.2.3. Nature Reserves, Marine Reserves, and Wildlife Sanctuaries

Reserves in this category are designed to protect ecosystems, natural habitats, specific species, groups of species, biotic communities and physical features of local or national importance. Provision is made to allow controlled use for scientific, educational and recreational purposes. Access may or may not be controlled. Generally these reserves and sanctuaries will be smaller more discrete areas than those selected for National Preserves or National Parks. Where a protected area comprises predominantly marine habitats it is appropriate to designate it as a Marine Reserve. Where an area is being set aside predominantly for the protection for a specific species such as the green turtle it would be designated a Wildlife Sanctuary.

3.2.4. Resource Conservation Area

This category of protected area is established at the request of the landowners or local community in cases where there is concern over the plight of one or more of the living resources of the atoll or its waters. Its aim is to provide a category of protected area which is established voluntarily for the conservation of specific living resources (plants, animals, fish, etc.) and managed locally with the assistance of the proposed Conservation Service (See Part III) according to a jointly agreed management plan.

3.2.5. Historic/Archaeological Reserves

These areas provide for the protection of surface (including buildings etc.) and subsurface remains and the locations of important cultural significance. The investigation of these sites, removal of artifacts to safe keeping, and the possible development of the site for educational purposes would be allowed under permit only.

3.3. Management Plans

Management of the above protected areas categories would be subject to the provisions of a management plan prepared by the managing authority in conjunction with the landowner(s) and with the local atoll communities. The plans will clearly state the objectives of the protected area and the action required to achieve these objectives. Provision will be made in the plan for adaptation to changing circumstances. Once approved by the managing authority and the local community, the plan becomes the guide for all operational activities.

3.4. Land Tenure and Protected Areas

The recommendations for specific parks and reserves in the following section are based primarily on ecological and cultural considerations and take no account of the tenure and legal status of the lands and waters involved. However, as one objective of this report is to provide guidance on the establishment of a protected area system, it is important that consideration be given to these issues. Accordingly, the following paragraphs outline the role of traditional land tenure in the Marshall Islands and identify some options which could be employed by the government in the establishment of the recommended parks and reserves. Much of the following information on the traditional and modern tenure system is derived from Mason, (1987).

The Constitution of the Marshall Islands emphasises the desire of the Marshallese people to preserve the traditional land and title system (Article X) including the rights and obligations of the Irooj laplap (paramount chiefs) Irooj-edik (lesser chief Radak chain only) Alap (Clan chief) and the Rijerbol (those with workers rights to the land). No land can be alienated or disposed of without approval of the above parties. The Nitijela (Marshall Islands legislature) is a democratically elected body and can supplement traditional land law as may be deemed necessary by appropriate legislation.

Article III recognises the traditional role of the Irooj laplap by the creation of a Council of Irooj. It reviews any action of the Nitijela (after the third reading) which deals with customary law, traditional practice or land tenure and can make recommendations. The Nitijela however, makes the final decision on land law. So far however, no legislation has been appointed that has not received the support of the Council of Chiefs.

The Constitution also provides for a Traditional Rights Court representing all four of the titled statuses mentioned above. The Court reviews titles, land rights and other legal interests that depend on customary law and traditional practice and advises the High Court (on request and by resolution) of its members views on these issues. The High court is bound only to give these due consideration.

The Bill of Rights declares there shall be no taking of land except by government and then only for public use. Such action must first be reviewed by the High Court with advice from the Traditional Rights Court. Just compensation is assured.

It is also worth noting that the rights of an atoll population shall extend to the sea and sea-bed of the internal waters and surrounding sea and sea-bed to a distance of five miles.

Mason (1987) concludes that the traditional system of land tenure in the Marshall Islands is still 'alive' but not 'well'. He suggests that generally the older generation still respects the traditional system of title and land tenure but the younger people are often less enthusiastic and well informed about the way the customary system works. He notes that while the Constitution recognises the traditional system, in practice the legislative and executive branches of a highly centralised form of government have the power to override any aspect of the customary law or traditional rights that is not convenient to the current needs of government.

From this brief summary it appears that there are two basic courses of action available to the government for the establishment of the recommended parks and reserves.

Firstly, the government can take land for public purposes following review by the High Court provided just compensation is paid. Such action would be justified only where the national value of an area is perceived to be such as to override traditional ownership rights and if all other avenues of negotiation had failed.

Secondly, in normal circumstances the approval of the Irooj laplap must be obtained before land or waters within 5 miles of an atoll are alienated (sold, leased, licenced etc.). Under this course of action government must negotiate a mutually satisfactory arrangement with the Irooj laplap. This is the preferred approach as it implies that the all important elements of public and traditional landowner support for the protected area and community acceptance of its management provisions will take place.

Under the second approach a wide range of options exist around which negotiations could take place. These include:

- (i) outright purchase by the government on a willing seller-willing buyer basis and at an agreed price;
- (ii) dedication of a proposed protected area to the nation for its conservation values by the traditional owners. This allows the proposed protected area to remain in its traditional ownership while providing for its future management as a protected area in consultation with the traditional owners. Normally the dedication would be legally binding on successors in title of the traditional owners. Variations to this aspect of the agreement are negotiable. Dedication of land could involve some form of annual compensation to the traditional owners, perhaps in the manner of a traditional tribute to the Irooj laplap.

- (iii) partnership management of an area for the protection of its conservation values and compatible development of low impact revenue-generating activities such as recreation and tourism. Under such an arrangement the protected area management agency and the traditional owners would enter into a joint management agreement for a specified period of time in which the rights and obligations of each party would be clearly spelt out. The agreement could be legally binding and overall management would be subject to a jointly approved management plan. The principal advantages of this approach are that the area stays in traditional ownership, the owners avail themselves of the abilities and expertise of the protected area management agency to protect the conservation values of the area and to help develop its revenue generation potential.
- (iv) a leasehold agreement whereby the ownership of the area remains in the hands of the traditional owners but the government acquires management control over its use. Many variations of the leasehold arrangement are possible relating to the term of the lease, the rental, renewal provisions, lessee/lessor rights etc., all of which are negotiable. However, there are several drawbacks to the lease approach. The long-term security of tenure implied by the term "protected area" is lacking unless perpetual rights of renewal are negotiated. The cost of the rental or leasehold consideration, although much less than that required for outright purchase, could prove to be very high in the long term. The government could be faced with sudden and substantial increases at the time of renewal, as a result of the increased value of the area following the development of, for example, recreation and tourism facilities.

As stated above, each of these four basic approaches give rise to many variations which should be canvassed during negotiations. The approaches outlined in (i), (ii), (iii) and (iv) are preferable to compulsory (forced) acquisition of an area. Ultimately the success of protected areas depends on the support of the landowners, the public and the neighbouring community. It is therefore important that the negotiations are carried out with fairness and integrity if public and community support for the concept of a protected area is to be fostered.

One way to ensure local community involvement in the management and development of protected areas established on remote atolls, is to appoint a local management committee. This would oversee management and would act as a forum for liaison between the national protected areas management agency and the local community. Proposals for such a committee (Atoll Conservation Committee) are discussed further in Part III.

The final choice of which approach to use must rest with the Marshall Islands government and the traditional landowners. The negotiations will not be easy, requiring frequent and long consultation and patience by the parties involved. However, it is extremely urgent that discussion, and hopefully action on getting a protected area system initiated in the Marshall Islands occurs as soon as possible. A very compelling reason in the Radak chain is the legitimate desire of the Iroij-laplap and his agent and advisor to bring some economic development to this eastern side of the Republic.

These beautiful tropical atolls are within 3 to 4 air hours of a large tourism and golfing market in Japan. Consequently, there are plans underway for the development of a resort complex somewhere on the 10 atolls of the Radak chain, owned by High Chief Hermeos. Hopefully such development could be sited on one of the already inhabited and disturbed atolls, in the more southerly section such as Aur, Maloelap or Wotje. Climate, distance from Majuro air service, existence or ease of boat docking or harbour, water supply and presence of people, all auger for such a location. However, both Taongi and Bikar have been mentioned as possibilities. In fact, a proposal exists for the transport of garbage from U.S. mainland and infilling in the lagoon at Taongi, as a precursor to resort development. Airstrips and boat harbours have also been mentioned. An appropriate system of protected areas could actually benefit tourism and in the Radak chain the survey recommendations which follow attempt to reconcile conservation and development. Therefore, it is important that the government moves quickly to establish an institutional framework for protected areas management which will allow negotiations to begin quickly. Part III of this Report advances proposals for such a framework.

Finally, it should be noted that the northern Marshall Islands survey does not represent a comprehensive national assessment of remaining natural diversity nor do the recommendations provide for a complete system of protected areas for the Marshall Islands. The survey and its recommendations represent only a first, but important, step in this direction. It is, however, reasonable to assume that the five uninhabited and one inhabited atolls (plus Jemo Island) that were surveyed contain some of the best undisturbed examples of natural habitat in the Northern Marshall Islands. The recommendations of this report, if enacted, will therefore go a long way towards providing for the protection of representative examples of the remaining natural diversity of the Northern Marshall Islands. However, if the goal of a comprehensive system is to be achieved further investigations must be undertaken elsewhere in the Republic, and the foundation recommended in this report built on in the future.

4. SURVEY RESULTS BY ATOLL AND CONSERVATION RECOMMENDATIONS

The following atoll by atoll accounts are summarised from the field data collected during the September 1988 survey and from the review of the natural history of the Marshall Islands prepared by Prof. F.R. Fosberg (1988) for this project. In each account there is a description of the general geography of the atoll, followed by information on the vegetation, fauna, cultural/archaeological resources, corals and reefs and marine fauna. Emphasis is given to identifying the most significant natural features of each atoll. Where possible comparative information from previous field studies is referred to, particularly where the 1988 survey team noticed obvious changes in habitat condition or species distribution and abundance.

Each section concludes with a discussion on the natural and cultural conservation values of the atoll and recommendations for protected area establishment, education, research and other appropriate potential uses.

4.1. TAONGI ATOLL

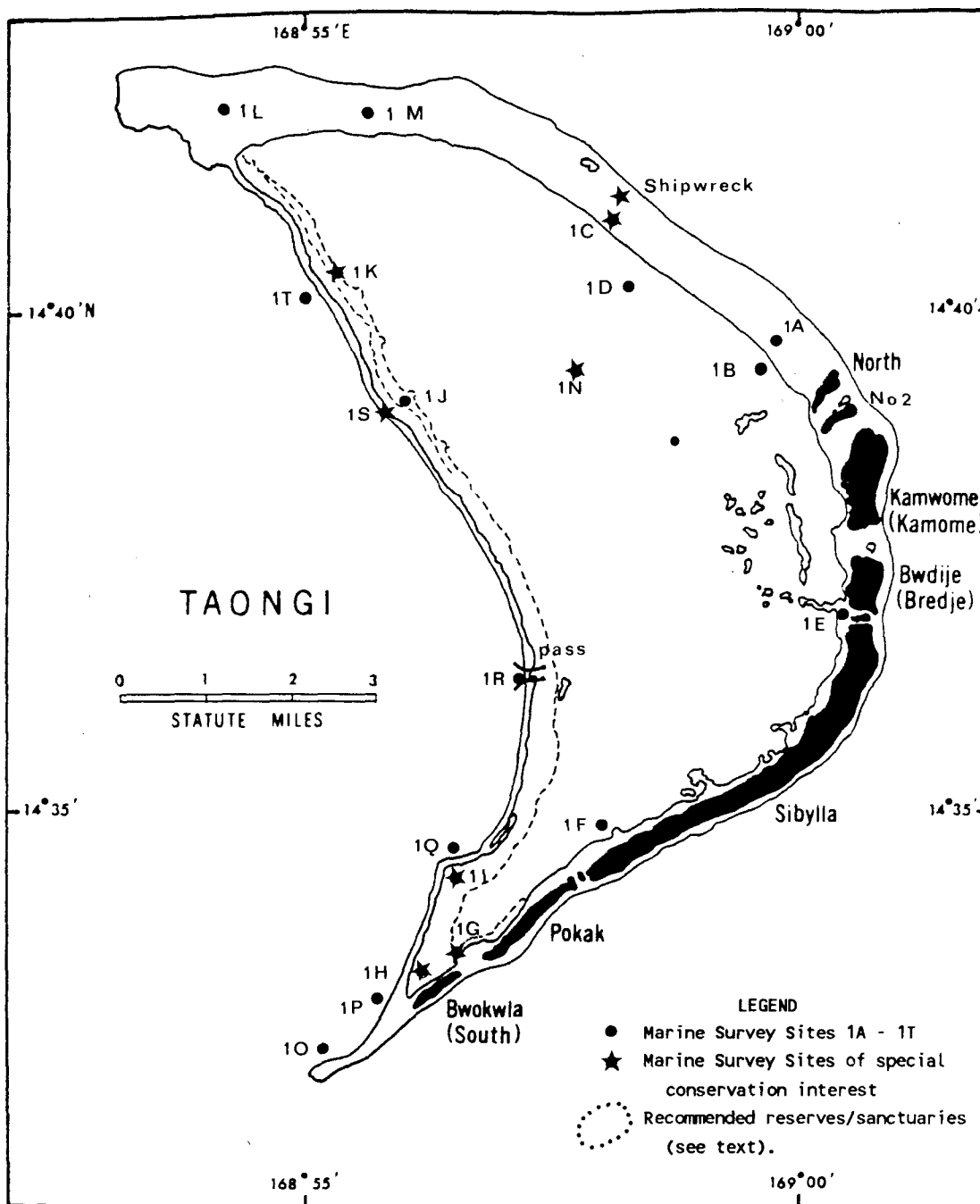
4.1.1. General Description

This atoll was the first visited by the survey party which spent three days (9-11 September) investigating its unique environment. At 14° 43'N, 168° 57'E it is the northern-most of the Marshall Islands lying about 150 miles NNW of its nearest neighbour in the Radak chain, Bikar atoll. The atoll is roughly crescent-shaped, about 11 miles x 5, orientated north-south with the convex side to the east (see Map 2). Although not inhabited now or in the past, the atoll has been occasionally visited by Marshallese who regarded it as a bird refuge and the harvesting of young birds and eggs was carefully regulated in the past (Fosberg, 1957).

In the early 1960's the atoll was declared a protected area under the Trust Territory of the Pacific Islands administration, a status which has now lapsed under the Republic. The atoll has claimed a number of wrecks, the most recent being a Japanese longline fishing boat thought to have gone aground on the NE reef in 1986. Being uninhabited and isolated by distance from population centres, it is the least disturbed of the atolls visited and probably of any of the atolls in the Marshall Islands. Access is difficult as the single meandering narrow boat pass empties the lagoon through the west side reef and is suitable only for small outboard powered boats. Passage is hazardous in the channel during ebbing tides due to very swift currents running "downhill" from the lagoon to ocean side.

Climatically, Taongi is the driest of the Marshall Island atolls, having a striking arid, semi-desert, character. Ten islets lie on the southern part of the eastern reef. At low tide several of the smaller islets join with the larger adjacent islets. All the islets were visited by the survey team and 20 marine stations were surveyed in the surrounding waters (See Map 2).

Map 2



Source: Adapted from Amerson, A.B. 1969

The largest islet, named Sibylla, is approximately 4.5 m (7.2 km) long and up to 1 000 ft (305 m) wide. Kamwome islet north-east of Sibylla is the second largest. Pokak (Taongi) islet after which the atoll is named lies to the south of Sibylla.

High boulder ridges and sand ridges indicate a history of severe storms and are a feature of these islets. The northern two thirds of the seaward shore of Sibylla is backed by an enormous boulder ridge up to 6 m high in places. Large boulders are also scattered inland, obviously carried by storm waves. The seaward sides of most of the islets have boulder and cobble ridges, sometimes two or even more concentrically parallel, their outer margins either lining or somewhat back from the actual shore. Inland on the wider islets are sand and rubble flats. Back from the lagoon shores are low sand and gravel ridges. On both seaward and lagoon sides are stretches of exposed rock platform, of coral conglomerate, its surface flat, about 3 ft (1 m) above mean high tide level, their outer edges sloping down, to the level of the reef flat, near mean low tide level.

The soils of Taongi are mostly very immature, in general belonging to the Shioya Series, characterised by very little humus accumulation. Large areas of fine sand show little development beyond the stage of unaltered coral sand. These sandy areas are often inhabited by large numbers of Wedge tailed shearwaters (*Puffinus pacificus*), burrowing beneath the surface. Most of the Shioya soils are mixture of coarser coral sand and gravel of various textures.

The atoll reef is almost unbroken except for the narrow 66 ft (20 m) pass mentioned earlier. This encircling aspect of the reef gives rise to highly interesting and unique reef formations and hydrological patterns which are discussed in greater detail below and illustrated in Appendix 9.

The lagoon is shallow, probably not exceeding 100 ft (30 m) depth, and has many coral heads and patch reefs, some reaching the surface. A massive algal ridge lines the outer edge of the windward reef, while the south and west reefs are coral-covered narrow flats where landings can be made at high tide in quiet weather. An interesting feature, perhaps unique to Taongi Atoll, is the presence of a tiny algal rim on lagoon shores of the western-most islets, on east facing lagoon reef-fronts, and on the windward edges of coral patches in the lagoon. This rim is a miniature living algal ridge 4-6 in (10-15 cm) high and is maintained by constant water flow over the reef flat during virtually all stages of the tide. Water level in the lagoon averages about 1.5 ft (0.5 m) higher than the surrounding ocean, and even at low tide the algal rim is constantly bathed with water flow across the reef from the lagoon to ocean side.

4.1.2. Vegetation

Botanically, along with Bikar Atoll, Taongi is the most impoverished of the Marshalls atolls in terms of species diversity, having only nine species of flowering plants. However, the atoll is unique in that all nine species are native to the Marshall Islands and the vegetation is completely undisturbed by exotics (see Appendix 7). The *Tournefortia argentea*, *Scaevola sericea* and *Sida fallax* shrubland associations described below are considered to be among the best remaining examples of their type adapted to dry atoll conditions in the Marshall Islands and most likely the entire Pacific region.

The following list comprises the entire vascular flora of Taongi:

| | |
|--------------------------------|------------------------------|
| <i>Lepturus gasparricensis</i> | <i>Sida fallax</i> |
| <i>Lepturus repens</i> | <i>Ipomoea macrantha</i> |
| <i>Boerhavia repens</i> | <i>Tournefortia argentea</i> |
| <i>Pisonia grandis</i> | <i>Scaevola sericea</i> |
| <i>Portulaca lutea</i> | |

There are, basically, six vegetation types on Taongi, each dominated by a single species. Various combinations of these occur, as well as different aspects with regard to height, density, luxuriance, etc.

The type that gives the atoll its character is a sparse low scrub forest of *Tournefortia*. This is from 6-20 ft (2-6 m) tall, with occasional taller trees. It is rarely so dense as to greatly impede walking and may be found in almost any substratum, with the exception of sand where it may occur only in patches. Locally it has an understory of *Scaevola*, this is often closed so as to make progress difficult without a machete. Ordinarily, where there is no *Scaevola*, the spaces between the trees may be occupied by sparse *Lepturus*, *Portulaca*, *Sida* or *Boerhavia*, the latter more abundant on broken coral rubble substratum (this likely because of lack of competition, as the species also does very well on sandy substrates).

The other forest type on the atoll is a small stand of decadent *Pisonia grandis* found on Kamwome islet with another very small stand of a perhaps 54 healthy trees in the centre interior of Sibylla islet. It is interesting to note that in 1952 Fosberg reported the Kamwome stand as dense, not over 20-27 ft (6-8 m) tall with trees of 6.5-10 ft (2.5-3 m) in diameter (comparison of 1945 and 1951 aerial photos and field observations in 1982 indicated the *Pisonia* forest patches were gradually enlarging). However, the 1988 survey indicated that many of the trees in this stand were now dead, the canopy open with a dense stand of *Lepturus repens* forming the ground cover.

Another prominent vegetation type is *Scaevola sericea* shrubland, 3-6 ft (1-2 m) tall, either pure or with scattered *Tournefortia* trees. This is commonly so dense as to impede walking and generally covers the ground completely and is often found on rock or broken coral. The low spreading branches, when covered by wind-blown sand, send out roots and form new plants. It rarely has any ground cover of other species. The largest stands of this type are found on Sibylla islet where it forms 50-75% of the ground cover at the southern end and approaches 100% cover on the islet's north eastern end.

The other woody type is a lower stature (1.5-3.0 ft, 0.5-1.0 m), more open *Sida fallax* shrubland. This may occur in a practically pure stand, but more often includes scattered *Tournefortia* trees. Often it is accompanied by *Lepturus*, *Portulaca*, or *Boerhavia*, or any combination of these. *Sida* associations may grow on either gravel or sand, rarely on broken coral. An extensive aspect of it is on found sandy stretches, usually on the lagoon sides of the broader islets, occupied by shearwater burrows. Here the *Sida* is usually mixed with one or more of the herbaceous species. Large areas of *Sida* shrubland were common on Kamwome and Sibylla Islands, it being the dominant type on the former.

Sida often grades imperceptibly into a bunch-grass savanna with one or both species of *Lepturus*. In its more luxuriant aspects grass-savanna occurs on sand and is also occupied by shearwater burrows. On thin gravel deposits on rock, or on recently available gravel habitats it is very sparse, composed usually of very small tufts of grass.

The limits between this and the remaining type, a pioneer community of *Portulaca lutea*, are hard to define. In sandy places on the lagoon side, especially around reentrants, and on rubble or even pure broken coral, *Portulaca* may exist in pure stand. Everywhere it tends to grade into the *Lepturus* type. At rocky sites, or even some sandy ones, *Portulaca* may form a sparse ground cover under *Sida* shrub and *Tournefortia* forest. It is usually sparse, under any circumstances, and does not completely cover the ground.

A prominent feature of the atoll landscape is open broken coral, usually the tops of boulder ridges or boulder flats, commonly on the seaward side or on the north ends of islets, absolutely devoid of macroscopic vegetation. This is a blue-grey colour, due to the presence, in the surface of the limestone, of microscopic algae. Also a prominent feature are exposures of old reef-rock, just above high tide level, on both seaward and, especially, lagoon sides. These, and the upper sand areas are also coloured blue-grey, by microscopic algae.

The vegetation of the shallow edges of the lagoon is, so far as observed, sparse nodular lithothamnion (encrusting fragments of coral, shells, etc.) and patches of *Caulerpa*. In the passages, also, *Caulerpa*, *Lithothamnion*, and *Turbinaria* occur.

4.1.3. Avian and Terrestrial Fauna

The bird fauna of Taongi is perhaps the most important feature of the atoll from the standpoint of preservation of natural diversity. The incredible abundance of sea and shorebirds present may be some indication of the prehistoric conditions on the other atolls, before human settlement and its impact. Indeed, the survey results of the seven atolls visited generally supports the view of Fosberg (1988) that a negative correlation exists between the abundance of birds and the presence and proximity of humans on or near atolls and atoll islets.

Amerson (1969) reports some twenty-six species of birds as being recorded from Taongi atoll (see Appendix 2). These include 19 seabirds, 5 shorebirds, 1 duck and 1 heron. Twelve of these are known breeders. 6 others are possible breeders, 6 migrants, one at-sea visitor and one accidental visitor.

Of these, 20 species were observed during the survey and one, an albatross (*Diomedea nigripes*) was seen at sea on the passage north to the atoll. The number of species observed and their general abundance was greater on Taongi than any other atoll visited resulting in it being rated highest in the comparative index of bird diversity and abundance prepared for each atoll (Appendix 6).

The breeding status of the Brown booby (*Sula leucogaster*) previously considered a possible breeder, was confirmed by the sighting of adults and chicks on the southern ocean side of Sibylla islet. In addition to the Brown booby, other species observed nesting during the survey included the Red footed booby (*Sula sula*), Great frigate bird (*Fregata minor*), Red tailed tropic bird (*Phaethon rubricauda*), Sooty tern *Sterna fuscata*, White tern (*Gygis alba*) and Brown noddy (*Anous stolidis*). A feature of note was the variation of the age of the young (from eggs to nearly full grown juveniles) which suggested a fairly long or continuous breeding season takes place on the atoll.

Birds were present in greatest densities on the three islets to the north of Sibylla; North (Kita), unnamed island No. 2, and Kamwome (see Map 2). Kamwome with some 15 species supported very large breeding populations of Red footed boobies, Great frigate birds, White terns, Sooty terns and Brown noddies. The larger birds were nesting throughout the *Tournefortia/Scaevola* and *Sida fallax* shrubland of the islet and both chicks and juveniles were evident. Red tailed tropic birds sitting on eggs were common on Kamwome and a large breeding colony of several thousand sooty terns occupied the sandy *Sida* shrubland on the north-west (lagoon shore). Another large Sooty tern colony, again of several thousand birds, was located in the sandy centre of North Islet. A feature of all three islets was the abundance of White terns numbering in the thousands. Brown noddies were also abundant and in greater numbers than the 100-200 per islet reported by previous observers (Amerson, 1969).

Sibylla islet supported large nesting populations of Red-footed boobies, Great frigate birds and White terns although the density of birds was much less than on the islets to the north. Of these, Red footed boobies and the Great frigate birds were the most obvious and spectacular, their numbers being greatest (in the thousands) on both Kamwome and Sibylla where they were nesting in the *Tournefortia*, *Scaevola* and *Sida* scrub.

A large area of apparently abandoned shearwater burrows in soft sandy soil and *Sida* scrub on the northern lagoon side of Sibylla was noted but no birds were present. This and similar areas on Bwdije, Kamwome and north islet have been reported by Amerson (1969) previously as habitat for many thousands of shearwaters. However, in this survey only a few Wedgetailed shearwaters were seen during the day on Kamwome, suggesting that the visit was very late in the shearwater breeding season.

Five of the six recorded migratory shorebirds were observed. Except for the Pacific reef heron (*Egretta sacra*) numbers of all species were generally lower than those reported by previous observers.

Other terrestrial fauna encountered included the Polynesian rat (*Rattus exulans*) which was observed only on Sibylla, particularly in the large abandoned shearwater burrow area (at least a dozen observed in daylight). The atoll still appears to be free from other more aggressive species of rats which is of great significance to its future as a bird breeding ground. However, the possibility of future ship wrecks or human visitation leading to the establishment of a population of *Rattus rattus* poses a great threat to the future of the atoll against which every possible precaution must be taken if the decimation of these spectacular bird populations is to be guarded against. A small lizard (*Cryptoblepharus boutonii poecilopleurus*) was common and several were collected for further identification. Large hermit crabs, mostly *Coenobita perlata* are common along with other unidentified insects and small terrestrial arthropods.

4.1.4. Cultural/Archaeological Resources

The survey represented the first time an investigation into the cultural and archaeological resources of the atoll had been undertaken. While it is understood that the atoll has traditional significance as a resource gathering (particularly sea birds) area controlled by the Irooj laplap for the northern Radak chain, no traditional Marshallese remains were identified. This was not surprising as the atoll has a harsh, desiccating climate, lacks significant sources of potable water and the islets, with the exception of Pokak islet, lack soil development.

However, four historic era sites were identified:

- A. Small homestead/camp with upright coral slab alignments, tin roofing and historic bottles situated at south end Kamwome islet.
- B. Possible rubble of wooden frame buildings and/or remains of wooden ship wreck along east-central (ocean) shoreline of Sibylla islet.

C. Recent grave site on south-central (ocean) shoreline of Sibylla islet. This grave was found in association with the battered hull of a 17 ft. skiff later determined to have been lost off Hana, Maui in the Hawaiian islands in February 1979. Human remains from the grave site have since been identified as those of one of the missing Hana fisherman (see Map 2).

D. Remains of a small Japanese WWII communication outpost along south, west-central, and center of Pokak (Taongi) islet.

In addition, there are at least two old, badly broken and weathered wrecks on the ocean side of Sibylla islet and the recent 1986/7 Japanese longliner wreck on the north-east reef (see Map 2). A large amount of unexploded WWII ordnance was encountered around the old Japanese outpost site.

4.1.5. Reefs and Corals

Until this survey little was known of the coral and other marine fauna of the atoll although the unique reef structure had been noted by C.G. Johnson and F.R. Fosberg in their 1952 visit (Fosberg, 1955; 1957 (a); 1965). The reef systems of Taongi and Bikar atoll to the south, are unique in the Marshall Islands in that they almost completely encircle the atoll, have only one very narrow pass and have an unusual 'stepped' windward reef structure with an elevated lagoon and elevated sloping leeward reefs. Lagoon waters are shallow, with depths not exceeding 100 ft (30 m), and the higher lagoon water level, sometimes up to 3 ft (1 m) above ocean water levels is maintained at a constantly high level by the influx of wind driven waters over the windward ocean reef. Unable to escape easily due to the lack of reef channel the water rushes out of the lagoon through the narrow winding channel creating pressure waves of up to 3 ft (1 m) and making small boat passage hazardous except for the short slack tide period. Water also flows like a waterfall over the coral covered rim and flats of the sloping leeward reef (see Appendix 9). The lagoon itself has a fine sediment bottom with many coral heads and patch reefs, some reaching to the surface. Another unusual feature was the presence of overhanging ribbon reefs in the lagoon, probably due to the stable elevated lagoon levels and dampened tidal effects. Algal ridge lines the outer edge of the windward east and north-east reef while the south and west reefs are narrower and coral covered.

After surveying the corals at 20 different stations (see Map 2 and Appendices 10 and 11), it was considered that the coral fauna, although healthy, was generally depauperate with species diversity low. Several genera common elsewhere in the Marshalls were missing suggesting some geographic isolation of the corals with the rest of the Marshall Islands. However, this is to be expected and is due to the geographic position of the atoll and its great distance from nearby reefs, and the isolation of the lagoon from other habitats. One unusual feature was the presence of shallow-water beds of the hard, pink, fan coral *Stylaster* sp. Seven of the surveyed sites were considered to have exceptional reef or faunal features (Map 2 and Appendix 3).

4.1.6. Marine Fauna

Throughout the survey particular emphasis was given to assessing marine turtle breeding activity and *Tridacnid* clam population status. Despite a great abundance of smaller clam species (*Tridacna maxima*, *Tridacna squamosa*, *Hippopus hippopus*) there was a total lack of giant clams (*Tridacna gigas*) at Taongi. No dead giant clam shells were observed. The abundance of smaller clam species at Taongi was greater than that reported at any of the other atolls and reefs visited during the survey (see Appendix 4).

Along with the absence of giant clams was a total absence of any marine turtle nesting activity (nests or tracks) on the atoll islets nor were turtles seen in the surrounding waters. Although the time of the visit coincided with the latter part of the summer breeding period, on the evidence of activity at Bikar and other atolls it would be reasonable to assume that any turtle activity on Taongi would have been noticed. The absence of marine turtles is also consistent with Fosberg's observations from his 1950's visit.

The reef fish population is dominated by Lethrinids, Scarids and *Lutjanus fulvus*, and is relatively low in diversity. However, the species present were extremely abundant and of large size. An interesting feature of the reef fish population at Taongi (as with the corals) is the evidence of a definite faunal break with the rest of the Marshall Islands. Noticeable was the absence of *Lutjanus bohar*, *Lutjanus gibbus*, leopard groupers (genus *Plectropomus*) which are all dominant apex carnivores throughout the rest of the Marshall Islands. A similar break in coral fauna is apparent from several missing coral genera noted above. Characteristic for the northern limit of their range, large individuals of the moray eel, *Gymnothorax javanicus*, were present at Taongi but were not recorded at the other atolls visited. Grey reef sharks (*Carcharhinus amblyrhynchos*) were very abundant at the ocean drop off on the west side of the atoll. This species and sharks in general were more abundant at Taongi than any other atoll surveyed.

Gastropod molluscs (cowries, cones, lambis etc.) were generally lacking although smaller bivalves were present. No top shell (*Trochus*) were found. Finally there were no marine mammals seen in the lagoon or the surrounding ocean waters.

4.1.7. Discussion

Although it exhibits less diversity in terms of the numbers of species present (except for birds) than other atolls in the Marshall Islands, Taongi clearly has unique and important features which give it great value for resource conservation and protection. Foremost amongst these is its virtually undisturbed, pristine state. It is rare in the world today to find a completely natural, unaltered atoll ecosystem and Taongi, with its isolation and treacherous access protecting it from the impact of visiting yachts and fishing boats, may be the best remaining example of an undisturbed semi-arid atoll in the world.

Taongi is certainly unique within the Marshall Islands. Although comprising only nine species of flowering plants its vegetation is pristine, completely free of any exotic plants. The *Tournefortia*, *Scaevola*, *Sida* dominated shrublands and the sandy bunchgrass savanna (*Lepturus* spp.) represent the finest examples of such vegetation types adapted to dry atoll conditions in the Marshalls and probably the entire Pacific region.

In terms of its natural diversity, the outstanding feature of Taongi is the birdlife and seabird rookery. The sheer number of birds of different species is breathtaking, especially the large Great frigate birds and Red footed boobies which exhibit a remarkable docility born of minimal contact with humans. Numbers of Great frigate birds together with Brown and Masked boobies (*Sula dactylatra*) far exceed those encountered on any other atoll. As a seabird rookery Taongi is clearly the largest and most important of its kind in the Marshall Islands. It is of regional and international significance both as a bird breeding ground and as a refuge for migratory shorebirds.

The atoll exhibits unusual and unique characteristics in its reef and shoreline formations and water circulation. These features, developed over millennia, are dependent on the maintenance of the natural ecological processes of the atoll and especially its oceanography. The ecological balance of the entire atoll could easily be disturbed or destroyed by ill-conceived development action such as dredging or blasting to create new channels, or widen the existing one, or implementation of the waste disposal proposal discussed below.

The marine environment has many features of interest not the least being the bio-geographical significance of the definite faunal break noticeable in both the corals and fish. The abundance of reef fish and smaller species of *Tridacnid* clams suggests the atoll also has an important role to play as a resource sanctuary or gene pool although it is interesting to note the absence of both marine turtles and giant clams.

The natural values which commend Taongi for protection also reduce its potential use for other human activity, particularly development. Its isolation, the harsh, dry environment, difficulty of access and lack of water continues to render it unsuitable for human habitation as has obviously been the case for thousands of years. Similarly, the tourist potential of the atoll is severely limited by these factors and particularly the lack of safe boat access and anchorage. Indeed, any human boating activity in or on the atoll brings with it the threat of rat liberation which would, if a breeding pair or pregnant female established on the atoll, have a catastrophic effect on the bird population, further reinforcing the appropriateness of a protective status.

This discussion would not be complete without comment on a proposal to use Taongi as a site for dumping unspecified wastes from the US mainland and to build a town, resort and golf course on the resulting landfill which was reported in the local newspaper several days prior to the survey term's departure.

At best, this proposal is ill-conceived and poorly researched. In the view of the survey team any proposal to ship wastes from the US mainland to a remote atoll like Taongi is suspect, purely on economic grounds unless perhaps those wastes are hazardous in nature and unable to be disposed of in the US. If this is the case it would be inconceivable that the US would allow their shipment to the Marshall Islands, already environmentally and socially devastated by US nuclear testing, or that the Marshall Islands Government would accept them. Indeed, as the first nation in the Pacific to sign and ratify the influential regional Convention for the Protection of the Environment and Resources of the South Pacific (the SPREP Convention), the Marshall Islands Government should be anxious to ensure the protocol against dumping of wastes in the region is not contravened in its waters.

Aside from the economic and legal issues affecting this bizarre proposal, a number of practical problems would need to be overcome. These include the present lack of large ship access to Taongi lagoon, the high frequency of cyclonic storms, the inadequacy of potable water, and the atoll's isolation. The environmental impact of such a proposal would devastate Taongi Atoll which can be considered the ecological 'jewel' in the crown of northern Marshall Islands atolls. Ship access would require extensive blasting of the reef, resulting in lowering of average lagoon water level with the subsequent killing of all leeward and ocean reef flat communities. These alterations of the delicate water flow balance between reef and lagoon which has evolved over millennia would, in large part, destroy the unique, perched lagoon and stepped reef system. Alteration of these marine characteristics together with the land disturbance created by humans and their machines, would drastically change the ecology of the atoll and lead to the total devastation of the magnificently abundant populations of seabirds and marine species occurring at present.

The proposal to convert the filled lagoon area to a settlement for Marshallese and tourists, complete with golf courses, is incomprehensible given the depth of the lagoon, the expected deterioration and settling of dumped refuse and the isolated exposed nature of the atoll which is clearly ravaged frequently by tropical storms. If this project were to proceed it would result in the loss of a unique national asset and the destruction of a natural habitat of regional and global bio-geographical significance. For these reasons, the survey team strongly urges that the proposal be opposed both by the Marshall Islands Government and concerned international conservation agencies and that dialogue be opened with the project proponents to ensure they are aware of the likely environmental impact of their proposal on this globally and nationally significant resource.

Similarly, there has surfaced a proposal to develop a resort hotel complex "somewhere" in the Radak chain by a combination of anchoring a floating hotel in a lagoon plus increasing land area by coral reef dredging and creation of fill for golf courses and supporting infrastructure. Taongi should not be considered as a candidate site.

4.1.8. Recommendations

Insofar as adoption of the following recommendations may impact on the traditional rights of Atoll landowners and resource users, their involvement and concurrence will be essential for protected area programme implementation.

1. That Taongi Atoll and its surrounding ocean waters be designated as a National Preservation Area for the purposes of protecting in perpetuity and in an undisturbed state, the entire atoll environment including its land and marine habitats, species diversity, ecological associations and ecological processes.
2. That all visitation to the atoll be prohibited except for purposes of authorised surveillance, scientific study, ecological monitoring and education.
3. That the introduction and spread of exotic flora and fauna, especially rats, be prevented through control of human access, ecological monitoring and the elimination as far as possible of any introduced exotic species.
4. That fishing boats, yachts and other unauthorised vessels be expressly excluded from approaching within 10 miles (16 km) of the atoll and that such a provision be included in all fishing licences and charts issued or approved by the Government of the Marshall Islands.
5. That in view of its national, regional and international importance as a unique undisturbed natural environment, the Government of the Marshall Islands oppose the proposal to convert Taongi Atoll to a waste disposal site, location for resort development, or dredging and enlargement of the existing channel for boat harbour development and appraise the traditional atoll owners and project proponents of the likely adverse environmental impacts of these proposals.
6. That in the long term and following establishment of the Preservation Area, consideration be given to its nomination together with Bikar Atoll as a World Heritage Site under the UNESCO World Heritage Convention.
7. That potentially dangerous unexploded ordnance and other debris associated with the WWII bombing of the Japanese communication outpost on Pokak islet be removed by appropriate experts.

4.2. BIKAR ATOLL

4.2.1. General Description

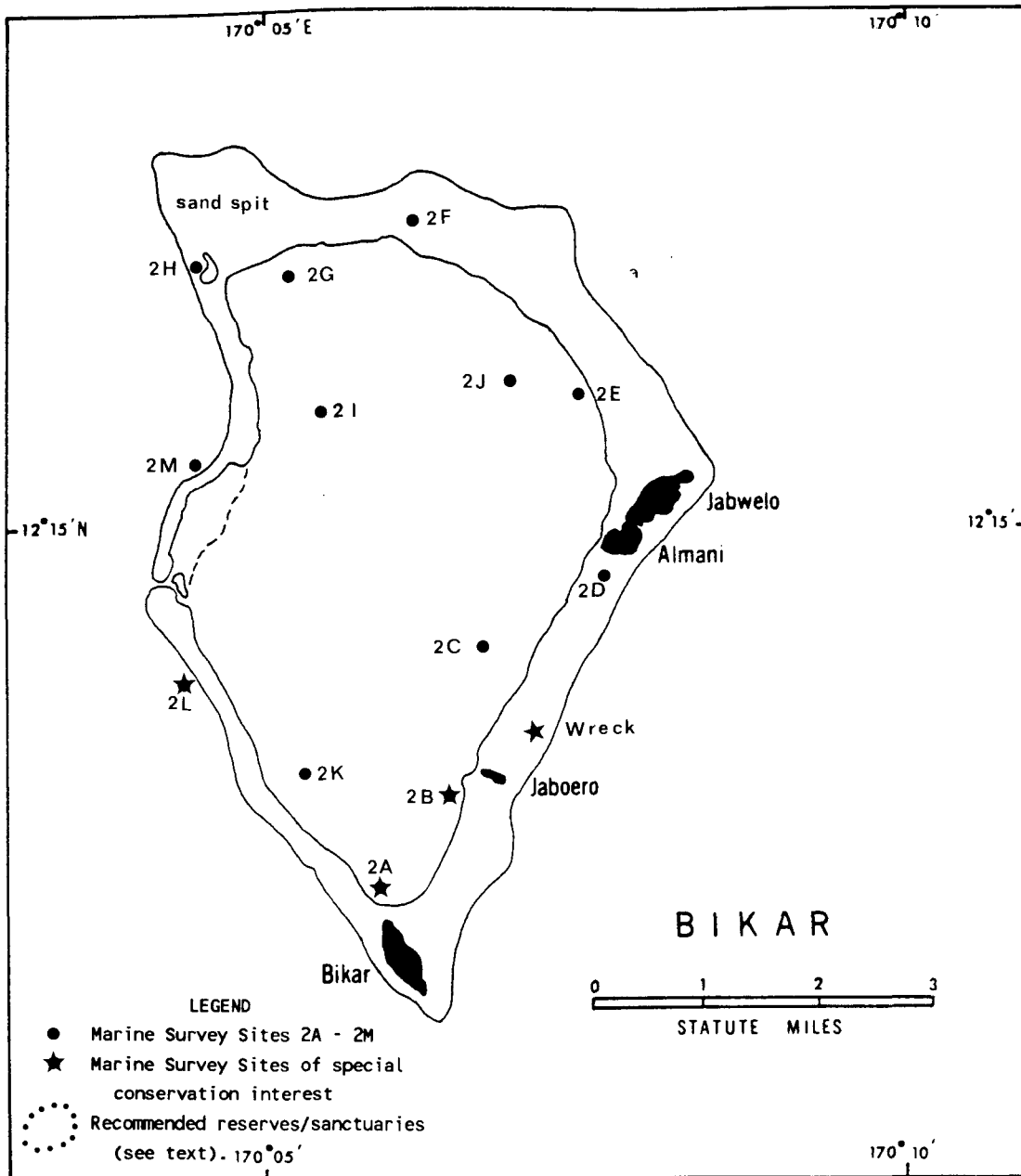
Visited on 12/13 September 1988, Bikar (12°15' N, 170°07'E) is the second-most northern atoll of the Marshall Islands and lies some 200 miles south of Taongi. The atoll is oval in shape, 7-8 miles (11-13 km) long, 4-5 miles (6.5-8 km) wide and its long axis orientated north/south. In many respects it is similar to Taongi. The reef is almost fully circumferential and is broken only by one narrow forked passage on the western side. A large patch reef isolated in the fork of the pass on the lagoon side and several coral heads are present in the passage itself. At ebb tide the out-flowing current makes passage difficult and hazardous for small outboard powered skiffs and impossible for larger vessels. There are five distinct islets although with the inclusion of exposed reef areas at low tide seven or eight can be identified.

The largest islet Bikar, is oval shaped with a large expanse of sand and beach on the northern end and extensive reef flats to the south and south-west. The centre of the islet is relatively high at 15-20 feet (4.5-6.0). Jabwelo and Almani, the second and third largest islets respectively, are separated only by a narrow channel at low tide and have more exposed aspects with extensive reef flats on their eastern shores. Jaboero, the smallest islet, is a simple sand/gravel cay of only 6-10 ft (2-3 m) elevation.

Although moderately dry, Bikar receives more rainfall than Taongi and has a more luxuriant and scenically attractive appearance because of the *Pisonia* forests on the three main islets. A feature of the soils of the islets is the presence of a thick layer of raw-humus over phosphate hard pan characteristic of the Jemo soil series which builds up under *Pisonia* forest. Biogeographically the atoll is linked to the islands of the Radak chain to the south rather than the dryer Taongi to the north.

However, the reef geomorphology at Bikar is closest to that of Taongi and Wake Atoll (to the north). Bikar is uninhabited but is visited occasionally by the Marshallese. Traditionally it is under the control of the Iroij lap lap of the northern Radak chain and has been regarded as a reserve for birds and turtles. These could be taken, after proper ceremonies, on one visit a year. As with Taongi, the relative isolation of Bikar and the difficulty of access have served as protection from human disturbance over the years.

MAP 3



Source: Adapted from Amerson, A.B. 1969

4.2.2. Vegetation

Previously only nine species of plants are recorded from the atoll (Fosberg, 1988):

| | |
|---------------------------|------------------------------|
| <i>Pandanus tectorius</i> | <i>Portulaca lutea</i> |
| <i>Lepturus repens</i> | <i>Triumfetta procumbens</i> |
| <i>Cocos nucifera</i> | <i>Tournefortia argentea</i> |
| <i>Boerhavia repens</i> | <i>Scaevola sericea</i> |
| <i>Pisonia grandis</i> | |

All except *Pandanus tectorius* were observed during the 1988 survey with *Triumfetta* being very rare (Appendix 7). Bikar, Jabwelo and Almani are each recorded as having dense, healthy *Pisonia* forests covering much of their interior. However the survey revealed that these forests were devastated by a cyclone some time since 1978 when they appeared still intact in aerial photos.

On Bikar the *Pisonia* forest included trees 60 feet (18 m) tall. Most of these larger specimens had been uprooted or broken off at the base or mid trunk by the wind, and lay in disarray. The *Pisonia* forest is surrounded by a narrow zone of *Tournefortia*. Small wind sheared *Pisonia* survives behind the *Tournefortia* on the relatively sheltered south and south-west side of the island. Few of the downed trees or their limbs have rooted, most being dead or partially decayed. *Tournefortia* is invading the devastated areas and young trees 6 feet (2 m) tall are scattered throughout. Several of the mixed age *Cocos* trees planted on the north side of the islet were also uprooted. Little ground cover persists on Bikar and even *Portulaca*, *Lepturus* and *Boerhavia* are uncommon.

On Jabwelo, an estimated 80-90% of the *Pisonia* was devastated with many fallen trees littering the centre of the islet. Completely open, it had a dense growth of *Boerhavia* covering or growing around the rotting fallen logs. Some *Pisonia* remained on the north-eastern (ocean) side where it was protected by a narrow fringe of *Tournefortia*. A few isolated *Pisonia* trees remained, nearly all along the margin of the forest. A dense pure stand of *Portulaca* ringed by a dense growth of *Lepturus* covered the large sand apron to the south of the islet.

An estimated 60-70% of the *Pisonia* forest on Almani islet was destroyed. Some large trees (40-45 feet) (12 - 17 m) remained but there is little regeneration of the forest occurring. *Tournefortia* shrubs were growing in the open devastated areas.

Jaboero islet, the smallest, supports only *Portulaca lutea*. There is no vegetation on the small sand cay to the north-west.

4.2.3. Avian and terrestrial fauna

Twenty-three species of birds are listed by Amerson (1969) of which 19 were observed during the survey (see Appendix 2). The 1988 survey probably took place after the main breeding season as there was a lack of nesting activity and chicks except in the Sooty tern colony on Jabwelo. Of the atolls visited during the survey Bikar rated second only to Taongi in terms of bird diversity and habitat importance (Appendix 6). Previous observers had sighted large numbers of Great frigate birds and Red footed boobies on all three main islets and these birds are the main large nesting birds on the atoll. Two flocks of 200+ mixed Frigate birds and Red footed boobies (mainly Frigates) were observed at dawn over Bikar islet. 50-100 Frigate birds were observed circling Jabwelo and 50 over Almani. Red footed boobies dominated the nesting birds with an estimated 500-1 000 on Bikar, 250 on Jabwelo and 150 on Almani. Although still abundant, these numbers appear to less than those recorded previously, perhaps due to the destruction of the *Pisonia* forests.

Another large sea-bird which occurs in relatively abundant numbers is the Red tailed tropic bird seen in flocks of 20+ on Bikar and Jabwelo and in smaller numbers on Almani. However, White tailed tropic birds (*Phaethon lepturus*) recorded as being present in large numbers in April and May of 1964 and 1967 (1 000+) were not common with only 3 birds being observed (one on a nest). The reduction in numbers may be related to *Pisonia* forest destruction. Masked boobies were present on all islets but not common. Brown boobies were common but in considerably lesser numbers than recorded in 1964 or 1967 e.g. only 50+ on Bikar, 20-50 on Jabwelo, 20 on Almani as opposed to 200+ in 1964 and 600+ in 1967.

Of the smaller resident breeding birds, White terns were the most common, numbering in the thousands for the atoll. Brown noddies were also abundant on the three main islands with perhaps 1 000 for the atoll. The numbers of these species were in keeping with those observed in 1967 (Amerson, 1969).

In past surveys, very large numbers (thousands) of Sooty terns were observed in rookeries on Jabwelo (35 000, 1967) and Almani (17 000, 1967). These numbers have declined greatly and only one small rookery (500-800 birds) was observed on the sand apron at the south-west end of the island with none sighted at all on Almani.

Migrants common to these islands; the Ruddy turnstone (*Arenaria interpres*), Wandering tattler (*Heteroscelus incanus*), Bristle thighed curlew (*Numenius tahitiensis*), Lesser golden plover (*Pluvialis dominica*) and Pacific reef heron are present in small numbers.

Other fauna noted were small skinks and Polynesian rats, the latter being common on Bikar and Jabwelo.

4.2.4. Cultural/Archaeological Resources

Although occasionally visited by the Marshallese, there is little possibility of intensive traditional use because of the dryness of the atoll and its susceptibility to cyclone and storm disturbance. No archaeological remains were identified and the atoll is ranked last of those visited in terms of its importance for historic preservation.

4.2.5. Reefs and Corals

The reef morphology of Bikar is very similar to that of Taongi with a continuous circumferential reef broken by a single narrow channel, unique stepped windward reefs, high lagoon water levels and elevated leeward reefs which slope seaward and lagoon ribbon reefs. The narrow channel makes access very difficult and at times hazardous, especially at ebb tide when the outflowing current becomes very strong and lagoon water level is 1.5 ft (0.5 m) higher than the ocean. The lagoon is relatively shallow with fine bottom sediments and the occasional coral head.

The coral fauna is generally depauperate and shows signs of frequent storm damage (see Appendices 10 and 11). Although the corals are not considered unusual for this habitat, it is interesting to note that Bikar contained several genera which were not reported for Taongi, providing further evidence of the bio-geographical isolation between these atolls. Three of the sites surveyed were considered to have exceptional features worthy of protection (see Map 3 and Appendix 3).

4.2.6. Marine Fauna

The most significant feature of Bikar from the point of view of its conservation value was its obvious importance as a Green sea turtle (*Chelonia mydas*) nesting ground. Over 264 sets of nesting tracks were observed around the perimeters of Bikar (176), Jabwelo (74), Almani (14) together with numerous new and old nest sites. Being late in the summer and on an undisturbed atoll, it is likely that the tracks observed would be those accumulated over at least a month, possibly longer. These tracks made Bikar the highest ranking atoll of those surveyed for Green turtle nesting (see Appendix 4). Although no turtles were seen on land a pair of large Green turtles were observed mating from the survey ship on the ocean side of the channel. One set of fresh tracks on the north east side of Bikar islet were only about 1.5 ft (0.5 m) wide, and were probably made by a Hawksbill turtle.

Although no giant clams were found, smaller clam species were very abundant, particularly *Hippopus hippopus* and *T. maxima*. Of the atolls surveyed Bikar ranks second only to Taongi for abundance of the smaller clam species (see Appendix 4). A large mound of dead *Tridacna* sp. shells were found in the lagoon off Jaboero islet, indicating human harvesting activity from an anchored small boat.

Fish species diversity was much greater than Taongi (Appendix 4) and the highest of all the atolls surveyed. *Lutjanus bohar*, *L. gibbus*, Leopard groupers, humphead parrot fish (*Bolbometapan muricatus*) were present at Bikar but all were absent at Taongi. These species indicate a distinct faunal break, at least in fish fauna, between Taongi and the rest of the Marshall Islands.

Although gastropod molluscs are uncommon, small bivalves including the black-lip pearl oyster were fairly common. The top shell *Trochus* was found at 3 of the 13 stations surveyed. No marine mammals were seen in the vicinity of the lagoon.

4.2.7. Discussion

As with Taongi, the natural diversity of Bikar Atoll, in terms of species numbers, is relatively low in comparison to other atolls of the Marshall Islands. Like Taongi, Bikar has the rare distinction of a virtually undisturbed, pristine natural environment due mainly to its isolation and hazardous access. These factors, together with its inhospitable climate and the frequency of tropical storms and cyclones, render it unsuitable for human occupation or development and has tended to ensure the protection of its natural diversity over the years.

However, Bikar atoll differs from Taongi in several important respects. Foremost of these is the presence of Green turtles not found at Taongi. This species utilises the sheltered waters and *Tournefortia* fringed, sandy beaches of the atoll islets for nesting. The level of breeding exceeds that recorded on other atolls in the Marshall Islands. The quality of habitat on Bikar, together with the isolation of the atoll and the lack of human interference, combine to make the atoll an outstanding Green turtle nesting area of national (and possibly international) significance.

Unfortunately little is known of the status and distribution of green turtles in the Marshall Islands, this being a subject which requires further research. However, it is not unreasonable to assume that the population is in general decline as is the case in the rest of the Pacific and globally. This trend is brought about largely by increased hunting pressure from growing human populations together with habitat destruction or modification. The widespread protection of the turtles and their breeding habitat, especially the latter, has become absolutely essential if they are to survive. In the Marshall Islands turtle nesting activity at Bikar atoll was much greater than on any atoll surveyed, clearly justifying its protection solely on these grounds.

However, Bikar has other important conservation values. It is a bird rookery of considerable importance ranking second only to Taongi in terms of species diversity and abundance with 13 species confirmed as resident breeders (three others as probable breeders). The numbers of Great frigate birds and Red footed boobies present on Bikar were not encountered on any of the other atolls visited except for Taongi. Great Frigate birds in particular, were noticeably less common on the atolls to the south and west of Bikar. This was also the case with most of the other breeding species recorded on Bikar (and Taongi) with the possible exception of White terns and Brown noddies. Thus Bikar complements Taongi as an undisturbed breeding refuge for the sea-birds of the Marshall Islands and because of its more southerly location, probably plays a more important role as a breeding centre of bird distribution for the rest of the Marshall Islands.

Although the vegetation of Bikar lacks the number of distinct semi-arid associations found on Taongi and has lost substantial ecosystem biomass with the recent loss of the mature *Pisonia grandis* forest, it is still, by Pacific atoll standards, relatively undisturbed by invasive exotics. The destruction of the *Pisonia* forest (doubtless a natural periodic event) and its subsequent regeneration or replacement by other species is of considerable scientific interest and should be the subject of further study.

The bio-geographical importance of Bikar is revealed in its marine environment which was studied for the first time by the survey team. The presence of fishes and corals common to the rest of the Marshall Islands but absent from Taongi, indicates a definite faunal break between the two atolls. Unusual reef formations similar to those at Taongi and not represented elsewhere in the Marshalls (except at Namorik Atoll) are present and their protection is paramount if the sensitive ecological balance of the atoll is to be maintained. The exceptionally large population of several different small clam species underscores the potential of these undisturbed atolls as 'resource banks' where habitat protection will ensure the protection of species which may well be lost to the Marshall Islands and the Pacific region in the future through over-exploitation and habitat destruction.

In summary, Bikar Atoll has unique natural features which justify its formal protection, the most important being its outstanding turtle nesting habitat. The protection of Bikar as a National Preserve would complement the diversity of species and habitat protected in Taongi, and would ensure that a significant proportion of the range of habitats and natural diversity represented in the northern Marshall Islands was under the same category of protection. Most importantly, it would ensure the ongoing protection of the single most important Green turtle nesting site in the Marshall Islands.

4.2.8. Recommendations

Insofar as adoption of the following recommendations may impact on the traditional rights of Atoll landowners and resource users, their involvement and concurrence will be essential for protected area programme implementation.

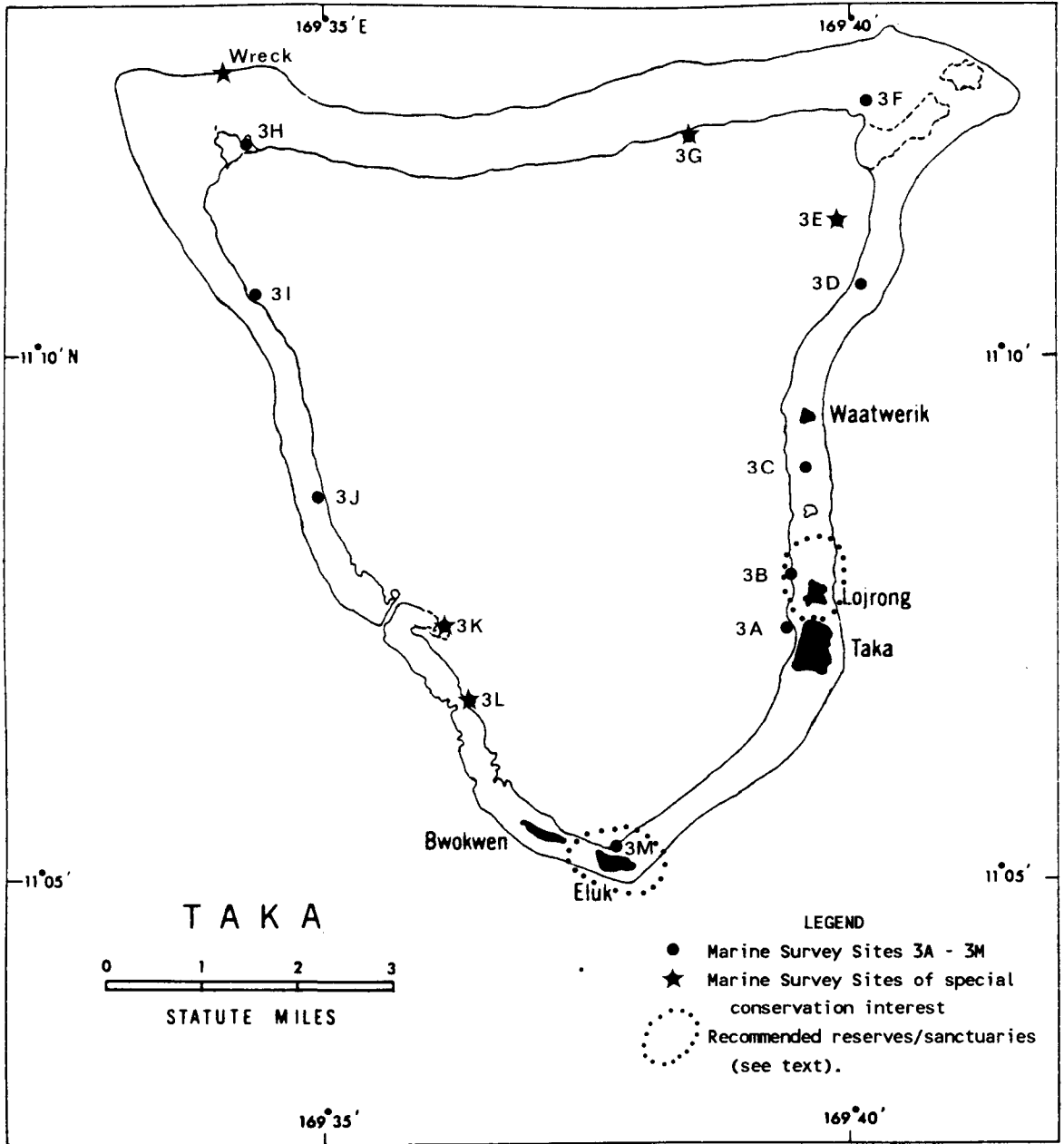
1. That Bikar Atoll and its surrounding ocean waters be designated a National Preservation Area for the purposes of protecting in perpetuity and in an undisturbed state, the entire atoll environment including its land and marine habitats, species diversity, ecological associations and ecological processes.
2. That all visitation to the atoll be prohibited except for purposes of authorised surveillance, scientific study, ecological monitoring and education.
3. That the introduction and spread of exotic flora and fauna, especially rats, be prevented through control of human access, ecological monitoring and the elimination as far as possible, of any introduced alien species.
4. That fishing boats, yachts and other unauthorised vessels be expressly excluded from approaching within 10 miles (16 km) of the atoll and that such a provision be included in all fishing licences and charts issued or approved by the Government of the Marshall Islands.
5. That no dredging or enlarging of the existing channel be undertaken in order to avoid catastrophic kills of all lagoon and leeward ocean reef flats.
6. That special consideration be given to the conservation of Green turtle (*Chelonia mydas*) habitat and the protection of this and other marine turtle species within the Preservation Area including the monitoring of the breeding population as part of a broader marine turtle conservation programme for the Marshall Islands.
7. That the natural succession or recovery of the *Pisonia grandis* forests on Bikar, Jabwelo and Almani islets be monitored.
8. That in the longer term and following establishment of the Preservation Area, consideration be given to its nomination, together with Taongi, as a World Heritage Site under the UNESCO World Heritage Convention.

4.3. TAKA ATOLL

4.3.1. General Description

Taka Atoll (11° 07'N - 169° 46'E) was visited 14-15 September 1988. The atoll is small, roughly triangular in shape, 9 miles (14 km) long (north-south) and 9 miles (14 km) wide (east-west) at the widest points. Its lagoon area is approximately 36 square miles (94 km²) there are six distinct islets, the largest being Taka, approximately 0.5 mile (0.8 km) long and 0.25 mile (0.4 km) wide. The highest elevation is approximately 15 feet (4.5 m).

MAP 4



Source: Adapted from Amerson, A.B. 1969

Taka Atoll is scenically very attractive. The islets have beautiful reefs, white sand beaches and luxuriant vegetation including coconut palms (on Taka islet). The clear aquamarine waters of the lagoon are encircled by the extensive reef system which is broken by a wide pass suitable for the passage of larger vessels. The lagoon affords safe anchorage and has an open tidal flushing and circulatory pattern typical of most of atolls in the Marshall Islands.

Climate is moderately dry with 60-70 inches (1520-1780 mm) of rainfall annually. Mean temperature is approximately 82°F and the prevailing wind is from east to north.

Soils on the ocean side of the islands above the reef generally consist of coral rock and rubble, beach rock and some sand, and on the lagoon side, sandy beaches with some coral rock outcrops. Interior soils on Taka include the sandy Shioya series, and a black soil. Jemo series soils are found on Lojrong islet. Although uninhabited, Taka is located only 6 miles south-west of the inhabited atoll, Utirik. People from Utirik visit several times a year to fish, harvest copra (Taka islet) and to gather birds and eggs.

4.3.2. Vegetation

All but two of the 23 plant species reported from the atoll by Fosberg (1988) were located during the survey (Appendix 7). The most luxuriant vegetation on the atoll is found on Taka Island. Here an abandoned coconut grove planted in 1951 dominates about 1/3 of the islet with mixed native species covering the rest. Within the coconut grove, in places where the canopy is closed, a dense, pure stand of *Phymatosorus* with fronds 12-18 in (30-45 cm) tall forms the ground cover. In more open areas, patches of *Boerhavia* spp. intermixed with *Lepturus*, *Laportea*, *Eragrostis* or *Digitaria* are found. The rest of the island interior is vegetated with a dense stand of mixed forest comprised mainly of *Guettarda*, *Pisonia*, *Pandanus*, *Tournefortia* and *Morinda*. The coastal fringes are dominated by dense cover of *Scaevola*, *Tournefortia*, *Pisonia* and *Guettarda*, (*Pemphis* and *Suriana* are also locally common).

On Lojrong islet sixteen plant species were present. The interior of the islet is vegetated by a low *Pisonia* forest with a ground cover of mainly *Boerhavia* and *Lepturus*. The south end of the islet consists of a sand spit vegetated by *Scaevola*, *Tournefortia* and *Suriana* and a dense stand of *Portulaca*, the latter being a nesting ground for Sooty terns. The ocean side is dominated by a dense fringe of *Scaevola* backed by *Terminalia samoensis* and the western side by mixed *Tournefortia*, *Scaevola*, *Terminalia* and *Pisonia* with *Suriana* common at the southern end.

The two other principal islets, Wotwerok and Eluk, have similar associations. However it is noteworthy that on Eluk islet, the generally open *Tournefortia* forest with *Pisonia*, *Scaevola* and a ground cover of *Portulaca*, *Boerhavia* and *Fimbristylis* extends to the vegetation line and no fringe association occurs. Generally the diversity of plant species on Taka is considered low, but the mixed broadleaf forest type developing on Taka islet is of potential scientific interest.

4.3.3. Avian and Terrestrial Fauna

The atoll was ranked third of the atolls visited for bird species diversity and abundance. Nineteen species of birds had been previously recorded for Taka Atoll and fourteen species were observed. The sighting of a White tailed tropic bird was a new record for the atoll (see Appendices 2, 6).

After visits to Taongi and Bikar Atolls, a noticeable feature of the avifauna of Taka Atoll was the generally lower numbers of larger resident breeding birds, e.g. Red footed boobies, Brown boobies and Great frigate birds. Nevertheless, the abundance of these species encountered on this survey represented a significant increase over the very low numbers observed by expeditions in 1964 and 1967 and together with the abundance of several other species, suggests a trend towards bird population recovery might be taking place.

Eluk islet appeared to be the centre of roosting and breeding activity on the atoll for most species with the exceptions of Sooty terns and Crested terns (*Thalasseus bergii*). For example, a flock of sixty Great frigate birds were seen circling over Eluk Island on arrival representing the largest number of this species ever recorded for the atoll and certainly a considerable increase over the fourteen birds seen in 1967.

An estimated 75+ Red footed boobies including sub-adults were present on Eluk islet compared to only 25 observed in 1967. This islet also hosted Brown boobies in small numbers (30+). Large numbers of White terns and Brown noddies were also present as was a colony of twenty-seven nesting Red-tailed tropic birds with chicks and juveniles.

A vast Sooty tern colony with an estimated 10 000+ birds present was located on the north, south and west of Lojrung islet. A large number of chicks were observed and eggs were so thick on the open sand and gravel that care was needed with every footstep. Another small Sooty tern colony (300+) is located at the south end of Waatwerick (Waterok) islet which also hosts a small breeding colony of 50+ Great crested terns.

Taka Islet itself was devoid of significant numbers of birds with the exception of White terns and Brown noddies, a reflection perhaps on the frequency of human visits as evidenced by a semi-permanent shelter and cooking pits on the northern beach. Other species of fauna sighted included large green tree geckos (*Lamprolepis* sp.), Polynesian rats and blue tailed skinks (*Emoia* sp.).

4.3.4. Cultural/Archaeological Resources

Although most of the islets were visited by the archaeological team, most effort was concentrated on Taka Island on the assumption that the largest islet would yield the most significant cultural information. In fact, the remains of a semi-permanent or permanent pre-modern (pre 1900) settlement were identified on Taka, located along the lagoon side of the islet. Sub-surface testing of one site suggested that a relatively thin (to 40 cm below the surface) cultural deposit may be located in this area. Radio-carbon dating samples were taken and results revealed human occupation or presence on the atoll sometime during the period 1415-1640 A.D. No other cultural remains were identified and the social and cultural significance of the site remains unknown.

4.3.5. Reefs and Corals

The reef and lagoon characteristics of Taka Atoll are more typical of the rest of the Marshall Islands than those of Taongi or Bikar. A deep wide pass on the western (leeward) side of the reef provides safe vessel access to the sheltered anchorages of the lagoon and several smaller passes are also present on the western reef. These facilitate a normal flushing and circulatory pattern for lagoon waters. General reef development is good and a high diversity of habitats and species are found in the lagoon (see Appendices 10 and 11). Natural features which enhance the lagoon habitats include broad corner reefs well flushed by wave action; the flushing effect and tidal currents of the passes; ocean reef slopes with calm waters protected from north-east waves and storms and southerly storm waves; the presence of well flushed pinnacles in the lagoon; and reef rims not degraded by island derived sediments. Four sites were identified as having special features worthy of conservation (Appendix 3 and Map 4).

4.3.6. Marine Fauna

Although there was evidence of Green turtle nesting on Taka (24 sets of tracks) and a Hawksbill turtle was sighted underwater at marine station 3-F, the atoll is ranked only as of intermediate importance for turtle breeding (see Appendix 4). Of the 24 sets of turtle tracks, Take had 16, Lojrong had 4 and Eluk had 4. The presence of large numbers of dead and some live giant clams apparently decimated by an overseas fishing boat about five years previously was noteworthy. The need to provide protection for the remaining giant clams was obvious.

The diversity of reef fish species was considered normal for such an atoll. Fish were abundant but signs of fishing pressure were obvious. As with most of the uninhabited atolls surveyed, of particular abundance were large schools of Scarids (parrot fish). Gastropod molluscs were much more abundant here compared to the northern atolls of Taongi and Bikar. Top shell (*Trochus*) were found at only two of the thirteen marine stations surveyed. No marine mammals were sighted either in the lagoon or in the surrounding ocean.

4.3.7. Discussion

Taka Atoll does not have the unique and outstanding features of its northern neighbours, Taongi and Bikar, the exception being the presence of giant clams. However, Taka possesses a diverse range of habitats representative of those found on many of the Marshall Islands. The reefs, coral gardens, clear lagoon waters, white sand beaches and vegetation covered islands combine in a physical environment of considerable natural interest and great aesthetic beauty. A diverse range of species - corals, breeding seabirds, green turtles, reef fishes, giant and small clams and coconut crabs all contribute to the natural diversity of the atoll.

Traditionally, Taka has been a 'pantry' atoll for the people of nearby Utirik who harvest the birds, fish, turtles and clams several times a year. Unfortunately, the survey team was unable to discuss the significance of Taka as a source of subsistence resources with the Utirik people. However, relatively recent campsites indicated continuing human visitation and some populations (e.g. reef fish and clams) showed signs of harvesting pressure. The future value of Taka as a 'pantry' will depend on effective sustained yield management of the most preferred resource species and particularly those now exhibiting signs of depletion. Clearly some resources can be harvested on a sustainable basis without detriment to the natural diversity of the atoll while others, (e.g. giant clams, turtles and sea-birds) must be carefully conserved and any harvesting strictly controlled within a framework of monitoring and management control. Declaration of this atoll as a National Park would provide appropriate habitat and species protection while allowing controlled resource harvesting under the provisions of a management plan based on a comprehensive scientific assessment of sustainable exploitation levels.

The diversity of Taka's natural resources and the overall high quality of its environment offers considerable potential for environmental education purposes, as well as the possibility of small scale tourism.

Although the people of Utirik and the Iroij-laplap have not been queried on their interest in promoting the tourist and educational potential of Taka, both activities would be compatible with the 'National Park' designation. In fact, Taka is well suited to such uses and with careful planning, sensitive development and good park management it is likely that small scale-low impact tourism based on locally owned accommodation at Utirik Atoll would be viable. International tourists or Marshallese visitors could be taken to Taka on day or overnight trips from Utirik necessitating little need for substantial accommodation development in the park itself. Good planning and management of the park is essential if this concept is to be developed as the success of such a venture would depend on the protection of the environmental resources on which it is based. Utirik also has a airstrip allowing potential park visitors to access Taka via boat from nearby Utirik, thus precluding the need for airstrip development of Taka.

In addition to its tourist potential, the Taka Atoll National Park could provide educational opportunities for young Marshallese, particularly those from urban centres who have little chance to experience the rich natural diversity and beauty of an undisturbed atoll environment. Regular field trips by school children to the park could be a feature of the environmental education curriculum and would be subsidised directly by the Government and/or from revenue earned from park visitor fees, which could also go towards offsetting park management costs and providing revenue for landowners.

Designation of the Taka Atoll National Park would provide employment and training opportunities for one or more young persons, preferably from Utirik, as local conservation officers. Similar indirect local employment opportunities based on the National Park will arise from the influx of visitors should tourism and educational use of the park be successfully developed.

4.3.8. Recommendations

Insofar as adoption of the following recommendations may impact on the traditional rights of Atoll landowners and resource users, their involvement and concurrence will be essential for protected area programme implementation.

1. That Taka Atoll and its surrounding waters be declared a National Park for the purposes of protecting and conserving in perpetuity, for the benefit, enjoyment and use of the Marshallese people, the natural environment, scenic beauty, ecological associations and ecological processes of the atoll.
2. That a Taka Atoll Conservation Committee with majority representation from the Utirik community and Taka landowners and including representation from appropriate government agencies, be established to guide park establishment, management, planning and policy.
3. That where compatible with the overall park objectives, provision be made for the controlled, sustained harvesting of subsistence resources using traditional means, by the Utirik people.
4. That to the extent compatible within the overall park objectives, provision be made for the promotion of education, tourism and recreation activities.
5. That all activities likely to disturb the archaeological sites of Taka islet be prohibited until such time as full subsurface archaeological investigation has been carried out and the extent and significance of the site determined.
6. That Eluk and Lojrong islets be accorded special protection either within the park, or until the park is established, as a Wildlife Sanctuary, with all harvesting and disturbance of the bird population prohibited.

7. That nesting Green and Hawksbill turtles and giant clams be fully protected.

4.4. JEMO Island

4.4.1. General Description

Jemo Island sits on a table reef formation lacking a lagoon or protected reef environment. This probable fragment of a former atoll lies at 10° 06'N, 169° 30'E about 27 miles (43 km) south-west of Ailuk Atoll. It was visited on 16 September 1967. Its mostly subsurface reef extends about 5 miles (8 km) to the north-east. The island is oval in shape, about 3/4 mile (1.2 km) long, and reaches an elevation of 30 feet (10 m). The only landing site is a relatively dangerous and exposed reef flanked beach on the south-west of the Island.

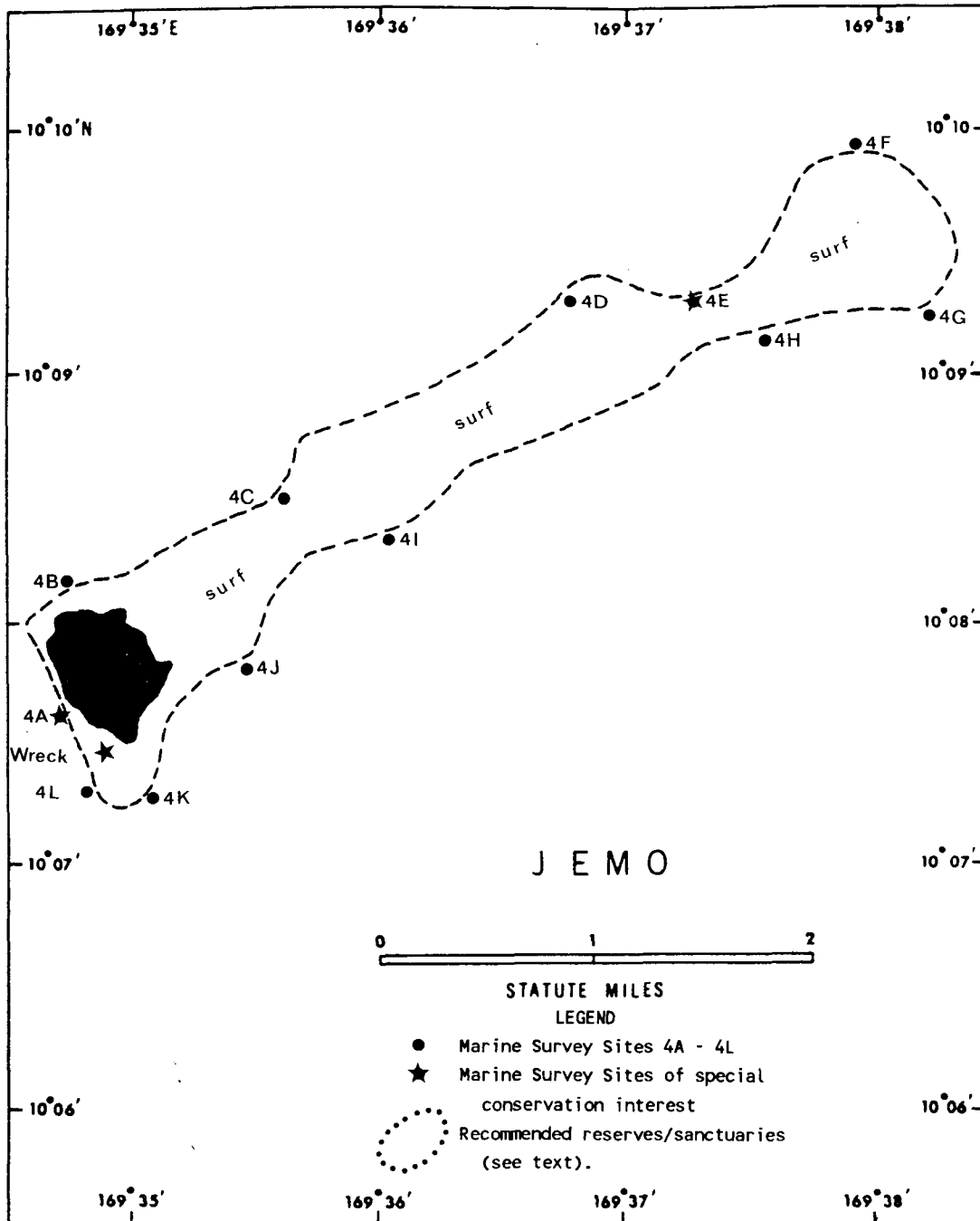
The atoll is normally uninhabited but visits, probably of several weeks duration, have taken place to harvest the coconuts planted around 1900 by Likiep islanders. A deteriorating frame house, copra shed and water tank built in 1951 for the copra harvesters is located in the interior of the island, north-east of the landing beach. In pre-European times Jemo was considered a bird and turtle sanctuary and was visited infrequently under the supervision of priests for the harvest of limited numbers of turtles and eggs (Fosberg, 1988).

The climate of Jemo is moderately wet with 70-80 inches (1780-2030 mm) of rainfall annually. Mean annual temperature is around 82°F and the prevailing wind is north-east. The beaches are white sand with some rocky outcrops and fine examples of beach rock (dipping seaward) are found around almost the entire island and particularly the north-east shoreline. The island is well known as the benchmark for the phosphatic Jemo soil series described earlier in this report.

4.4.2. Vegetation

Thirty-eight species of plants have been recorded for Jemo, approximately half of which are aliens indicating the generally disturbed nature of this ecosystem. Five new species were recorded by the survey, three of which were native and two aliens (see Appendices 7 and 7 (a)).

The vegetation of the island interior is dominated by the coconut plantation now comprised of mainly old, unattended trees. A few other trees, mainly *Pisonia*, are scattered throughout and both the ground and many trees are covered with vines. *Canavalia* is extremely abundant and intermixed with *Ipomoea macrantha*. Open spaces can have dense stands of *Boerhavia*, *Phyllanthus*, *Lepturus*, or *Physalis*.



Source: Adapted from Amerson, A.B. 1969

A narrow strand of vegetation fringes the island, chiefly *Tournefortia*, *Scaevola* and *Pisonia* with *Cordia* on the south-west side, and some *Terminalia* mostly on the north or north-east side. It is interesting to note that the many weeds recorded by Fosberg in 1951 (Fosberg, 1955) around the copra house site are now gone, probably outcompeted by *Canavalia*.

4.4.3. Avian and Terrestrial Fauna

Ten of the fourteen species of birds recorded for Jemo were observed during the survey (Appendix 2). White terns and Brown noddies were the most abundant species (1 000+ birds). Red footed boobies were relatively common with 35 observed circling at one time but numbers are estimated to be well below the 1-2 000 observed in 1964 and 1967 respectively. A few Brown boobies were present but Great frigate birds were not observed. The island ranked fourth among the atolls (and island) surveyed in terms of avifauna diversity and abundance (Appendix 6).

4.4.4. Cultural/Archaeological Resources

A major archaeological site was identified atop and on a sandy soil berm 9-10 ft (3 m) in height inland of the main boat landing area and near the recent copra processing area. A dense scattering of indigenous Marshallese artifacts (pearlshell fishing lures) were found and collected for further identification. A single test pit excavation identified an in situ cultural deposit extending 30-36 in (80-90 cm) below ground surface.

Although the extent of the site is unknown at this time it is probably the most important single site identified during the field survey, suggesting a possible special single function (pelagic fishing) camp/settlement. No other such traditional Marshallese sites have been previously identified nor studied in the Marshall Islands. The island was ranked third in terms of its importance for historic preservation (Appendix 5).

4.4.5. Reefs and Corals

A most interesting feature of Jemo Island is the extensive elongated table reef reaching approximately 5 miles (8 km) to the east-north-east. This is probably a remnant atoll reef. The island shoreline and reefs are very high energy zones subject to strong wave action and wave driven rip currents. A strong drift to the north exists along the reef. Spurs and grooves cross in the path of these currents and the combination of current and waves makes boat landings across the reef hazardous in all but the calmest weather.

With the general absence of protected reef areas near the island, coral communities and species diversity are impoverished (see Appendices 10 and 11). In fact, only 40 per cent (approximately) of the coral species and genera found elsewhere during the 1988 expedition were noted here. However, at a relatively sheltered station well out on the elongated table reef, the presence of rich coral associations with good diversity was noted. Two sites were identified as being worthy of special consideration for conservation (Appendix 3).

Although the Jemo table reef lacks a true lagoon reef facies, the long south-east facing axis is clearly more depositional, with gravel, some sand and rubble deposits accumulating at the base of massive buttresses and canyons. In contrast the north-west facing long axis of the reef showed signs of scour and exposure to heavy waves. Few corals showed relief of more than 1-2 ft (0.5 m) on the outer reef margin, further evidence of control by the forces of large waves.

4.4.6. Marine Fauna

The high energy nearshore environment noted above and the lack of protected reef areas contributed to a generally low level of reef fish species diversity. However, there was a great abundance of certain reef fish e.g. large snappers (*Macolor niger*, *Lutjanus bohar*), Scarids, and black ulua (*Caranx lugubris*), while Grey reef, Black and White tipped sharks were common on the outer reaches of the table reef.

Macro-invertebrates were rare, probably due to the high energy environment, and no *Tridacna* sp. of any species or *Trochus* were found.

The most significant marine species occurring Jemo Island is the Green turtle. Fifty-three pairs of turtle tracks were counted around the shoreline and signs of nesting activity were prevalent with one nest containing fresh eggs being discovered. This level of activity was second only to that on Bikar Atoll (see Appendix 4) of the atolls surveyed and indicates that this small island is a valuable and prominent green turtle breeding ground for the Marshall Islands. Signs of recent harvesting of Green turtle was evident.

4.4.7. Discussion

The most significant conservation features of Jemo Island are its importance as Green turtle nesting site and the potential value of its previously unknown cultural and archaeological resources.

The high ranking ascribed to the island as a Green turtle nesting site, together with its close proximity to the inhabited atolls of Likiep, Ailuk and Wotje, suggest that it is an important centre of nesting activity for the turtles found migrating through these waters. Our survey found evidence of frequent human visitation and turtle/egg foraging on Jemo. Continued and unrestricted human interference with turtle breeding activities at key locations such as this will only hasten the decline of the marine turtle population throughout the Marshall Islands. It is imperative, if overall turtle stocks are to be maintained or improved, that important nesting areas such as Jemo and Bikar receive formal, supervised protection.

The discovery of archaeological remains on Jemo Island could add significantly to our understanding of pre-history Marshallese culture. Although the extent of the site is unknown, it has probably been used as a transient or semi-permanent fishing camp of a type not previously studied in the Marshalls. Evidence of some recent site disturbance due to pedestrian traffic along the berm was a point of some concern and it is important that future site disturbance be kept to a minimum. Further archaeological investigations should take place to assess the full extent and significance of the find. All artifactual remains from these investigations should eventually be returned to the Marshall Islands and could possibly be used to support educational or tourist displays on Marshallese culture in Majuro or on neighbouring Likiep or Ailuk Atolls.

Aside from its value as marine turtle habitat and as an important cultural/archaeological site, Jemo Island is not considered outstanding in terms of its natural diversity and the quality (degree of disturbance) of its ecosystems. Although close to Likiep and Ailuk Atolls, both of which have airstrips and presumably some tourism potential, Jemo island is generally unsuited to tourist visitation or development for human use because of the hazardous, uncertain access.

4.4.8. Recommendations

Insofar as adoption of the following recommendations may impact on the traditional rights of Atoll landowners and resource users, their involvement and concurrence will be essential for protected area programme implementation.

1. That Jemo Island be designated a Wildlife Sanctuary for the protection of marine turtles and their habitat.
2. That a research programme into Green and other marine turtle nesting activity on Jemo Island be developed and implemented as part of a broader marine turtle research and conservation programme for the Marshall Islands.
3. That disturbance of the archaeological site area be prohibited and access to the island be restricted to authorised persons until a systematic archaeological (surface and subsurface) investigation is completed.

4. That a systematic investigation of the surface and sub-surface archaeological and cultural sites on the island be designed and implemented in conjunction with the Alele Museum, Marshall Islands.
5. That any artifactual remains from the investigation in 3 and 4 above be returned to the Alele Museum, Majuro for use for public education or tourism displays in Majuro or on Likiep or Ailuk atolls.

4.5. WOTHO ATOLL

4.5.1. General Description

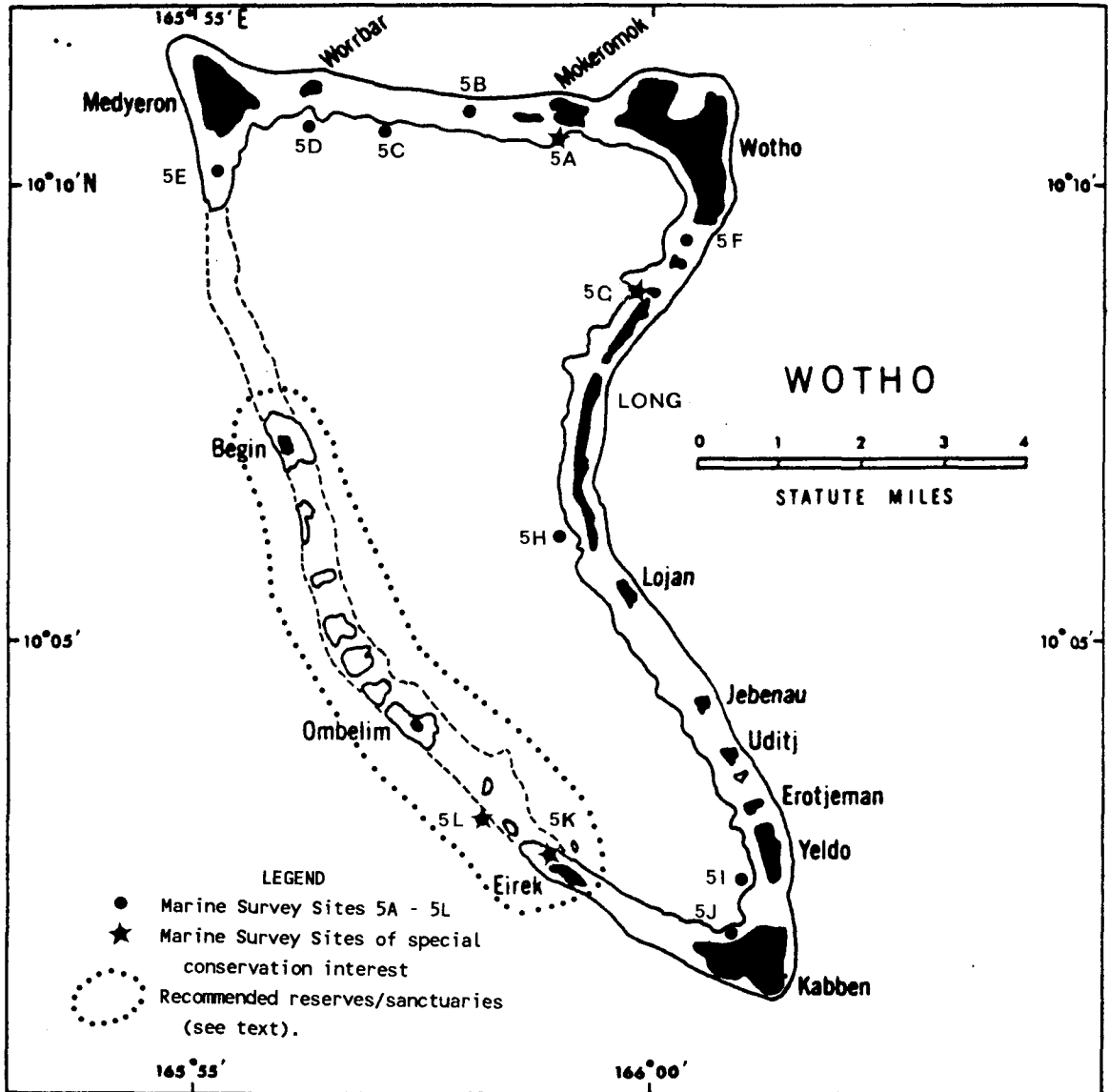
Wotho Atoll was added to the survey itinerary after failure to obtain landowner approval for visiting uninhabited Ailinginae Atoll. Wotho Atoll (10° 6'N, 165° 59'E) lies in the Ralik chain of the Marshall Islands and was visited on 18-19 September at the invitation of the Wotho Atoll Local Council. With a population of about 100, it was the only inhabited atoll to be surveyed. The atoll itself is an irregular triangular shape, 11 by 9 miles (19 by 14 km) and has some 18 islets, mostly on the east reef (Map 6). There is a wide but shallow pass on the west reef. Unlike most of the atolls surveyed Wotho has a considerable land area of 1.60 square miles (4.1 km²), and although only one of the eighteen islets is populated it retains substantial natural biodiversity.

Its climate is moderately wet with about 70-100 inches (1780-2540 mm) of rainfall per annum. Mean temperature is around 82°F and the prevailing wind is from east to west.

The lagoon shores of the islands are dominated by beautiful white sand beaches which at times take on a pinkish hue. The beaches often grade to a low broad sand ridge and are frequently lined by beach rock dipping lagoonward. The seaward shorelines are more diverse and can consist of boulder beaches and broader boulder flats. The interior soils of the islets commonly comprise a fine grey silty material (organic) with occasional admixtures of coral gravel or rubble of ranging sizes. Well-developed peat/humus soils are often encountered under *Pisonia* forests.

The atoll is a fine example of the scenic beauty often ascribed to such places. Like Taka Atoll, the white sand beaches, aquamarine lagoon waters and lush green vegetation all combine to produce a "tropical paradise". Wotho islet has the added attraction of a cultural landscape formed around an immaculately tidy traditional village and highly sculpted taro gardens in the interior.

MAP 6



Source: Adapted from Amerson, A.B. 1969

4.5.2. Vegetation

The wet climate of the atoll has resulted in the presence of many more species and more diverse ecosystems than on the dryer, less disturbed atolls at the northern end of the group. The atoll has the greatest species diversity of those surveyed; 60 species of which 40 are native and 20 alien (Appendix 7). Fifteen new atoll records were established of which 4 were native species (Appendix 7 (a)). Not all the islets were able to be visited in the time available. However, the following general descriptions of the vegetation types on a several of the surveyed islets provide an indication of the botanical character of the atoll.

Wotho Islet, which is the largest on the atoll and location of the settlement, is heavily disturbed, particularly in the northern part where clearing for houses, coconuts, agriculture and a new landing strip have significantly altered the character of the vegetation. In the village, ground cover of *Vigna*, *Lepturus*, *Thuarea*, *Eragrostis*, *Frimbristylis*, *Cassytha*, *Canavalla*, *Ipomoea* etc. is present. A small patch of *Cyrtosperma* was planted in a rough garden area near the village. Most of the garden had reverted to *Clerodendron*, *Wedelia* and *Cocos* with some *Paspalum* and *Cyperus odoratus* observed. Fosberg (1988) reports that in 1952 the centre of the island was a series of long winding troughs and ridges, most likely ancient taro pits. Many breadfruit trees were present and the pits were dense tangles of *Clerodendrum*, *Vigna*, *Wedelia*, *Canavalia*, *Ipomoea* and young *Pandanus*. Also reported was an enormous area of almost pure *Neisosperma* forest, 40-50 ft (13-15 m) tall with a complete canopy. The existence of this forest in 1988 was not verified. On the exposed open areas of Wotho islet where sandy soils/boulder flats prevail, the vegetation generally consists of mixed association of *Scaevola*, *Guettarda*, *Suriana*, *Tournefortia*, *Pisonia* and *Soulamea*. Ground cover in these areas is generally *Lepturus*, some *Fimbristylis* and *Cassytha*.

Bokonaetok (Long islet), a long narrow sand islet has *Scaevola* and *Tournefortia* co-dominant on the ocean side with the occasional *Pandanus*, *Cocos* and *Suriana*. Lagoon-side vegetation included these species with the occasional *Pisonia* and rare *Cordia*. Kabben islet, the second largest on the atoll, has similar lagoon-side fringe vegetation of *Scaevola* and *Tournefortia* with *Guettarda* and *Terminalia* occasionally intermixed. Vines of *Canavalia* and *Ipomoea macrantha* cover the vegetation. Ocean side fringe vegetation is mostly an open *Scaevola* dominated shrub association. *Tournefortia* is common as is *Cassytha*. Stunted *Guettarda* and *Terminalia* are occasional and scattered throughout. Ground cover is very sparse; mainly *Lepturus* and *Wedelia* with occasional *Boerhavia*. The interior of Kabben islet is an old coconut plantation now invaded (or present as remnant patches) by other often vine covered trees; *Guettarda*, *Pisonia*, *Tournefortia*, *Pandanus*, *Morinda* and *Neisosperma*.

The smaller Eirek islet has very similar associations: on the ocean side is an open *Scaevola* association with *Tournefortia* and *Cassytha* and infrequent ground cover of *Lepturus* or *Wedelia*. *Guettarda* and *Terminalia* are sometimes present but occur more frequently further inland. A second main association occurs inland of that described above and comprises less *Scaevola*. *Guettarda*, *Pisonia* and *Cassytha* are more common and the ground cover also includes *Boerhavia repens*. On the lagoon side the main vegetation species are *Pisonia*, *Cocos* and *Terminalia*.

4.5.3. Avian and Terrestrial Fauna

Prior to the survey fifteen bird species were known from Wotho Atoll. The survey documented one previously unrecorded species, the Red footed booby and observed thirteen other species (Appendix 2). Two fledgling Great crested terns were spotted on Ombelin islet indicating this species is breeding on the atoll. Similarly, two Black naped terns (*Sterna sumatrana*) terns with one juvenile were observed on Begin islet. Birds in general were not abundant especially on populated Wotho islet. White terns and Brown noddies were the most common of the smaller birds and Brown boobies (70+) were the most abundant of the large seabirds. Few Red footed boobies and only two Great frigate birds were observed in contrast to Fosberg's observation of over 100 frigate birds roosting on Ombelin islet in 1952. Migrant shorebirds, Lesser golden plovers, Bristle thighed curlews, Ruddy turnstones, and Wandering tattlers were all present in low numbers.

Clearly the close proximity of the settlement of Wotho is a factor inhibiting the value of the atoll as bird habitat. Of the islets surveyed, Begin had the greatest number of bird species (9), with numbers in comparative abundance. The islet was relatively undisturbed and also contained a fine stand of natural *Pisonia* forest which enhanced its value as habitat. It would be desirable to see this island protected as a local bird sanctuary.

Of the other animal species present the coconut crab is the most important. Coconut crabs are regularly eaten by the Wotho islanders and up to 500 per annum are taken for this purpose with foraging trips taking place almost every week for the few months of the year when fuel supplies are available for the atoll's one outboard powered boat (N. Nashon, Mayor per. comm.). At the time of the visit no trips had been made since February 1988 (6 months) due to a lack of fuel. Very few large crabs appear to remain on the atoll although one such crab 2-3 kg in weight, was caught by a Marshallese survey team member on Kabben islet which appears to host the main crab population. Several smaller crabs of up to 1 lb (500 gm) were observed on the south side of the island.

It is known that the growth rate of these crabs is very slow; 12-15 years to reach 9 cm carapace size and 30 years or more to become a large crab (Fletcher, R.W. 1988). Population recruitment rates are generally very low. The obvious implication of continued harvesting and slow growth rates is a depleted resource characterised by smaller sizes and fewer adults. Judging from the few large crabs observed it would appear that there is cause for concern for the future of the coconut crab populations on the atoll. Other species present included skinks, geckos and Polynesian rats.

4.5.4. Cultural/Archaeological Resources

Wotho Atoll is a place of high traditional and social status in the Marshall Islands; the name means "old place" and indicates the traditional Marshallese assessment of the atoll. In keeping with this background it was not surprising that the survey discovered extensive pre-modern (pre 1900) and probably prehistoric (pre 1800) remains on Wotho and Kabben islets. The atoll is ranked highest for historic preservation of the atolls visited (Appendix 5).

These locations are considered to be of very high archaeological research potential. This is especially so when one considers the close proximity of Bikini Atoll where the earliest (to 1900 B.C.) yet identified cultural deposits in Micronesia have been found. It is not unreasonable to assume that similar deposits may be present on Wotho.

Probable prehistoric cultural remains (both surface and sub-surface) are present on Wotho islet inland of the village through the centre of the island and along the lagoon shoreline. The centre of Kabben islet is another promising location. On Kabben the probable remains of a chief's house, paved and lined walkway and a cemetery as well as an extensive village settlement (including 37 house sites) were located. Several Marshallese artifacts were recovered from the surface in this area.

Time and logistical constraints precluded the archaeological sampling of the sub-surface deposits on Wotho Atoll. However, probable cultural deposits inspected and viewed on Wotho islet within existing rubbish pits, planting holes and fresh water wells suggest the cultural deposits may extend to 3 ft (1 m) or more beneath the present ground surface.

A rare traditional Marshallese ocean-going sailing canoe was beached near the village on Wotho islet. This represents a significant cultural resource in itself as the canoe is over 40 years old and the ability to build such vessels is fast becoming a lost skill in Marshallese society. Virtually all remaining traditional canoes are of smaller size for restricted (lagoon) use. The Wotho ocean canoe should be restored and placed under shelter where it could become a point of great interest to visitors to Wotho, and the younger generation of Marshallese.

4.5.5. Reefs and Corals

The reef configuration of Wotho, with at least two wide passes and broad corner reefs, is typical of the configuration of most Marshall atolls. The reefs are picturesque and easily accessible. They contain a large variety of habitats, and the corals show moderate to high diversity (see Appendices 10 and 11). Three of the 13 stations surveyed were notable for coral communities of high diversity, the presence of giant clams, and high fish diversity (Appendix 3). Another had interesting transitional features within the coral community from the lagoon to the pass. Generally, the corals and reefs were in very good condition and as discussed later, would prove to be safe and important attractions for visitors to the atoll seeking recreational snorkeling or diving experiences.

4.5.6. Marine Fauna

The reef fish populations showed signs of regular fishing pressure with abundance generally low, particularly in the northern part of the atoll, relative to numbers observed on the uninhabited atolls. Still there is high diversity of species, and fish are plentiful with many large specimens present.

The numbers of giant clams observed at Wotho exceeded those seen on any other atoll - 15 live and 16 dead compared with 5 live and 27 dead on Taka, the second ranked atoll in terms of giant clam abundance (see Appendix 4). This was a little surprising as local sources informed the survey team that large numbers of giant clams had been harvested by a Taiwanese fishing vessel eight years previously. However, it was also revealed that the Wotho islanders (and Marshallese generally) do not normally harvest this species, preferring the smaller *Tridacna* species for food. Also, apart from the one isolated but devastating incident mentioned above, the presence of inhabitants obviously discourages poaching. Despite recording the highest abundance of living clams the almost 1:1 ratio of live to dead giant clams on Wotho indicates the vulnerability of such a population to exploitation, even on a 'one time' basis occurring several years previously. It was noticeable that there were fewer of the smaller clam species tending to confirm that these are locally preferred to giant clams.

Green turtles nest on Wotho but low in numbers. A total of eight pairs of tracks were observed (see Appendix 4) and one female green turtle was taken from Long islet on 18 September by the crew and villagers after it had laid its eggs. Pairs of tracks were found on Begin islet (4), Kabben islet (2), and Long islet (2). Turtles are harvested infrequently with 'several' being taken from the outer islets each summer (N. Nashon pers. comm.). Indications are that the local people are very conscious of the vulnerability of the nesting turtle population and limit their harvesting activities accordingly.

4.5.7. Discussion

Although inhabited, Wotho Atoll has a remarkable range of intact natural habitats representative of many of the central atolls of the Marshall Islands. Natural diversity is relatively high (compared to the dryer northern atolls) and the presence of Coconut crabs, Green turtles, giant clams and many species of seabirds on this one atoll is notable. The beautiful reefs are easily accessible and comprise many rich and diverse coral communities and habitat for a wide variety of reef fish. Islets with white sand beaches and verdant vegetation contrast with the changing colours of the clear lagoon waters giving the atoll environment great scenic beauty very similar and equal to that of Taka Atoll.

The presence of the traditional and largely subsistence community of Wotho with its immaculate village, adds a special cultural dimension to the environment obviously missing from the uninhabited atolls visited. Indeed, under the stewardship of the Wotho islanders, the environment in which they live has been well cared for and has natural and cultural qualities of special interest, particularly to tourists and Marshallese visitors from more urban settings.

It was therefore co-incidental to learn from the Mayor that the people of Wotho are interested in the development of tourism on their atoll. Clearly the atoll is very well suited to such activity providing the scale of the operation is kept small, is locally controlled, and the tourist activities are low key and of low impact, culturally and environmentally.

The atoll is now well served by air and sea access and this will greatly facilitate any tourism development. An appropriate scale of development for Wotho would be 3-6 thatched cabins constructed primarily of local materials with sewage, running water, electricity and ceiling fans. A central cook house/dining room would also be necessary. Desirably, such a complex would be located on a beach front site (lagoon side) but far enough away from the village to buffer the local people from the constant attention of the visitors and vice versa.

Initial demand for this accommodation would clearly come from the heavily populated Kwajalein Atoll (both US base personnel and local Marshallese from Ebeye) and from Majuro. Assistance for the venture could come from a variety of sources - the government, through Air Marshall Islands (AMI), which would be the principal carrier and could promote the scheme either on behalf of the Wotho owners, or as a minority joint venture partner. The Office of Outer Island Affairs, Ministry of Resources and Development could also assist and at the regional level, the Tourism Council of the South Pacific, based with the South Pacific Bureau of Economic Co-operation in Suva, Fiji, could help with planning and financing this venture and a similar one for Taka.

Principal tourist activities would be relaxation, snorkeling, diving, picnicking and day-long nature trips to the outer islets to view bird and turtle nesting and the cultural remains on Kabben Island. Other experiences would include the local culture and traditional ocean lore using the large canoe as a focal point. Visits would probably be only of 3-4 days duration.

In addition to its obvious tourist potential, the atoll has the natural environment and cultural resource base suitable for use as a location for education activities, particularly if a decision to proceed with the building of small scale accommodation is taken. Wotho would be of particular value for senior school level studies of atoll ecology and village lifestyles, and would be an important cultural experience for many Marshallese children who have grown up on Ebeye or Majuro. Indeed, the possibility of an annual field trip for outstanding students drawn from the main Marshall Islands schools, as suggested for Taka Atoll, should also be investigated here. Such a trip could be subsidised by AMI from some of the profits or tax revenues of operating the tourist transport to Wotho in conjunction with the Department of Education and the proposed Conservation Service (see Part III) as part of their environmental education programme.

The increased activity described above would inevitably place additional pressure on the natural resources and environment of the atoll. This would occur primarily in the form of additional harvesting of fragile resources such as the coconut crab, turtles and clams to provide 'local' specialities on tourist menus and from disturbance of habitats and species (especially birds), through increased human visitation to otherwise largely undisturbed outer islets. The presence of the tourist accommodation complex, although of small scale and of low impact design, would generate additional demand for water, necessitate a sewage disposal system and the disposal of additional domestic garbage. The social impact of such a venture on a largely traditional community may also be high and should be thoroughly assessed before the development proceeds. In particular, the introduction of alcohol to a 'dry' atoll and the allocation of jobs and revenues within the local community will require close scrutiny.

One mechanism for maintaining both the natural diversity of the atoll and controlling the impact of visitors is to establish a National Park over the atoll excluding Wotho islet. Management of the park would take place within the framework of a management plan developed in conjunction with the local community.

Establishment and planned management of the atoll as a National Park would ensure the protection of habitats and species, control over visitor activities and the managed harvesting of vulnerable resources such as clams, coconut crabs etc. on a sustainable basis. The preservation of cultural/archaeological resources would also be provided for.

An important function of the National Park is to educate and inform visitors about the park's natural environment and cultural resources. A park at Wotho would provide many opportunities for the explanation of the ecology of an atoll environment and the habitats and species to be found there. Wotho Atoll also represents an excellent opportunity for developing cultural resources for both tourist and educational purposes. The archaeological and cultural sites on Kabben could be interpreted for visitors and students and aspects of the modern village lifestyle and Marshallese culture could be the subject of special visits and lectures. For example, in addition to being very scenic the interior portions of Wotho islet could be recultivated for taro in the traditional manner for tourist and educational purposes and integrated into a programme emphasising traditional Marshallese technology such as *Tridacna* adze tool manufacture and canoe building. At least, a small museum display based on the traditional canoe and artifacts discovered from the archaeological investigations could be established.

The management plan for the National Park would, in effect, become a resource management plan for the atoll generally. As such it would require intensive local involvement in its preparation. This would be assured by the establishment of a Wotho Atoll Conservation Committee comprising local personnel and appropriate government representatives. The Committee would function to oversee all policy and planning activities related to the park and its operation.

Day to day management of the park would require the appointment and training of at least one local conservation officer/park manager and possibly assistants. As park development gets underway and visitor numbers increase, further staff may be needed for park management and related employment.

Even if the park concept does not proceed it is advisable that consideration be given to the selective protection of key islets or habitats on the atoll. In particular Kabben islet should be considered for its cultural/archaeological resources and Begin and Ambelim for their vegetation and seabird breeding habitat. Protection or controlled harvesting of turtles, giant clams and coconut crabs, based on monitoring of their populations and estimated sustainable harvest should also be considered.

4.5.8. Recommendations

Insofar as adoption of the following recommendations may impact on the traditional rights of Atoll landowners and resource users, their involvement and concurrence will be essential for protected area programme implementation.

1. That with the exception of Wotho islet, Wotho Atoll be declared a National Park for the purposes of protecting and conserving in perpetuity, for the benefit, enjoyment and use of the Marshallese people, the natural environment, scenic beauty, and ecological associations of the atoll.

2. That a Wotho Atoll Conservation Committee, with majority representation from the Wotho community and landowners and including representation from appropriate government agencies, be established to guide park establishment, policy, planning and management and policy.
3. Provision be made for the controlled and sustainable harvesting of subsistence resources by the Wotho people.
4. That to the extent compatible with the overall Park objectives, provision be made for the promotion of education, tourism and recreational activities in the Park.
5. That special consideration be given to the conservation of the cultural and archaeological resources of the atoll through:
 - (a) the intensive archaeological survey and subsurface testing of all major atoll islets concentrating on Wotho and Kabben islets.
 - (b) the clearing of the Kabben islet village area, protection of the site and its interpretation as a traditional village living area.
 - (c) the restoration of the old traditional Marshallese ocean sailing canoe to its original condition for display and use as an existing example of this ancient but nearly lost art of Marshallese society.
6. That specific protection be given to the islets of Eirek, Ombelin and Begin and the intervening reef areas as representative examples of the terrestrial and marine habitats of the atoll having particular importance as bird sanctuaries for turtle nesting and as giant clam habitat, either within the National Park framework or as a Nature Reserve should the park not proceed.
7. That a research programme into the status and dynamics of Green turtle and coconut crab populations of the atoll be undertaken by the Marshall Islands Marine Resources Authority with the objective of determining the sustainable harvest of both species and appropriate species management needs.
8. That until the programme recommended in 7. above is established, the Wotho Atoll Local Council control the harvest of these vulnerable species for local consumption only.
9. That a voluntary moratorium on the taking of giant clams be introduced by the Wotho Atoll Local Council.
10. That the assistance of the Tourism Council of the South Pacific be sought by the Marshall Islands Government for a feasibility and planning study for a small scale tourism development on Wotho Atoll.

11. That an assessment of the environmental and social impact of developing a small scale, tourism venture on Wotho Atoll be undertaken by the Marshall Islands Environmental Protection Agency, in conjunction with the Wotho Atoll Local Council and villagers, before such a venture is approved.

4.6. RONGERIK ATOLL

4.6.1. General Description

Rongerik was visited by the survey team on 20-21 September. It is a medium sized, highly scenic, open atoll with a large area of approximately 70 square miles (182 km²) lying at 11° 21'N, 167° 26'E. It has 5 principal islets and a number of smaller ones well distributed around the roughly circular reef which is open to the west (Map 7).

The climate consists of a moderate rainfall of about 60-70 inches per annum, mean air temperature of 82° F and a prevailing wind from the north-east.

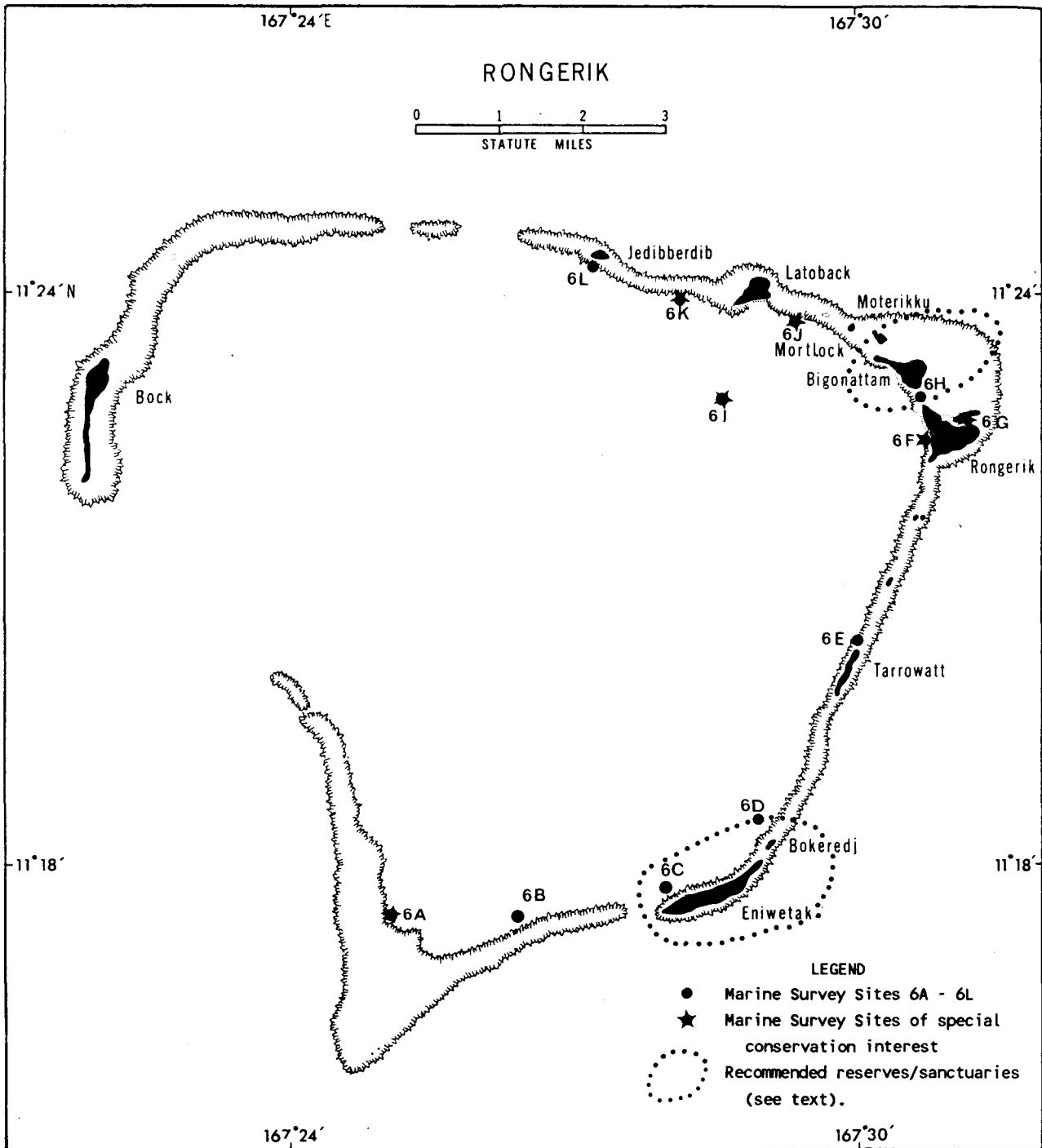
The main islands range up to 28 feet (9 m) in height. On the ocean side, the shoreline usually comprises coral boulder and rubble berms or beaches, or beach rock, often to the vegetation line. The coarser substrate materials of the ocean side gradually grade to gravelly or sandy soils as the islet is traversed towards the lagoon. Shorelines on the lagoon side usually consist of either white and pink sand beaches or beach rock outcrops interspersed or overlain with sand. High sand berms are often found above the beach, such as on Eniwetak Island.

Historically the atoll is of considerable interest. Although not presently inhabited, the Bikini people were relocated to Rongerik by the US Navy in 1946 to make way for the nuclear tests on Bikini. They were unable to subsist there, and were moved again in 1947, eventually setting on Kili Island.

4.6.2. Vegetation

Thirty-five plant species were noted during the short survey of six of the islets which included the largest, Rongerik. Of these 9 were aliens and 26 were native species (Appendix 7). Twelve new records were established of which 7 were native, and 5 exotic (Appendix 7a).

MAP 7



Source: Adapted from Amerson, A.B. 1969

One of the most botanically interesting islets is Eniwetak. Reported to have been heavily disturbed by the construction of a road and radio communications (Fosberg, 1956), by 1988 the islet was exhibiting good general recovery. The most impressive feature of the islet is the intact interior *Pisonia grandis* forest with trees growing to 70 feet (21 m) tall in places. Areas in these forests are dominated by *Cordia* or a mixed broadleaf community of *Guettarda*, *Cordia* and *Tournefortia*. Ground cover in open areas includes *Lepturus*, *Boerhavia tetrandra* and occasional *Triumfetta*. These *Pisonia* and *Pisonia/Cordia* forests are in good health with regeneration of the *Pisonia* occurring where limbs or trees have collapsed. This is without doubt the best *Pisonia* forest observed during the entire survey which contrasts with Fosberg's observation that in 1956 they were in very poor shape with much of the *Cordia* dead locally. Fosberg also reports that the soil in these forests was very peculiar, resembling only that found on Sifo islet, Alinginae Atoll. The upper horizon is a brown fluffy loam underlain by fine grey sand.

The ocean side vegetation of Eniwetak and several other of the islets surveyed consisted of a *Scaevola* - *Tournefortia* association with occasional *Guettarda* and *Suriana*. *Cassytha* was common on Eniwetak. Lagoon shore vegetation was the common *Scaevola* - *Tournefortia* association with *Pisonia*, *Cordia*, *Pandanus*, *Guettarda* and *Cocos* occurring. With the addition of *Pemphis*, these species are typically the most common on all the islets .

Rongerik islet is unusual for the large coconut forest which dominates the centre of the island with a scattering of other trees, *Morinda*, *Pandanus*, *Guettarda* and *Pisonia*. Ground cover was usually a dense stand of *Triumfetta*, frequently covering a heavy litter of fallen or husked coconuts and fronds.

4.6.3. Avian and Terrestrial Fauna

The diversity and abundance of the avifauna of Rongerik Atoll was sufficiently high to rank it third of the atolls visited after Taongi and Bikar (see Appendix 6). Twelve species had previously been recorded for Rongerik Atoll. Ten of these plus three new atoll records, Red footed bobbies, Brown boobies and the Pacific reef heron, were observed on this survey. Both Booby species were breeding. Great crested terns were also confirmed as breeding (Appendix 2).

Generally White terns and Brown noddies were the most abundant species with numbers ranging from 100 (Tarrowatt Islet) to 2 000 and 500+ respectively on Bigonattam Islet. The presence of breeding Red footed and Brown boobies not previously recorded on Rongerik atoll was of considerable interest especially as numbers of both species were relatively high. Thirty plus Brown boobies were observed on Tarrowatt islet (including one nest with eggs) and fifty birds were estimated to be on Bigonattam, these being the two islets with the most abundant populations. While Brown boobies were encountered on all of the six islets visited, Red footed boobies were restricted to Bigonattam islet where a large colony (estimated at 1 200 birds) was nesting in *Tournefortia* and *Pisonia* on the open south end of the island. Some 300+ nests were counted with birds on eggs and downy chicks.

Black naped terns were encountered on three of the six islets visited, Bokeredj (10), Tarrowatt (few) and Jedibberdib (53). A small colony of 18 adult Crested terns and 10 chicks were observed on an outlier sand spit at the north end of Rongerik islet and another 9 birds of this species were observed elsewhere on the atoll. Great frigate birds were rare with only 7 seen on Bigonattam.

The populations of the migrant species were the highest encountered on any atoll during the survey. Most of these were found on the north-west reef flat of the northern outlier islet of Rongerik islet where substantial numbers of Ruddy turnstones, Bristle thighed curlews, and Lesser golden plovers were observed.

Judging from the presence of the breeding Booby species and the Crested terns, the atoll and particularly Bigonattam islet, is slowly becoming an important bird breeding location in the northern Ralik chain. It is reasonable to speculate that the large number of birds found on Bigonattam result from the fact the islet has always been uninhabited. It is relatively undisturbed compared with neighbouring Rongerik islet which was home for the Bikinians for a short time has been converted to a coconut plantation), and now lacks substantial avifauna diversity.

Unfortunately the team was unable to survey Bock islet and some of the other smaller islets on the north-west perimeter of the atoll which might account for the failure to observe previously recorded Wedgetailed shearwaters and Sooty terns. Bock also has long stretches of sandy beach which raises the possibility of sea turtle nesting.

Of the other terrestrial fauna present, most remarkable was the abundance and large size of the Coconut crab population on Rongerik islet. The coconut plantation on this islet provides favourable habitat and judging by the large size of the crabs caught by the Marshallese crew (probably around 7-10 lbs; 3-5 kg or more), the population has been left virtually undisturbed since the Bikinians departure in 1947. Unfortunately it is unlikely the limited population on Rongerik can survive in the face of the exploitation such as that undertaken on this one visit, where over fifty large adult specimens of this very slow growing, low recruitment species were removed in a matter of hours.

Other animal species present included Polynesian rats, skinks and green tree geckos which were all observed on Rongerik islet.

4.6.4. Cultural and Archaeological Resources

Rongerik Atoll has very interesting cultural and archaeological features centred on the islets of Eniwetak and Rongerik. Extensive eroding cultural deposits as well as one historic gravesite were identified along the island lagoon shoreline of Eniwetak islet. Cultural deposit samples taken from these sites were radio carbon dated and indicated human presence between 1600-1700 A.D. and in the 1800's. Immediately inland from this site the remains of a small village site were discovered and towards the centre of the islet the deteriorating ruins of an atomic bomb (Bikini Atoll) communications and monitoring complex were located.

On Rongerik islet itself, the remains of the Bikini islanders resettlement village are obvious near the lagoon shoreline. Some probable prehistoric habitation remains are present even closer to the lagoon, along a fossil beach berm and also in the centre of the islet. Radio carbon dating of samples taken from these remains revealed human presence in the period 1500-1700 A.D. Every effort should be made to investigate and protect these discoveries, particularly the rapidly eroding sites on Eniwetak Islet.

4.6.5. Reefs and Corals

Generally the reefs of Rongerik are well developed with good habitat diversity, lagoon pinnacles, extensive back reef areas etc. The atoll can be considered typical of the large atolls of the northern Ralik chain. However, the open nature of the lagoon (more so than any of the other atolls visited) made it quite difficult to visit all the reef types although eleven stations were surveyed. Of these, six exhibited special geomorphological features of coral and fish communities of exceptionally high diversity and abundance (Appendices 3, 10 and 11). These included a unique and highly unusual blue coral filled sub-lagoon on the north side of Rongerik islet; flourishing corals and fish on a deep lagoon pinnacle north-west of Biggonattam islet; back reef and lagoon pinnacles with high coral diversity between Latoback and Jediberidib islets and unusual pink foraminifera beaches on Rongerik islet and offshore coral mounds (lagoon side) near Rongerik islet.

4.6.6. Marine Fauna

This atoll has the third highest abundance of reef fish encountered during the survey with some species which are rare on other atolls (*Lutjanus kasmira*, *Mulloidichthys vanicolencis*) being noticeably abundant (see Appendix 4).

Contrary to popular opinion and advice, sharks were not common, certainly in comparison with other atolls visited, except on the deeper offshore lagoon pinnacles. Harmless nurse sharks were however, common on the reefs near Rongerik islet.

In contrast to the relative abundance of reef fish, only four live giant clams were observed compared to 16 dead shells, indicating heavy exploitation in the past ten years. Smaller clam species were present although not in particular abundance suggesting that these too, have been exploited in the past.

This was the only atoll where marine mammals were sighted. A school of large dolphins probably *Tursiops truncatus*, was seen close outside the reef. The absence of marine mammals generally, both in the open ocean and near the atolls, over the seventeen days of the survey was puzzling and requires further research to determine whether this is a seasonal/migratory phenomenon or due to fishing or hunting pressure.

Evidence of Green turtle nesting was found mainly on Eniwetak islet with 33 pairs of tracks. One additional pair of tracks was found on Tarowatt islet. The survey team was unable to visit Buck islet which appeared to have beaches particularly suitable as turtle nesting sites. The atoll ranked fourth of the seven visited for turtle habitat (Appendix 4) on the basis of actual evidence.

4.6.7. Discussion

Ecologically Rongerik Atoll appears to have recovered from any past disturbances associated with the brief period of habitation by the displaced Bikini islanders. A very scenic atoll, Rongerik displays a level of natural diversity very typical of the atolls of the central Marshall Islands region with vegetation associations, seabird and turtle nesting sites and reef and coral communities suitable for conservation. Special and unique natural features are to be found including the high quality *Pisonia grandis* and *Pisonia-Cordia* forests on Eniwetak islet, the geomorphology of the islets and reefs and diversity and health of the coral and reef fish communities, particularly the blue coral community near Rongerik islet.

Culturally, Rongerik is of considerable interest for the discoveries of remains and past village sites on Eniwetak and Rongerik islets and of course, as the location chosen for the abortive resettlement of the Bikini islanders. This latter event is one of great significance in the modern history of the Marshall Islands and should be commemorated on site.

Species diversity on the atoll was high in the marine habitats and average for the terrestrial fauna. The confirmation of several resident breeding bird species indicating a low recent level of human disturbance on the atoll in general and Biggnottam islet in particular was of special interest. The evidence of Green turtle nesting on Eniwetak islet adds to the impressive natural and cultural values of the atoll. Unfortunately, the same cannot be said of the clam population (particularly the giant clams) which showed signs of exploitation, probably by distant water fishing vessels from Taiwan. In terms of their natural values both Eniwetak (for the quality of its vegetation associations and turtle nesting habitats) and Biggonattam (bird nesting) have natural values sufficient to warrant their protection within reserves.

The natural environment of Rongerik together with the atoll's cultural values, is of sufficiently high quality and interest for the atoll to have limited tourist potential. Activities which could possibly be developed are snorkeling and diving on the spectacular reefs and coral pinnacles, nature tourism, the inspection of cultural and historic sites and the thrill of visiting an uninhabited atoll. However, there are a number of drawbacks to development of Rongerik for this purpose which include:

- (i) the lack of an airstrip (or dock) and the limited land area available for airstrip construction without destroying or adversely impacting on the natural values described above.
- (ii) the lack of a village infrastructure and inhabitants to service the tourist activity and more importantly, to provide a measure of security and safety should unforeseen accidents occur.
- (iii) the open exposed nature of the lagoon which can make travel between the western and southern islets difficult.
- (iv) the need to ascertain the quality and quantity of potable water and establish a water system. The atoll may have been in the path of nuclear fallout from the 1948 hydrogen bomb test (Bravo) at Bikini. The groundwater might be contaminated with either Caesium-137 or Strontium-90.

These same drawbacks would affect any proposal for resettlement of a small number of people. Without water, buildings, an airfield or a dock, permanent settlement is not feasible. If re-establishment of a small settlement was being contemplated, two steps should be taken: first a thorough investigation of the reason why the Bikini islanders resettlement project failed; second, a thorough testing of groundwater and food supplies such as coconuts and coconut crabs for radionuclide contamination would be essential.

4.6.8. Recommendations

Insofar as adoption of the following recommendations may impact on the traditional rights of Atoll landowners and resource users, their involvement and concurrence will be essential for protected area programme implementation.

1. That Eniwetak and Biggonattam islets and their surrounding reefs and waters be declared Nature Reserves for the purposes of protecting in perpetuity, their natural features, flora, fauna, ecological associations and ecological processes. (See Map 6).
2. That the ordeal of the displaced Bikini islanders on Rongerik Atoll be commemorated with a suitable memorial located near the village site on Rongerik islet.

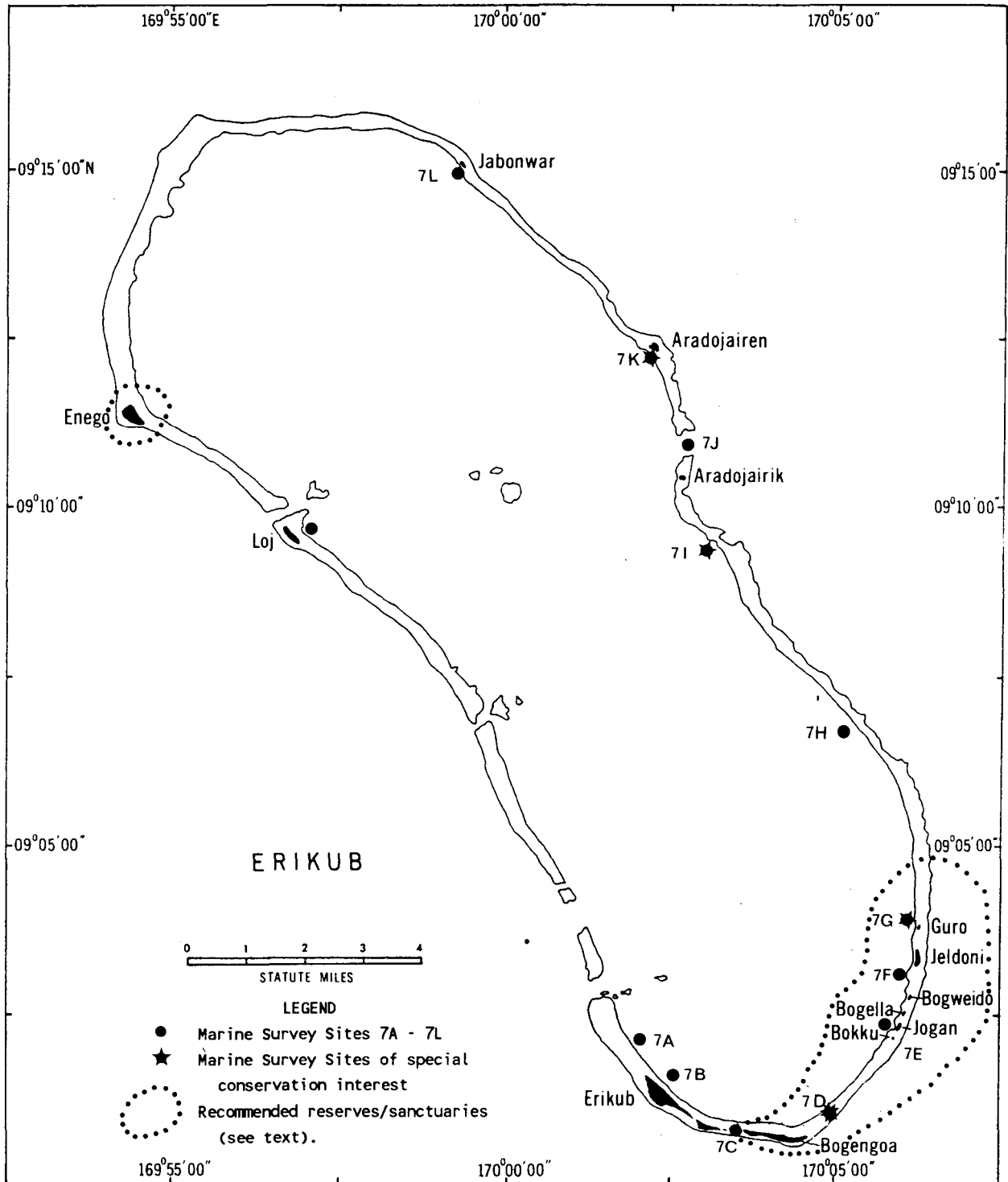
3. That an urgent archaeological investigation be undertaken on the rapidly eroding cultural remains along the lagoon shoreline of Eniwetak islet.
4. That an archaeological survey and subsurface testing for a cultural site be undertaken on Rongerik Islet.
5. That any future tourism development or permanent settlement of the atoll be confined to Rongerik islet and be subject to a thorough evaluation of the likely environmental impact and human safety requirements, including the possibility of contamination from radioactive food and other sources.
6. That full protection be afforded the giant clam population of the atoll, and any harvesting of smaller clams be restricted to the traditional owners of the lagoon.

4.7. ERIKUB ATOLL

4.7.1. General Description

Erikub Atoll, lying at 09° 08' N, 170° 02' E, just south of Wotje Atoll was visited on 22-23 September. The atoll is 17 miles (27 km) long and 5 miles (8 km) wide enclosing the largest lagoon of any atoll visited in the September 1988 survey. However, its 14 islets have a land area of only 0.3 square mile (0.91 km²). Most of these lie near the south-east end of an oblong, NW-SE orientated reef (Map 8). The largest islets are Erikub and Bogengoa. The atoll has a moderately wet climate and is uninhabited. It is however, regularly visited by the nearby Wotje islanders who came to harvest copra and food resources.

The atoll and its islets exhibit very similar geographical features to Rongerik Atoll. The islets generally have robust moderate to steep shorelines of coral, coral boulders or rubble and beach rock on the exposed windward ocean side, often extending right to and beyond the vegetation line (e.g. Erikub islet). Traversing inland from the ocean side, the coral boulders, rubble or beach rock gives way to grey sandy gravelly soils often overlaid with rotting cover of vegetative litter, particularly on Erikub and Bogengoa where there are coconut plantations. On the ocean side it is usual to find either fine or coarse coral sand. On some islands e.g. Bogengoa, beach rock is interspersed with sand along the lagoon shoreline.



Source: Adapted from Amerson, A.B. 1969

4.7.2. Vegetation

Thirty species are recorded for the atoll of which 27 are native and 3 exotic (Appendix 7). Eight new records were established (Appendix 7a). A range of diverse vegetation associations are present. On the two largest islets, Erikub and Bogengoa, ocean side vegetation was dominated with *Scaevola* in association with *Tournefortia*, *Guettarda*, and *Terminalia*. Some *Callophyllum* was present on Erikub and *Pandanus* was an uncommon addition on Bogengoa. *Cassytha* was parasitic on many of the plants. The lagoon side fringe vegetations of the islets was a similar mixture of *Scaevola* and *Tournefortia* with occasional *Cocos*, *Terminalia*, *Guettarda* and *Pisonia*. *Suriana* is common on Erikub with *Vigna*, *Canavalia* and *Cassytha* all present, but uncommon, in this vegetation type. The interior of both islets is dominated by *Cocos* in association with a mixed broadleaf forest of *Intsia bijuga* and *Pisonia* (most common) with occasional *Tournefortia*, *Guettarda* and *Pandanus* occurring on Bogengoa islet. On Erikub, *Guettarda*, *Pandanus*, *Terminalia*, *Scaevola*, and *Tournefortia* were all common with *Pisonia* and *Marinda* being uncommon or occasional.

The presence of a particularly good and dominant stand of *Intsia bijuga* on Bogengoa islet is of considerable botanical interest as this species is not usually dominant in an atoll vegetation association. The association on Bogengoa with its undisturbed "bird's nest" understory is unusual and could be unique. The usual litter of old coconuts, husks and fronds dominate the interior ground cover of both islands, and *Lepurus*, *Triumfetta*, *Tacca* and *Boerhavia tetrandra* are common in the more open areas.

Asplenium nidus (Bird nest fern) is common or abundant in the wetter more shaded parts of the interior of Bogengoa islet with plants growing up to, but seldom over 3 feet tall, occurring both as an epiphyte but more commonly as a terrestrial plant, adding further to the high botanical interest of Bogengoa.

A group of six islets are located in close proximity to each other to the north-east of Erikub and Bogengoa islets. These are Bokku, Jagon, Bogella, Bogweido, Jeldoni and Guro. They are closely linked and at low tide it is possible to walk over the reef flat between Bogella, Bogweido, Jeldoni and Guro. The floristic associations on all these islands are very similar but they differ from those on Erikub and Bogengoa. On the ocean side the fringing vegetation consists mainly of a *Tournefortia*, *Terminalia*, *Scaevola* association. *Pisonia* is a commonly occurring species in the association on Guro and on Jeldoni the *Tournefortia* grows to 25 feet and is fronted by a disjunct and distinctive low, wind sheared line of *Scaevola* with some *Terminalia* on the windward shoreline. Coral boulders and beach rock commonly occur up to and inland of the vegetation line on these islets.

Lagoon side associations on these islets are dominated by *Terminalia* and *Tournefortia*. On Guro, *Terminalia* dominates the *Tournefortia* with *Pisonia* and *Morinda* occurring rarely. On Jeldoni the association is more mixed with *Cocos*, *Pisonia*, *Pandanus*, *Guettarda*, *Cordia* and *Scaevola* (on the south end) all occurring either commonly or occasionally. On Bogweido the *Tournefortia-Terminalia* association includes the occasional *Alphylus* and *Scaevola*.

The interior vegetation of these islets comprises a dense basic association of *Tournefortia*, *Terminalia*, and *Pisonia*. On Guro and Bogella islets occasional *Guettarda*, *Morinda* and a rare *Allophylus* can be found. Coconut occurs on both Jeldoni and Jagon Islands. Ground cover in the open interior areas consists of mainly of *Lepturus*, *Boerhavia tetrandra* and *Triumfetta*. Seedlings of *Pisonia* and *Terminalia* are common.

4.7.3. Avian and Terrestrial Fauna

The avifauna of Erikub Atoll is very similar to that of Wotho and Rongerik Atolls with relatively low species diversity and numbers, reflecting the impact of repeated human disturbance both of the birds and their habitat. Fourteen species of the eighteen previously recorded were observed and the atoll ranked fifth in terms of its relative species diversity and abundance (Appendices 2 and 6).

Surprisingly, low numbers of birds were present on Erikub and Bogengoa, probably as a result of habitat modification for the coconut plantation and the frequency of visits by Wotje islanders to harvest copra, coconut crabs and turtles. Large breeding birds (except for a few Brown boobies flying over) were completely absent and White terns and Brown noddies were the most abundant species on both islets. However, less than 200 of each species were observed. The usual migratory shorebirds were present in good numbers with over 30 Bristle thighed curlews being observed on Bogengoa.

The islets of Jagon, Bogella, Bogweido, Jeldoni and Guro, linked one to the other at low tide by the wide exposed reef flat, present a different picture. Individually and collectively they have the best remaining natural bird habitat on the atoll in the form of dense interior mixed broadleaf forests of *Pisonia*, *Tournefortia* and *Terminalia*.

A large flock of 50 Frigate birds was observed soaring over the islets of which 10 were identified as the Lesser frigate bird (*Frigata ariel*) observed for the first and only time on the survey. Over 100 Brown boobies were counted and the presence of juveniles indicated these were breeding. Red footed boobies (50) were also present, 25% of which were in the white tailed, brown color phase. White terns and Brown and Black noddies (*Anous tenuirostris*) were abundant and a small colony of 20 Black naped terns was recorded on Bogella islet. Comparatively large numbers of migrant shorebirds were observed confirming the importance of this small group of islets for wintering over by Arctic shorebirds.

Other fauna observed on the atoll included large numbers of Polynesian rats on Erikub, Bogengoa and Aradojairen Islands, all of which have heavily modified habitat. Skinks and green tree geckos (on Erikub) are also present.

Despite advice that Erikub islet was renowned for its large coconut crab population, only one large coconut crab was observed along with many large empty burrows. A number of small crabs were sighted which suggested that over-exploitation of the crab population has occurred and tighter controls over future harvesting should be introduced.

4.7.4. Cultural and Archaeological Resources

The atoll is ranked second in its importance for historic preservation (Appendix 5). Of the seven islets surveyed Erikub and Loj were the most interesting and it is thought probable that pre-historic cultural remains are present on these and Aneko islet (unsurveyed). Radio carbon dating samples collected from Erikub islet indicated human presence during the period 1600-1700 A.D. A major pre-modern village was identified near the lagoon shoreline and in the centre of Erikub islet. The site was remarkable for a very dense scattering of indigenous artifacts (mostly *Cassis cornuta* and *Cypraecassis rufa* adzes) which, if systematically collected, would number in the hundreds.

The probable remains of turtle harvesting camps on an inland fossil sand dune or berm on Loj islet were noted. Further surveys of these and exploration of Aneko islet would be desirable.

4.7.5. Reefs and Corals

A striking feature of Erikub Atoll is its deep, open lagoon giving rise to unusual steep reef drop-offs on the lagoon side of some islets and only a few pinnacles.

Thirteen marine stations were surveyed and despite these being limited to shallow water and the windward reefs due to the lagoon depth and the lack of dive equipment, coral diversity and abundance was considered generally high (see Appendices 10 and 11). Four sites were considered to have exceptional features worthy of consideration for protection (Appendix 3).

4.7.6. Marine Fauna

Reef fish and small clams were not overly abundant and there were indications of comparatively heavy fishing pressure with temporary fishing camps found on most of the larger islets. Of the smaller clams only *Hippopus hippopus* and *Tridacna maxima* were common with *T. squamosa* occurring very occasionally. Only one giant clam was seen although poor habitat in the form of steep lagoon slopes which preclude large benthic organisms finding a stable environment, may be the reason rather than heavy fishing pressure. Although the reef fish appeared depleted, stocks of baitfish and pelagic game fish were excellent.

Erikub was ranked third in importance for Green turtle nesting habitat based on the forty-nine pairs of track observed on the atoll islets (Appendix 4). However, from the evidence of frequent visits by people from Wotje Atoll, the number of nest marker sticks, temporary camps and "middens" of turtle remains, it is clear that human predation on eggs and adult females must account for a high percentage of the annual production. Unfortunately it was not possible to discuss their use of the atoll resources with the Wotje people. While tracks were present in small numbers on some islets one, Enego, showed a higher frequency with 23 sets recorded. Sets of tracks recorded on the other islets were: Erikub (13 pairs), Jagon (6), Aradojairik (3) and Loj (4).

4.7.7. Discussion

The overriding impression gained of Erikub is of a relatively exposed, open atoll having low to medium natural diversity. Human disturbance has led to habitat modification and species depletion and overall, the quality of the natural environment is insufficient to warrant full protection of the atoll. However, Erikub does have specific natural and cultural features which should be protected if the present character of the atoll is to be preserved. Controls over the harvesting of some resources are also required if these are to survive in significant numbers for sustainable harvesting.

Features which warrant protection include the possibly unique vegetation association of *Intsia bijuga* on Bogengoa islet, together with the very good examples of moist, atoll mixed broadleaf forest on the smaller south-west islets. Both are of considerable botanical interest. The five south-west islets provide good habitat for seabirds and the presence of a relatively high population of Frigate birds, scarce on the other atolls of the Ralik chain, enhances their conservation value. Several specific reef and lagoon locations exhibit high coral diversity and abundance and provide particularly good fish habitat. The identification of potentially important archaeological sites adds a cultural dimension to the conservation values of the atoll, sufficient in importance to have it assessed as second only to Wotho in terms of value for historic preservation.

With the exception of the cultural sites on Loj, Aneko and Erikub islets, the above features are confined to Bogengoa islet and the five south-west islets of Guro, Jeldoni, Bogweido, Bogwella and Jagon and their reefs. The protection of the *Intsia* forest of Bogengoa and the flora and fauna of the groups of five islets within a Nature Reserve is therefore desirable and would ensure the most important of the atoll's natural diversity is preserved.

The archaeological sites on Loj, Aneko and Erikub should be systematically investigated through both surface and subsurface surveys. The cultural remains on Erikub islet would be suitable for interpretation to students and tourists if the atoll were ever developed for visitor use. In these circumstances clearing of the vegetation and identification of the village site would be required, and the site could be designated as a cultural reserve and maintained by people from Wotje Atoll.

In assessing the overall resource conservation requirements of the atoll the depleted state of key food resources must be addressed. Clearly the atoll has an important traditional role as a 'pantry' for the Wotje islanders. However, unless the harvesting of small clams, coconut crabs, seabirds and turtles is regulated there is a very real possibility that these key resources will become increasingly scarce and perhaps lost from the atoll. To be really effective, harvesting regulations will need to be voluntarily imposed by the traditional authorities of Wotje Atoll acting on the advice of the proposed Conservation Service (see Part III) and the Marshall Islands Marine Resources Authority which should begin regular monitoring of the populations of these species. The desirability of a moratorium on all turtle harvesting activities for up to five years and full protection for all nesting seabirds should be investigated.

The potential of Erikub for either permanent settlement or Marshallese tourist use is low and limited by the lack of a dock or airstrip. Physical resource limitations such as the small size of the islets, deep lagoon waters, climate and insufficient water have probably limited human habitation in the past and would still be valid today.

However, it is possible that the atoll could be used for short duration, boat based or camping (on Erikub only) visits by tourists or students on a field trip. The beaches, islets, vegetation, seabirds and corals would all be of interest to these groups as would the cultural sites discussed above. The atoll should also continue to serve as a 'pantry' for nearby atoll islanders, subject to controls over depletion of vulnerable species.

4.7.8. Recommendations

Insofar as adoption of the following recommendations may impact on the traditional rights of atoll landowners and resource users, their involvement and concurrence will be essential for protected area programme implementation.

1. That the islets of Guro, Jeldoni, Bogweido, Bogwella, Jogon and Bogengoa and their surrounding reefs and waters be designated as a Nature Reserve for the protection, in perpetuity, of their terrestrial and marine flora and fauna, natural habitats, ecological associations and ecological processes (see Map 8).
2. That the islet of Enego be designated as a Wildlife Reserve specifically to protect the marine turtle nesting population.
3. That in consultation with the Iroi-laplap and Wotje Atoll residents monitoring of turtle, giant and small clam, reef fish, and coconut crab populations be undertaken by the proposed Conservation Service and the Marshall Islands Marine Resources Authority and a sustained yield harvesting plan be developed and implemented.
4. That a systematic surface and subsurface archaeological investigation on Erikub islet, together with further exploratory work on Loj and Aneko islets be undertaken through the Alele Museum.

PART II. ENDANGERED AND THREATENED SPECIES CONSERVATION

1. INTRODUCTION

One objective of the survey was to identify species whose survival in the Marshall Islands was thought to be endangered or threatened and to develop a preliminary list of endangered and threatened species. Although the survey visited only seven of the thirty-four atolls and islands of the Marshall's archipelago, all but one, Wotho, were uninhabited. These represented the majority of uninhabited atolls in the archipelago and contained much of the least disturbed habitat in the Marshall Islands. Therefore, it is not unreasonable to infer that any species considered endangered or threatened relative to these atolls would warrant that status throughout the archipelago. This assumption has been made by the survey team when assigning species to these categories on the basis of evidence from the field survey. Other species have been included on the basis of their identification as endangered or threatened species in the IUCN Red Data Books (IUCN 1982, 1983), by the US Fish and Wildlife Service and in the Marshall Islands Marine Resources Act.

Listing species as endangered or threatened in itself does nothing to protect them. The establishment of protected areas is often the most effective way of preserving natural habitats and vegetation, but this is not always so for fauna. The mobility and migratory habitats of many animal species, particularly vertebrates (mammals, birds, reptiles and fish, cetaceans), together with their value as subsistence resources, make them vulnerable to exploitation outside of protected areas (and within, if poaching is uncontrolled). Many species suffer the fate of "common" or "free" resources, being exploited by all, particularly where there are no legal constraints on their harvesting or where peer, community or traditional controls over harvesting are ineffective.

To overcome these problems species conservation often requires national level laws and controls over harvesting to complement the protection offered by *in situ* protected areas. Such laws can conserve species by imposing controls such as total bans on harvesting, individual quotas which can be varied from location to location, seasonal restrictions, size limits etc. Where traditional or community control over species harvesting is still effective, as is the case in many Pacific island communities, voluntary compliance with conservation measures imposed by the traditional authorities are often most effective.

In the Marshall Islands species conservation legislation is limited to the Marine Resources Act. This been introduced to regulate fishing with explosives, poisons, chemicals, etc., and to protected endangered species. In this latter respect, the Act stipulates limitations on the taking of sea turtles, specifically hawksbill turtles, control of the harvesting of artificially planted or cultivated sponges and control of the harvesting of black-lip mother-of-pearl oyster shell. There is no legislation to control the exploitation of other forms of wildlife.

In most instances the enactment of conservation legislation and regulations is insufficient by itself to achieve the desired conservation objectives and must be accompanied by public education programmes explaining the need for the restrictions. On-going research into the population status of the species is also required if the conservation measures are to be seen by the public to be realistic and effective.

The list which follows identifies species which are considered to be endangered or threatened in the Marshall Islands which will require some form of effective conservation action if they are to survive, certainly in numbers which may allow limited, sustained harvesting. Also included are species which are internationally recognised as endangered or threatened which are thought to occur on the Marshall Islands but which were not assessed by the Survey team.

1.1. Definitions

The IUCN Red Data Book "Endangered" category refers to taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating.

Other Red Data Book categories of threatened species are:

"Vulnerable" - Taxa believed likely to move into the Endangered category in the near future if the causal factors continue operating.

"Rare" - Taxa with small world populations that are not at present Endangered or Vulnerable but are at risk.

"Indeterminate" - Taxa known to be "Endangered", "Vulnerable" or "Rare" but where there is not enough information to say which of the three categories is appropriate.

"Commercially threatened" - Taxa not currently threatened with extinction but most or all of whose populations are threatened as a sustainable commercial resource, or will become so unless their exploitation is regulated.

The USFWS category "Endangered" applies to a species in immediate danger of extinction and the "Threatened" category to species likely to become Endangered species within the foreseeable future throughout all or a significant portion of its range. A Candidate Endangered Species is one in the various stages of the legal process to be listed as an Endangered Species.

2. LIST OF ENDANGERED OR THREATENED SPECIES - MARSHALL ISLANDS

2.1. Endangered Species

Hawksbill Turtle (*Eretmchelys imbricata*). Only one individual was seen and one possible nesting site identified (Bikar Atoll) during the survey of ninety-six lagoon and ocean reef stations, and over a hundred hours in or on the water. The species is already listed as Endangered in the IUCN Amphibia, Reptilia Red Data Book (IUCN, 1982) and by the U.S. Fish and Wildlife Service. Although it occurs naturally in low densities, most populations are known to be severally depleted. The Hawksbill suffers from hunting for its shell, meat and eggs and whole populations have been known to be decimated for commercial gain. It is specifically referred to in the Marshall Islands Marine Resources Act as an endangered species.

Green Turtle (*Chelonia mydas*). The Green turtle is listed as Endangered by the IUCN (IUCN, 1982). The U.S. Fish and Wildlife Service lists it as a Threatened species. This species occurs in the waters of the Marshall Islands and nests on many of the suitable islets of the 34 atolls and islands. However, only one of the uninhabited atolls visited, Bikar, exhibited signs of intensive nesting activity. In addition, green turtles were seen in the water at Taka, Rongerik and Erikub Atolls. With the exception of Bikar there was evidence that this species is under heavy hunting pressure for its shell, meat and its eggs on most atolls. This is certainly the case throughout the world and numbers are declining dramatically as one population after another is depleted for commercial gain.

It should be noted that the Marshall Islands Marine Resources Act prohibits the taking or killing of Hawksbill or sea turtles while on shore and the taking of their eggs. In addition, no Hawksbill turtle with a carapace length of less than 27 ins (67.5 cm) or Green turtle with a carapace length of less than 34 ins (85 cm) shall be taken or killed. No sea turtle of any size shall be taken or killed from 1 June to 31 August or from 1 December to 31 January. The taking of sea turtles and their eggs can however be authorised by Cabinet. The penalty for violation of these provisions is a \$ 100 fine or 6 months imprisonment.

These blanket restrictions are virtually impossible to enforce without the full support of the atoll communities and may, in some areas, be unduly restrictive of traditional harvesting practices thus inviting violation. In addition, there is no provision for the protection of nesting habitat which is vital to the long-term survival of these species in the Marshall Islands. There is also a need to halt the taking of turtles for commercial purposes either by local Marshallese or distant water fishing vessels. Finally in order to achieve public support for turtle conservation, a public education programme should be undertaken to inform Marshallese of the plight of the turtles, and the need for conservation measures and what these are.

Conservation Recommendations

That the conservation of Hawksbill and Green turtles be given priority within an overall national marine turtle conservation strategy to be prepared jointly by the proposed Conservation Service (See Part III) and Marshall Islands Marine Resources Authority (MIMRA). This would include:

- a ban on the taking of all Hawksbill turtles;
- provisions for Marine turtle habitat protection through the establishment of Reserves and Sanctuaries;
- provision for the development of Regulations under the Marine Resources Act for local restrictions on the harvesting of Green turtles and eggs in to be set in conjunction with, or at the request of, Atoll Local Councils or Conservation Committees (see Part III of this report) and traditional landowners, including moratoriums on all harvesting activity where populations have been noticeably depleted in recent years;
- provision for the monitoring of marine turtle populations and the scientific estimation of sustainable harvest yields;
- establishment under the Marine Resources Act of restricted fishing zones off all major nesting areas (e.g. Bikar; Jemo; Eniwetak islet at Rongerik Atoll; and Enego islet at Erikub Atoll), other sites could be included as further investigations are undertaken;
- discouragement and very heavy penalties under Marshall Islands Marine Resources Authority Act for distant water and local fishing vessels found to be exploiting marine turtles for commercial gain;
- provision for heavier penalties for the violation of the conservation provisions of the Marine Resources Act by Marshall Islanders including the confiscation of boats and equipment;
- provision for a public education on the need for marine turtle conservation;
- investigation of the feasibility of a joint MIMRA and proposed Conservation Service 'head start' programme for Marine turtles;
- accession of the Marshall Islands to the CITES Convention and a ban on the taking of turtles for commercial purposes and on the commercial trading in turtle products.

Giant clam (*Tridacna gigas*). Giant clams are registered in the "Indeterminate" category by the IUCN (IUCN, 1983). On the basis of the survey it is considered that giant clams are in danger of local extinction in the Marshall Islands if continued heavy exploitation is not stopped. Giant clams are the largest living, shelled mollusc and grow to 55 in (137 cm) in length and a weight of over 440 lbs (200 kg). The large powerful abductor muscle is a sought-after delicacy in Far East-Asia and this places the species under considerable pressure from illegal harvesting by Taiwanese and Korean fishing boats. The clam is particularly vulnerable to harvesting pressure as it is found in shallow sandy lagoon waters. However, it has a fast growth rate (up to 22 in (55 cm) in six years) and is thought to reach reproductive maturity at 5 years which suggests that some population recovery could be possible in 5-6 years if breeding stocks are still present and active.

Conservation Recommendations

That the giant clam be recognised as an endangered species under the Marine Resources Act and provisions introduced to provide for the formulation of regulations for their conservation in conjunction with traditional landowners and Atoll Local Councils.

- that the status of giant clam populations on all atolls be surveyed by the Marshall Island Marine Resources Authority in conjunction with Atoll Local Councils;
- that on the basis of this survey the MIMRA make recommendations to Atoll Local Councils/landowners for the conservation of giant clams, including the introduction of moratoriums on harvesting if appropriate (at least 6 years to allow stocks to recover);
- that where conservation controls are introduced, monitoring of population recovery be undertaken by the MIMRA and Atoll Local Council;
- that the feasibility of re-seeding depleted populations using baby clams or breeding stock obtained from the Micronesian Mariculture Development Centre, Palau be investigated. Re-seeding should be conducted at atolls accepted for some form of protected area status and management;
- that provisions for heavier penalties for the violation of giant clam conservation provisions for commercial gain by Marshall Islanders, including the confiscation of boats and equipment, be introduced;
- that monitoring, surveillance and enforcement measures be increased to discourage illegal exploitation of this species and heavy penalties be provided for under the Marshall Islands Marine Resources Authority Act for violations by vessels of distant water fishing nations;

Radak Micronesian Pigeon (*Ducula oecania ratakensis*). This forest bird is thought to be the only surviving endemic bird in the Marshall Islands. It is listed in the "Indeterminate" category by the IUCN and as a Category 2 Candidate Threatened or Endangered species by the US Fish and Wildlife Service. It is recorded only from two atolls, Arno and Wotje and neither was visited on the survey. Little is known of its distribution on Wotje but it has apparently disappeared from some suitably vegetated islets on Arno Atoll (Hay, 1985). Reasons for its decline are not well understood but they may involve a combination of hunting pressure, habitat disturbance and possibly the introduction of rats (*Rattus rattus*), on Arno Atoll at least.

Conservation Recommendations

- that an immediate ban on hunting and taking of this species be imposed on Arno and Wotje Atolls until such time as the status of the populations can be ascertained;
- that the proposed Conservation Service and Alele Museum jointly organise a survey of both atolls to gather up to date information on the population status of this species and arrange a public education campaign on the plight of the pigeon, in conjunction with the Atoll Local Councils, landowners and residents;
- That the ban on hunting be reviewed in the light of the information obtained from the above mentioned survey and a strategy for the conservation of the species be developed and implemented by the proposed Conservation Service.

2.2. THREATENED SPECIES

Coconut Crabs (*Birgus latro*). This extremely slow growing species is a popular delicacy and is categorised as "Rare" by the IUCN (IUCN, 1983). Coconut crabs were seen on several islets at atolls where human occupation was evident and usually where coconuts (the crabs preferred food) had been planted. There was a great abundance of very large crabs on Rongerik Atoll and more than 50 of these individuals were taken by the Marshallese members of the party in a few hours of hunting. This example demonstrates how vulnerable these creatures are and the ease by which over-exploitation of the limited populations on small islands could occur. On all other islets few large crabs were observed although populations of small crabs up to 500 g were noted. Repeated heavy harvesting can decimate stocks of this vulnerable species which is reported to have very poor population recruitment rates (Fletcher, 1988). Its commercial value places it at great risk in the Marshall Islands.

Conservation Recommendations

That the proposed Conservation Service and/or the Marshall Island Marine Resources Authority recommend to all landowners and Atoll Local Councils:

- (i) that where crabs are heavily depleted, a ban be imposed on their collection until such time as it is assessed that the population has recovered sufficiently to allow limited harvesting on a sustained yield basis;
- (ii) that collection of crabs with a carapace length smaller than 3.5 in (9 cm) (the median size of female reproductive activity) be prohibited and that the introduction of individual, seasonal quotas be considered;
- (iii) that the collection of crabs from beaches two days before and 6 days after a new moon be prohibited to allow females to deposit their eggs in the sea undisturbed.

That the proposed Conservation Service and/or MIMRA mount a public education campaign featuring the coconut crab and the need for its conservation.

That Regulations for the protection of the coconut crab based on (i), (ii) and (iii) above be promulgated under either the Marine Resources Act or the proposed Nature Conservation legislation (see Part III) when it is enacted.

Black-lip Mother-of-pearl Oyster

This commercially valuable bivalve (*Pinctada margaritifera*) is considered endangered under the Marshall Islands Marine Resources Act. Its harvesting is limited to the period 1 August - 31 December. A minimum shell size of 4 inches diameter is also identified and the collection of shells of any size for scientific purposes can be authorised by cabinet. Although several black-lip mother-of-pearl shell oysters were encountered during the survey insufficient information is available to further clarify the status of this species and it is included here on the basis of its inclusion in the Marine Resources Act.

2.3 INDETERMINATE

Marine Mammals

Insufficient information is available on the occurrence of marine mammals in the waters of the Marshall Islands for species specific recommendations relating to their endangered or threatened status. However, from the evidence of the survey where only one pod of dolphins (probably *Tursiops truncatus*) was seen in seventeen days at sea, it would appear that populations of these species are under threat. It was reported by the crew that Marshallese fisherman occasionally harpoon dolphins for food, which may explain the dolphin's wariness of boats. Further research is required to determine which species, if any, are threatened and endangered.

Conservation Recommendations

That a long-term survey of the status of marine mammals in the Marshall Islands be undertaken based on observations to be recorded by the MIMRA fishery surveillance vessels and from distant water and local fishing vessels.

Other species

Other species which are listed specifically by the IUCN (IUCN, 1983) but which are not included on this list through a lack of information are the Giant Triton (*Charonia tritonis*), (listed as "Rare") and Black coral (*Antipathes spp.*) (listed as "Commercially Threatened"). The status of both species together with other commercially valuable shellfish (e.g. *Trochus spp.*) and coral species in the Marshall Islands should be further investigated.

2.4 GENERAL

It is emphasised here that the success of species conservation efforts depends to a large degree on effective public education and awareness programmes, good liaison between traditional chiefs, local communities and the government agencies which provide advice on appropriate conservation measures. This is especially so in the Marshall Islands where the reliance of remote atoll communities on tradition subsistence resource harvesting makes their support for conservation initiatives vital if these are to have any chance of success. Here the importance of persuading the community, traditional landowners and Local Atoll Councils to introduce controls or support resource conservation regulations on a voluntary, self regulating basis cannot be over-emphasised. Central government agency surveillance and enforcement of conservation laws and regulations on these atolls is virtually impossible so it is essential that government agencies work with traditional landowners and local communities to explain the need for conservation measures and develop responses which are considered acceptable and appropriate by the resource users themselves. Programmes such as this should become a priority activity for the proposed Conservation Authority and the Marine Resources Authority and the employment of one or more National Conservation Officers to visit the atolls for this purpose would be desirable.

Nationally, applicable laws and regulations are still important, particularly as a means of controlling commercial exploitation of living resources which poses a real threat to commercially valuable species. Planned and well financed surveillance programmes such as that being developed by the MIMRA, coupled with heavy penalties for offenders and bans on the commercial trading of the listed species should be effective in this sphere.

PART III INSTITUTIONAL ARRANGEMENTS FOR PROTECTED AREA MANAGEMENT AND NATURE CONSERVATION.

1. INTRODUCTION

The implementation of the recommendations in Parts I and II of this report will require the development of new policy and legislation, additional financial and manpower resources and changes to the organisational structure of at least one RMI government agency. This section addresses these matters by discussing the need for a national policy on conservation, possible protected areas and nature conservation legislation and by proposing a restructuring of an existing ad hoc agency or Ministry to provide for the administration of the proposed legislation.

2. A NATIONAL CONSERVATION POLICY

The development of national policy on resource conservation and sustainable development in the RMI is desirable as a means of formally expressing the nation's commitment to the conservation and sustainable development of its living resources, including its natural diversity. The policy would provide the government with a mandate for conservation action and would assist it to define the priority to be placed on conservation. The policy would also include a statement of the nation's commitment to the protection of representative ecosystems and species through a programme of protected area management. Such a statement would:

- recognise the importance of the sustainable use of the limited natural resources of the Marshall Islands and the need to conserve these for the benefit of present and future generations of Marshallese;
- recognise the cultural, traditional and spiritual importance of living natural resources to the nation;
- recognise the importance of a programme of protected areas and forest, fisheries and wildlife management if representative examples of the remaining natural ecosystems are to be maintained or enhanced and living natural resources conserved;
- provide a mandate for the incorporation of resource conservation principles in national development planning and resource management legislation, and in social, cultural and education policy.
- provide for control and conservation of natural shorelines and reef areas through a government permit and review process, set back requirement or other management procedures.

Ideally, the policy would be included in the Constitution after adoption by the Nitijela. Its provisions would then be integrated into national planning legislation, development plans and resource management legislation.

Another way of assessing the nation's conservation goals and objectives and defining policy and strategies for their achievement, is through the preparation of a National Conservation Strategy (NCS). An NCS identifies the country's conservation needs and objectives as well as areas and resources of particular significance which are in need of protection. It describes the programmes needed to achieve these conservation objectives, identifies the institutions responsible and suggests or reviews the appropriate legislative framework necessary for implementation (MacKinnon et. al., 1986). The process by which it is developed is particularly appropriate for small island countries where community affinity with the environment is strong through the subsistence and traditional use of natural resources. It is based on widespread public consultation at all levels and aims to achieve a national consensus on desirable conservation goals and appropriate paths for their achievement. It recognises that ultimately, it is the actions of the people which determine the quality of the environment and consequently it is the people who must decide how they want their country to be in the future (Dahl, 1988).

An NCS for the Marshall Islands could be developed with the assistance of international conservation agencies such as the IUCN, SPREP or the East West Center. At this stage of the nation's development, an NCS would provide valuable guidance in the rational and sustainable development of the country's resources.

3. PROTECTED AREAS AND SPECIES CONSERVATION LEGISLATION.

Although Taongi and Bikar atolls were declared reserves in 1958 by order of the District Administrator under the Trust Territory of the Pacific Islands administration, this status is not now recognised by the Marshall Islands government or the Irooj laplap. Therefore, there are no legally established protected areas in the Marshall Islands, nor is there any legislation for this purpose.

In the Marshall Islands, species conservation legislation is presently limited to the provisions of the Marine Resources Act administered by the Marshall Islands Marine Resources Authority. This Act provides for the control of destructive fishing methods, prohibits the killing of marine turtles on land or the taking of their eggs and sets size and seasonal limits on their capture at sea. It also limits the harvesting of cultivated sponges and exerts size and seasonal limitations on the taking of black-lipped mother-of-pearl oysters.

The legal basis of a protected area is fundamental to its long term success. There must be no question of the legal status of a park or reserve once it is established or the legal authority of those charged with its management. Ambiguity in these areas can seriously undermine the conservation value of a protected area and the quality of its management should they ever be disputed.

Therefore, to implement the recommendations of this report it will be necessary to develop more comprehensive legislation which provides the legal mandate for the establishment of a range of different categories of protected areas, their management and administration, and the implementation of more comprehensive species conservation measures. Such legislation will provide its administering agency with a strong mandate for advocating natural resource conservation and the protection of the natural environment generally.

In addition, in the Marshall Islands where virtually all land is held in traditional ownership, the legislation must make provision for strong landowner involvement in the management of protected areas. Similarly, controls over exploitation of living resources will be largely ineffective (at least in the outer islands) unless they are well understood and supported by the traditional leaders and local community, again requiring strong local participation in the planning and decision making processes.

These principles, together with the need to provide for flexibility in the negotiations for protected areas, have guided the development of the proposed Nature Conservation legislation outlined in Appendix 8 and the proposed administrative structure for protected areas and species conservation discussed in the following section.

4. PROPOSALS FOR ORGANISATIONAL CHANGES

The administration of the legislation discussed above and outlined in Appendix 8 will require a government commitment of additional resources and personnel and changes to the existing government structure. The following proposals have been developed with several principles in mind:

- the establishment and management of a protected area system cannot be achieved without the involvement and concurrence of traditional landowners and the local atoll communities;
- the wide geographical spread of the Marshall Islands means that there must be strong outer islands community commitment and involvement in the management of protected areas and the conservation of species;
- that the central government role in conservation management should be largely that of co-ordination and the provision of policy, advice, guidance and incentives.

Investigation of the RMI legislation reveals that two agencies, the Marshall Islands Environmental Protection Authority and the Ministry of Resources and Development have the potential for undertaking the functions inherent in the proposed protected area and species conservation legislation.

The Ministry of Resources and Development includes responsibility for tourism development within its diverse functions. The Minister of Resources and Development is the Chairman of the Marshall Islands Marine Resources Authority (MIMRA) which is a well supported ad-hoc agency responsible for the development and management of the national fishing industry, including the control and surveillance of the activities of distant water fishing nations in RMI territorial waters. The MIMRA is housed with the Ministry of Resources and Development and also has specific responsibility for the protection of marine turtles and other marine resources under the Marine Resources Act referred to above.

The Marshall Islands Environmental Protection Authority (EPA) has as its responsibility the administration of two environmental management Acts; the National Environmental Protection Act 1984 and the Coast Conservation Act 1988. The Authority is an independent ad hoc agency serviced by a General Manager and small number of support staff. Its primary purpose as set out in the National Environmental Protection Act is "...to preserve and improve the quality of the environment". Objective (g) of the Act requires the EPA "to preserve important historical, cultural and natural aspects of the nation's cultural and heritage maintaining at the same time an environment which supports multiplicity and variety of individual choice" (sic).

The Coast Conservation Act empowers the EPA "to make provision for a survey of the coastal zone and the preparation of a coastal zone management plan; to regulate and control development activities within the coastal zone; to make provisions for the formulation and execution of schemes for coast conservation and to provide for matters connected therewith or incidental thereto".

There are distinct advantages in having the protected areas and species management programme in a large relatively well supported Ministry such as the Ministry of Resources and Development. Although the Ministry's role is primarily that of resource development, it also has a resource conservation responsibility and more than any other agency, should be working towards balancing the potential conflict between development and conservation through the definition and implementation of programmes of sustainable development. The Ministry has within its functions the responsibility for tourism development and through the Minister of Resources and Development, the MIMRA, both being functional areas from which support for the proposed protected areas and species conservation programme will be required. At present, the Ministry does not have specific conservation functions but the MIMRA, to which it is linked through the Minister, is responsible for the Marine Resources Act.

On the other hand, the EPA is an independent authority with clear statutory responsibilities for environmental protection including the preservation of nature and coastal zone planning and protection. As an independent authority the EPA is well placed to act as a national advocate for the preservation and conservation of natural resources and to objectively undertake the protection and management functions of the proposed legislation.

The final choice of an appropriate agency to administer the proposed legislation is one for the RMI Government, which should take into account the existing functions and responsibilities of each agency and their relative ability to:

- logistically support the proposed Conservation Service, National Conservation Authority and Atoll Conservation Committees;
- administer the provisions of the proposed Nature Conservation legislation;
- achieve the co-ordination and liaison needed between the government agencies, national and local conservation agencies, traditional leaders, local communities and the public to ensure the successful implementation of the Conservation Programme.

As outlined in the proposed legislation, it is suggested that three main organisational features will be required to assure its effective administration. They are:

- (i) an ad hoc National Conservation Authority which can act in the role of providing guidance to the Minister responsible for the Act, developing and reviewing protected area and species conservation policy and programmes and acting as mechanism for co-ordination and consultation between government agencies and landowners;
- (ii) local Atoll Conservation Committees to act as a mechanism for encouraging local commitment and involvement in the management of parks or reserves and wildlife on the atolls;
- (iii) a Conservation Service within either the MRD or EPA comprising
 - a centralised technical support staff for the National Conservation Authority.
 - a decentralised (regional/local level) field management network.

A proposed administrative structure which incorporates these elements is outlined below (See also Figure 1):

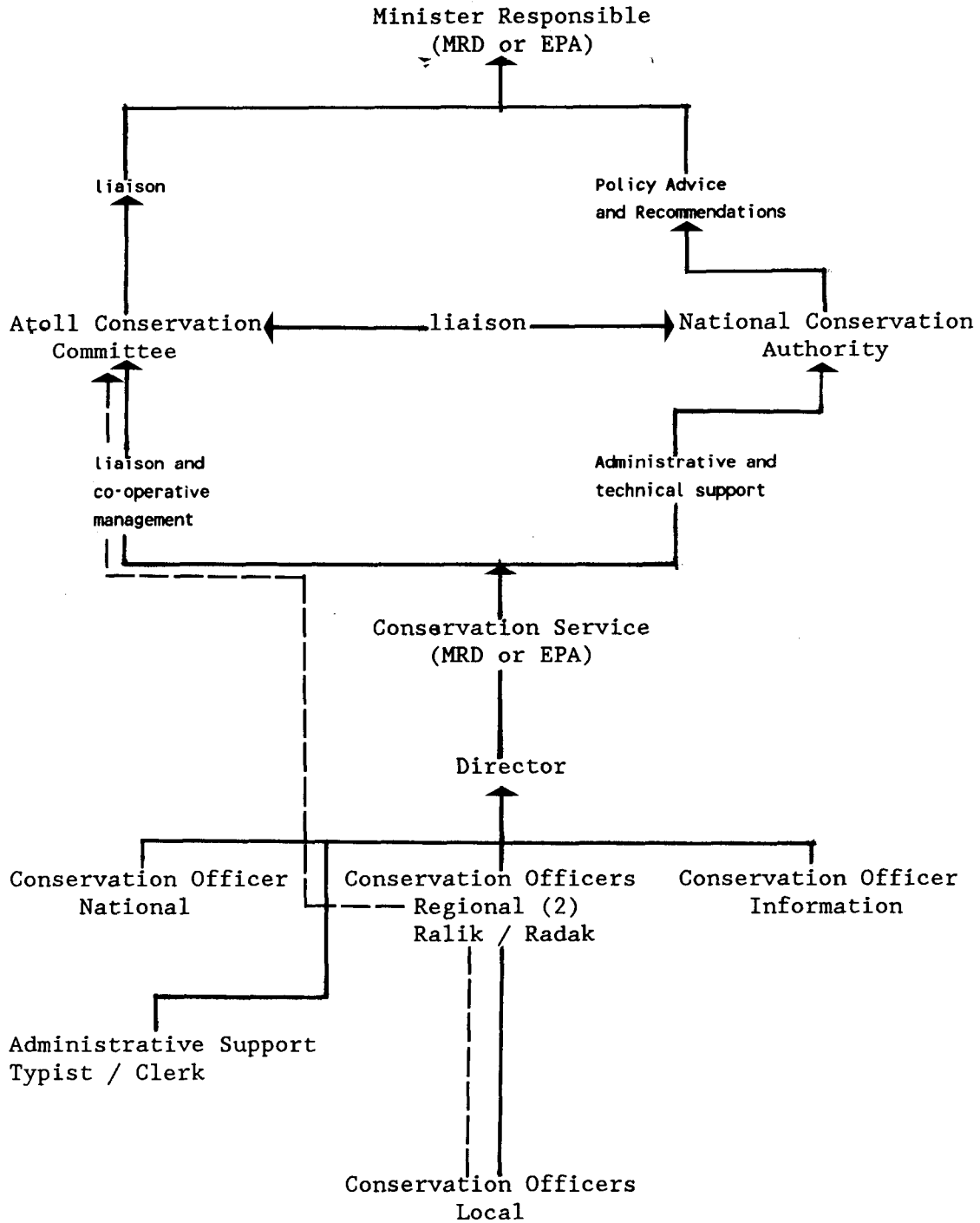
- (i) National Conservation Authority

The chief role of this body is to bring together representatives of key government agencies and the private sector so as to ensure that the mechanism exists for the liaison and consultation needed to make the protected area and species conservation programme work. Such an authority should include in its composition representation from the following:

The Ministry of Resources and Development
 The Environmental Protection Authority
 The Ministry of Interior and Outer Island Affairs
 The Alele Museum
 The Education Department
 The Council of Irooj (Traditional landowners)
 Local Atoll Conservation Committees.

**ORGANISATION CHART FOR PROPOSED PROTECTED AREAS AND
NATURE CONSERVATION MANAGEMENT
MARSHALL ISLANDS**

Figure 1



The principal functions of the Authority under the proposed legislation would include:

- oversight of the administration of the proposed Act.
- provision of advice and recommendations to the Minister responsible for the Act on protected area and species conservation matters.
- the development and review of policy for the management of protected areas and species conservation.
- approval of negotiations for protected areas and recommendations to the Minister for their establishment
- approval of management plans for parks and reserves
- approval of species conservation controls and related licenses and permits
- promotion of a public education programme on living resource conservation and information dissemination
- evaluation of relevance of international conservation conventions and treaties to the Marshall Islands and recommendations to the Minister on their application in the Marshall Islands.

(ii) Atoll Conservation Committees.

Because the Marshall Islands are widely dispersed geographically and are comprised of small isolated atoll communities, it is essential that the support and co-operation of these communities and their traditional leaders is obtained if parks and reserves are to be established and their purpose and objectives realised. Similarly, if species conservation activities are to be effective, they too must have local community and traditional leader support. A mechanism is needed which promotes the close, co-operation of the community and its leaders in the management of these assets. It is therefore proposed that Atoll Conservation Committees with representation decided on by the community and including a Regional or Local Conservation Officer from the proposed Conservation Service, be established for this purpose.

The Atoll Conservation Committees would:

- evaluate proposals for protected areas of various kinds and for species conservation as they relate to the atoll and participate in negotiations for their establishment;
- participate with the local or regional conservation officer in the development of management plans for these areas;
- review any proposals for research and assist with scientific monitoring activities;
- general oversight of the management of any parks or reserves which may be established and community compliance with any species management controls;
- adopt and help implement policies with respect to alien plant or animal introductions.

In some cases the Committee and the community could, in effect, be the Atoll Local Council. It is also anticipated that through the close involvement of the local Conservation Committee in the management of the protected areas and in species conservation activities, management provisions which are culturally appropriate and incorporate a strong element of traditional resource management knowledge will be introduced.

(iii) Conservation Service.

To provide the managerial and technical support necessary for the effective implementation of the proposed new legislation it is proposed that a Conservation Service be established within the Ministry of Resources and Development or the Environmental Protection Authority. The principal functions of the Service would be:

- the administrative and technical servicing of the National Conservation Authority;
- liaison, advice and support to Local Atoll Conservation Committees;
- the preparation of protected area and species conservation policy management plans and related proposals;
- initiation of negotiations for protected areas and species conservation agreements;
- field management activities related to protected areas and species conservation;
- control of species exporting activities;
- development of public education programme on nature conservation;
- development and oversight of an integrated research programme and policy for the Marshall Islands;

The Service would ideally comprise the following staff:

- A Director of Conservation: as the chief executive of the Service he would be directly responsible to the for its day to day operation and the servicing of the National Conservation Authority. Other duties would include negotiations with landowners, staff appointments, financial planning, expenditure and reporting, co-ordination of an annual work programme and liaison with other government agencies and landowners.
- National Conservation Officer - based in the Majuro, this officer would be mainly responsible for the technical servicing of the EPA i.e. the development of policy, protected areas system planning, management planning, liaison, public relations and staff management and training.
- Conservation Officer - Information and Education: also based in Majuro this officer would be responsible for the development and implementation of a national conservation and wildlife education and information programme in liaison with the Education department and Alele Museum.
- Regional Conservation Officer - Radak Chain: based at Majuro or this officer would be responsible for liaison and negotiations with Atoll Conservation Committees appointed in the Radak chain and landowners, the development of parks and reserves in conjunction with the Atoll Committee's, public education activities, surveillance and enforcement activities and management planning.
- Regional Conservation Officer - Radak Chain: based on Ebeye with the same responsibilities as the other Conservation Officer Radak Chain.

Desirably both the regional officers would be from an atoll within the chain they are responsible for:

- Local Conservation Officers - Suitable local persons appointed to work with the local Conservation Committees on day to day management of parks, reserves or in species conservation programmes. Positions could be part time and appointments need only take place when parks or reserves are established and then on the advice of the local Conservation Committee. Such appointments would be necessary if the Taka or Wotho National Park proposals proceed.

5. TRAINING

Overcoming the considerable challenge of legally establishing parks and reserves is the first step in the development of an system of protected areas. However, the long term viability of the system depends to a large extent on the quality of management both in the planning and operational sense. Protected area management is a specialist task requiring skills in a wide range of areas including public relations and education, administration, planning, ecology, species conservation, facilities design and construction and law enforcement.

There are no personnel trained in protected area management skills in the Marshall Islands and training will therefore have to be organised for the Conservation Officers on their appointment. There are opportunities for training at various levels in the Pacific region, including diploma and short courses. These are outlined in a report of the East West Center (1988), based on a recent workshop involving universities and other training initiatives. Also initial practical training might be arranged through regional institutions such as SPREP and the EWC on a 'one-off' basis in the form of either:

- (i) a 3-6 month training attachment to a Parks Service in a country where there is a well developed and managed system of protected areas of e.g. New Zealand, Australia or Hawaii, or,
- (ii) through the secondment of a training officer from one of the Parks Services mentioned above to the Marshall Islands for 3-6 months.

The latter option would be preferable if two or more Conservation Officers were appointed at the outset and has the advantage of ensuring training takes place under local conditions.

6. EDUCATION

One of the important benefits of a protected area system is the opportunity it offers for the development of a public education programme in nature conservation. Such a programme can have several facets:

- (i) the development of general conservation information and educational materials e.g. pamphlets, posters, based on the species and ecosystems found within the parks and reserves;
- (ii) the production of site specific interpretative materials for each park or reserve aimed to provide tourists and other visitors with an informative background to the area and its conservation values;

- (iii) radio interviews and talks by Conservation Officers;
- (iv) visits to schools by Conservation Officers for talks on nature conservation and protected areas.

Annual (or more frequent) visits to remote parks and reserves by selected Marshallese students accompanied by knowledgeable conservation officers can be extremely valuable in fostering interest in conservation by these potential professionals and decision makers. These visits would aim to improve the student's knowledge of the atoll ecological processes and the species which inhabit the atolls. They could be both incentive and reward for scholastic achievement during the year and should be aided and subsidised by the government and organised in conjunction with the Education Department and MIMRA, the latter being in the best position to provide suitable transport via the fisheries surveillance boats.

Although each of the proposed Conservation Officers would be involved in education activities, principal responsibility for the production of the education and interpretation materials would rest with the Conservation Officer - Information.

7. RESEARCH

Research is an important part of good management of a protected area and is essential if some of the longer term objectives for controlled harvest of some species on a sustained yield basis are to be realised. However, to be effective, management orientated research must be planned, clearly related to the achievement of objectives and be compatible with those objectives. A policy on research should be developed by the Conservation Service which could require:

- (i) Director level approval for all research activities in parks and reserves based on compatibility with management objectives and in consultation with local Atoll Conservation Committees and their communities;
- (ii) researchers to submit reports during and on completion of the project;
- (iii) employment or use of local counterpart staff where appropriate;
- (iv) special permission for the taking of specimens or artifacts or the physical disturbance to the reserve. Following analysis, specimens or artifacts should be eventually lodged with a reputable agency in the Marshall Islands such as the Alele Museum.

Two very important aspects of research in a protected area are the development of a resource inventory and the monitoring of populations of important species. The inventory aims to answer the question of what species and communities occur within the protected area, where and in what numbers, and monitoring shows trends in these populations over time. (MacKinnon et.al.1986).

The inventory and a related monitoring programme are important tools for protected areas management as they provide the baseline data on which to assess the need for selective species management policies and the means of assessing the effectiveness of these policies over time. It is important to endeavour to begin the inventory for each protected area soon after it is established in order to accurately assess the recovery or change in species populations and ecosystem condition resulting from the protective status and management.

8. RESOURCES AND EQUIPMENT

Aside from the financial resources which may be necessary to secure protection of land and water held in traditional ownership, the establishment of the National Conservation Authority, Conservation Service and Atoll Conservation Committees will require a on-going commitment of funds by the government. Meeting expenses and member's fees and travel costs will have to be met for the National Conservation Authority and possibly the Atoll Conservation Committees. The costs of salaries of the Director, Conservation Officers and secretariat support for the Conservation Service will have to be met. Funds for the operating expenses of the Service, (telephone, postal, copying, travel, etc) will also be required.

In-country travel costs will potentially be high because the distances between the atolls and the need for a decentralised field service. To defray the travel costs of the Regional Conservation Officers visiting the remote, uninhabited atolls in their region, co-ordination and co-operation with the MIMRA will be vital. The MIMRA surveillance vessels *Ionmeto 1*, and *Ionmeto 2* are the only government vessels in a position to visit and carry out surveillance on a regular basis in these atolls. Establishment and subsequent liaison with local Atoll Conservation Committees will also require travel to meetings by air, as will negotiations with landowners. Funds will eventually be required for the employment of Local Conservation Officers to assist with the development and maintenance of facilities especially when the Taka and Wotho National Parks are established.

Equipment requirements will include uniforms for Conservation Officers. These are important to ensure a high public profile for the Conservation Service and for identification purposes when undertaking enforcement activities. A Conservation Service logo should also be developed and displayed prominently on uniforms, displays and literature. Should the proposed national parks at Taka and Wotho Atolls be established, suitable boats will be required for facilities development and visitor activities.

Funds will also be required for miscellaneous equipment such as tools, paint, lumber etc for the development of facilities, signs, etc. as and when parks and reserves are established.

9. CONCLUDING REMARKS

The conservation of biological diversity through the wise management of living resources, including the establishment of protected areas, is an important component of a balanced and sustainable approach to economic development and the maintenance of a nation's spiritual and cultural values. This is especially so in small Pacific island countries where long term economic and social prosperity depends on the careful management of a relatively limited resource base and the people live in close symbiosis with their environment.

With its newly independent status, there is an understandably strong desire within the RMI to press ahead with development initiatives which will establish the economic foundation for the future prosperity of the nation. Many such projects will be based on the development or exploitation of natural resources and if carefully planned and implemented, will ensure maximum benefits are obtained on a long term, sustainable basis. Examples of such projects involving small scale, low impact, locally owned tourism ventures were outlined in the report. Others however, will be ill conceived, poorly planned and will have irreversible environmental effects which may include the over-exploitation and depletion of commercially valuable living resources. Indeed, this project has revealed that some important food species are threatened and will need careful management if they are to remain available at levels which will allow sustained yield harvesting.

Until now, and with the exception of some marine resources, the need for formal species conservation and habitat protection has not been comprehensively addressed in the RMI. Thus the project has been timely. If implemented, the project report will provide the RMI with a framework for the establishment of a legally based system for the protection of representative examples of some of the best remaining and least modified natural ecosystems in the Marshall Islands. Further, it will provide for the co-ordinated and effective conservation of threatened or endangered species. Opportunities for nature based tourism, education, recreation and scientific research will be safeguarded and importantly, examples of the natural diversity of the atolls on which much of Marshallese traditional lore and custom is based, will be retained. Continued funding of the RMI Coastal Inventory and Atlas programme would provide for the valuable information on these important atolls and additional support for follow-on studies and publications for parks and protected areas.

Implementation of the report will take time and a national commitment to the concept of conservation. At the government level there must be the political will to see the legislation through and to support the protected area and species conservation programme. Perhaps more importantly however, it will also require the goodwill and support of the traditional leaders and atoll communities as it is these people who, through their ownership of the land and resources, hold the fate of the natural heritage of the Marshall Islands in their hands.

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AVIFAUNA CHECKLIST

The following checklist was prepared for each atoll surveyed and is based on the previously recorded information presented in Atoll Research Bulletin No. 127, Ornithology of the Marshall and Gilbert Islands by A. Binion Amerson, 1969 and the observations from this survey, made by P. Thomas (SPREP) and J. Juvik (EWC) neither of whom are trained ornithologists.

A list of the species observed on the survey and their common names is produced below for reference:

| | |
|-----------------------------|--------------------------|
| <i>Fregata minor</i> | Great frigate bird |
| <i>Fregata ariel</i> | Lesser frigate bird |
| <i>Sula sula</i> | Red footed booby |
| <i>Sula leucogaster</i> | Brown booby |
| <i>Sula dactylatra</i> | Masked booby |
| <i>Phaethon rubricauda</i> | Red tailed tropic bird |
| <i>Phaethon lepturus</i> | White tailed tropic bird |
| <i>Gygis alba</i> | White tern |
| <i>Anous stolidis</i> | Brown noddy |
| <i>Anous tenuirostris</i> | Black noddy |
| <i>Procelsterna cerulea</i> | Blue grey noddy |
| <i>Sterna fuscata</i> | Sooty tern |
| <i>Sterna lunata</i> | Grey backed tern |
| <i>Thalasseus bergii</i> | Great crested tern |
| <i>Sterna sumatrana</i> | Black naped tern |
| <i>Puffinus pacificus</i> | Wedge tailed shearwater |
| <i>Numenius tahitiensis</i> | Bristle thighed curlew |
| <i>Arenaria interpres</i> | Ruddy turnstone |
| <i>Heteroscelus incanus</i> | Wandering tattler |
| <i>Pluvialis dominica</i> | Lesser golden plover |
| <i>Egretta sacra</i> | Pacific reef heron |
| <i>Gallus gallus</i> | Feral hen |
| <i>Diomedea nigripes</i> | Black footed albatros |

| SPECIES | TAONGI | | BIKAR | | TAKA | | JEMO | | WOTHO | | RONGERIK | | ERIKUB | | Recorded Presence 1988 (No. Atolls) |
|---------------------------------|--------|------|-------|------|------|------|------|------|-------|------|----------|------|--------|------|---|
| | P | S | P | S | P | S | P | S | P | S | P | S | P | S | |
| 1. <i>Fregata minor</i> | ro | r/b | o | r/b | o | r/b? | r | r/b | ro | r/b? | o | r/b? | ro | r/b? | 6 |
| 2. <i>Fregata ariel</i> | | | | | | | | | | | | | ro | r/b? | 1 |
| 3. <i>Sula sula</i> | ro | r/b | ro | r/b | ro | r/b | ro | r/b | o | r/b? | o | r/b? | ro | r/b | 7 |
| 4. <i>Sula leucogaster</i> | ro | r/b | ro | r/b | ro | r/b | ro | r/b | ro | r/b? | o | r/b? | ro | r/b | 7 |
| 5. <i>Sula dactylatra</i> | ro | r/b | ro | r/b | | | | | | | | | | | 2 |
| 6. <i>Phaethon rubricauda</i> | ro | r/b | ro | r/b | ro | r/b | | | | | | | r | r/b? | 3 |
| 7. <i>Phaethon lepturus</i> | ro | r/b | ro | r/b | o | r/b? | ro | r/b? | | | | | r | r/b | 4 |
| 8. <i>Gygis alba</i> | ro | r/b | ro | r/b | ro | r/b | ro | r/b | ro | r/b | ro | r/b | ro | r/b | 7 |
| 9. <i>Anous stolidis</i> | ro | r/b | ro | r/b | ro | r/b | ro | r/b | ro | r/b | ro | r/b | ro | r/b | 7 |
| 10. <i>Anous tenuirostris</i> | ro | r/b | ro | r/b | ro | r/b | ro | r/b | ro | r/b | ro | r/b | ro | r/b | 7 |
| 11. <i>Procelsterna cerulea</i> | ro | r/b | ro | r/b | | | | | | | | | | | 2 |
| 12. <i>Sterna fuscata</i> | ro | r/b | ro | r/b | ro | r/b | r | r/b? | | | r | r/b? | | | 3 |
| 13. <i>Sterna lunata</i> | ro | r/b? | r | r/b? | | | | | | | | | | | 1 |
| 14. <i>Sterna sumatrana</i> | ro | r/b? | ro | r/b? | ro | r/b | | | ro | r/b? | ro | r/b | ro | r/b? | 6 |
| 15. <i>Thalasseus bergii</i> | ro | r/b | ro | r/b | ro | r/b | | | ro | r/b? | ro | r/b? | ro | r/b? | 6 |
| 16. <i>Puffinus pacificus</i> | ro | r/b | ro | r/b | r | r/b? | | | r | r/b? | r | r/b? | | | 2 |
| 17. <i>Puffinus nativitatus</i> | r | r/b | r | v? | | | | | | | | | | | - |
| 18. <i>Puffinus assimilis</i> | r | a | | | | | | | | | | | | | - |
| 19. <i>Bulweria bulwerii</i> | r | r/b? | | | | | | | | | | | | | - |
| 20. <i>Numenius tahitiensis</i> | ro | m | ro | m | r | m | ro | m | ro | m | ro | m | ro | m | 6 |
| 21. <i>Arenaria interpres</i> | ro | m | ro | m | ro | m | ro | m | ro | m | ro | m | ro | m | 7 |
| 22. <i>Heteroscelus incanus</i> | ro | m | ro | m | r | m | r | m | ro | m | ro | m | ro | m | 5 |
| 23. <i>Pluvialis dominica</i> | ro | m | ro | m | ro | m | ro | m | ro | m | ro | m | ro | m | 7 |
| 24. <i>Crocethia alba</i> | r | m | r | m | | | | | | | | | r | m | - |
| 25. <i>Diomedea nigripes</i> | ro | v | | | | | | | | | | | | | 1 |
| 26. <i>Egretta sacra</i> | ro | r/b? | ro | m | ro | r/b? | ro | r/b? | ro | r/b? | o | m | ro | m | 7 |
| 27. <i>Anas acuta</i> | r | a | | | | | | | | | | | | | - |
| 28. <i>Sterna anaetheta</i> | | | r | a | | | | | | | | | | | - |
| 29. <i>Actitis macularia</i> | | | | | r | vg | | | | | | | | | - |
| 30. <i>Erolia melanotos</i> | | | | | r | vg | | | | | | | | | - |
| 31. <i>Stercorarius sp.</i> | | | | | r | vg | | | | | | | | | - |
| 32. <i>Gallus gallus</i> | | | | | | | r | | ro | i/b | | | | | 1 |
| 33. <i>Cairina moschata</i> | | | | | | | | | r | i/b | | | | | - |
| 34. <i>Numenius phaeopus</i> | | | | | | | | | r | m | | | | | - |
| 35. <i>Chen hyperborea</i> | | | | | | | | | | | | | r | a | - |

Species observed 1988 Survey 21 19 14 10 14 13 14
New species observed - - 1 - 1 3 -

NOTATIONS: r: previously recorded; ro: observed 1988 survey; r/b: resident breeder; r/b?: possible r/b
v: visitor at sea; vg: vagrant; m: migrant; i/b: introduced breeder; P: Presence; S: Status

LIST OF EXCEPTIONAL CORAL REEF SITES NOTED DURING THE SURVEY

The following sites exhibited or comprised either coral communities of high diversity or development, unique geomorphological features, high levels of fish abundance or unusual shellfish development. They are considered suitably unique or unusual to make them worthy of recognition, protection and education or visitor interest. Site numbers are shown on Atoll Maps 2-8 in the report.

TAONGI - 7 Sites (Map 2)

Site 1 C Corals and Shipwreck
 Site 1 G Corals, clams and raised lagoon reef
 Site 1 H Corner reef with high coral and fish abundance
 Site 1 I Corals and raised lagoon reef
 Site 1 K Corals and lagoon ribbon reefs
 Site 1 N Lagoon pinnacle with unique, diverse corals
 Site 1 S Leeward ocean pinnacle and diverse corals

BIKAR - 3 Sites (Map 3)

Site 2 A Accessible lagoon back reef near Bikar Island
 Site 2 B Unique and diverse corals and lagoon fringe reef
 Site 2 L Leeward ocean reef slope

TAKA - 4 Sites (Map 4)

3 E Lagoon pinnacle with high coral development near reef corner
 3 G Back reef pinnacle with high fish abundance and diverse coral
 3 K Reef pool and coral mounds in transition pass
 3 L Pass habitat in lagoon reef area

JEMO - 2 Sites (Map 5)

4 A Accessible ocean reef slope and reef flat protected by island with high coral and fish abundance
 4 E Semi-palmated reef embayment with high coral

WOTHO - 4 Sites (Map 6)

5 A Back reef pinnacle with high coral and giant clams
 5 G High giant clam area
 5 K High coral area in transition from lagoon to pass
 5 L Leeward ocean reef high in coral, fish and shark abundance

RONGERIK - 6 Sites (Map 7)

- 6 A Open windward lagoon deep reef flat
- 6 G Unique blue coral mount next to islet
- 6 I Flourishing corals and fish on deep lagoon pinnacle
- 6 J Back reef pinnacle and corals
- 6 K Back reef and lagoon pinnacles with high coral abundance
- 6 F Pink foram beaches on Rongerik islet and accessible offshore pinnacles

ERIKUB - 4 Sites (Map 8)

- 7 D High coral abundance and diversity on back reef
- 7 G High fish, coral and single giant clam site
- 7 I Lagoon back reef pinnacle
- 7 K Transition pass and lagoon reef high in coral abundance

The number of sites worthy of special consideration or protection is 31 of the 96 surveyed. All sites should be briefly described and located on all atoll charts. They should not be "ranked" for individual site (station) protection. This "waters down" the concept of protection if select sites are given such status within each lagoon. A more thorough survey may find areas which are more deserving of protection.

PRINCIPAL MARINE RESOURCE RANKINGS

| RESOURCE | RANKING | | | | | | |
|---|------------|---------------------|-------------|------------|--------------|-------------|------------|
| | TAONGI | BIKAR | TAKA | JEMO | WOTHO | RONGERIK | ERIKUB |
| 1. Green turtle nesting: Pairs of track sighted in () | 7 (0) | 1 (264) | 5 (24) | 2 (53) | 6 (8) | 4 (34) | 3 (49) |
| 2. Live giant clam Abundance: No. of live T. gigas obs/(No. of dead T. gigas) | 6 0/(0) | 5 0/(18)* 0/0 | 2 5/(27) | 6 0/(0) | 1 15/(16) | 3 4/(16) | 4 1/(0) |
| 3. Small clam species abundance (T. maxima, Hippopus hippopus, T. squamosa) | 1 | 2 | 3 | 7 | 5 | 4 | 6 |
| 4. Diversity of Fish species | 7 | 1 | 3 | 6 | 4 | 2 | 5 |
| 5. Reef fish - abun- dance and size (reflects fishing pressure) | 1 | 2 | 5 | 4 | 6 | 3 | 7 |
| 6. Coconut crab abundance | 4 | 4 | 4 | 4 | 3 | 1 | 2 |
| Atoll Ranking score | 26 | 15 | 22 | 29 | 25 | 17 | 27 |
| Overall Ranking | 5 | 1 | 3 | 7 | 4 | 2 | 6 |

ASSESSMENT FOR HISTORIC PRESERVATION IMPORTANCE

Based solely on the apparent richness and research potential of the archaeological resources in the surveyed areas, the following ranking would be applicable (from most to least significant for historic preservation):

1. Wotho Atoll
2. Erikub Atoll
3. Jemo Islet
4. Rongerik Atoll
5. Taka Atoll
6. Taongi Atoll
7. Bikar Atoll

Wotho, Erikub and Rongerik are the most amenable for incorporation into educational/tourist development.

Intensive archaeological studies are recommended for the larger islets of Wotho, Erikub, Jemo, Rongerik and Taka Atolls. Minor archaeological investigations are recommended for small specific areas of Taongi and Bikar only if there is to be some form of direct development.

RELATIVE INDEX OF AVIFAUNA DIVERSITY AND ABUNDANCE

In order to facilitate a general comparison between atolls with respect to bird diversity and abundance, a crude index was constructed using parameters collected in the September 1988 Survey. The aggregate atoll index value was calculated as a sum score of the following parameters:

- a) species presence (1 pt)
- b) species confirmed resident breeder (1 pt)
- c) species large bodied (food resource species) (2 pts)
- d) species with large atoll population exceeding 1000 birds (2 pts)
- e) rare species (occurring on two or less of the atolls surveyed and with a total atoll population of less than 100 birds).

| ATOLL | BIRD SPECIES RECORDED 1988 SURVEY | ATOLL DIVERSITY ABUNDANCE INDEX | RANK |
|----------|--------------------------------------|------------------------------------|------|
| TAONGI | 20 | 52 | 1 |
| BIKAR | 19 | 45 | 2 |
| RONGERIK | 13 | 32 | 3 |
| TAKA | 14 | 31 | 4 |
| ERIKUB | 14 | 29 | 5 |
| WOTHO | 12 | 23 | 6 |
| JEMO | 10 | 16 | 7 |

**CHECKLIST OF THE VASCULAR PLANTS OF SIX ATOLLS AND
ONE ISLAND OF THE NORTHERN MARSHALL ISLANDS**

This checklist is based upon observations made on 9-23 September 1988, during a reconnaissance survey of 40 islets in six atolls and Jemo Island, Marshall Islands, and on information gathered during a search of pertinent botanical literature. Each entry is alphabetised under its family name and includes the scientific name, the common name (if known), the status of the species and its relative abundance. The symbols used in column 1, the status column are:

N = native to the Marshall Islands,

X = exotic, i.e. alien species of accidental or deliberate introduction to the islands and are cultivated or have become naturalised there.

The remaining columns list the species growing on each atoll or island. Relative abundance ratings are given for each species. These ratings are based upon the frequency with which the species occurs on each atoll or island, as compared to all other species on that atoll or island. It does not include the abundance of the species throughout the 41 islets and islands surveyed. The symbols are:

A = abundant,

C = common,

O = occasional,

U = uncommon,

R = rare.

Three other symbols are used in the list:

P = propagated, i.e. the species was found only as a cultivated plant in a garden or as a landscape plant around a house.

L = literature, i.e. the species was not observed during this survey, but references were found to its presence during the literature search.

* = new atoll or island record.

The common names are from the Marshallese-English Dictionary, A. Takaji et. al., University Press of Hawaii, 1976.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 ⁺ |
|---|---|---|---|---|----|----|----|----------------|
| PTERIDOPHYTA | | | | | | | | |
| Polypodiaceae | | | | | | | | |
| Asplenium nidus L. (kartōp) | N | - | - | - | - | - | - | U |
| Phymatosorus scolopendria (Burm. f.) Pichi Sermolli (kino) | N | - | - | 0 | - | 0 | - | 0 |
| MONOCOTYLEDONAE | | | | | | | | |
| Araceae | | | | | | | | |
| Cyrtosperma chamissonis (Schott) Merr. | X | - | - | - | - | P | - | - |
| Arecaceae | | | | | | | | |
| Cocos nucifera L. (ni) | X | - | 0 | C | A | A | A | C |
| Cyperaceae | | | | | | | | |
| Cyperus odoratus L. | N | - | - | - | - | U | - | - |
| Fimbristylis cymosa R. Br. (drolijman) | N | - | - | U | - | U | U* | R |
| Liliaceae. | | | | | | | | |
| Agave sisalana Perrine | X | - | - | - | 0 | - | - | - |
| Crinum bakeri Schum. | N | - | - | - | - | P | - | - |
| Musaceae | | | | | | | | |
| Musa xparadisiaca L. (keeprān) | X | - | - | - | - | P* | - | - |
| Pandanaaceae | | | | | | | | |
| Pandanus tectorius Park. ex Z. (bob) | N | - | L | U | 0 | 0 | 0 | 0 |
| Poaceae | | | | | | | | |
| Cenchrus echinatus L. (lōklōk) | X | - | - | - | L | U* | - | - |
| Dactyloctenium aegyptium (L.) Willd. | X | - | - | - | - | O* | - | - |
| Digitaria radicata (Presl) Miq. | N | - | - | U | - | - | - | - |
| Digitaria setigera Roth | N | - | - | - | 0 | U | R* | - |
| Eleusine indica (L.) Gaertn. (katejukjuk) | X | - | - | - | L | U | - | - |
| Eragrostis scabriflora Swallen | X | - | - | - | - | - | R* | - |
| Eragrostis tenella (L.) R. & S. (ujoiij) | X | - | - | U | L | 0 | L | - |
| Eustachys petraea (Sw.) Desv. | X | - | - | - | - | O* | - | - |
| Lepturus gasparricensis Fosb. | N | U | - | - | - | - | - | - |
| Lepturus repens (Forst. f.) R.Br. (ujoiij) | N | A | C | C | 0 | C | A | A |
| Paspalum distichum L. | N | - | - | - | - | U* | - | - |
| Thuarea involuta (Forst. f.) R. & S. (kakkūmkūm) | N | - | - | - | - | U | - | - |
| Taccaceae | | | | | | | | |
| Tacca leontopetaloides (L.) O. Ktze. (makmōk) | X | - | - | - | L | 0 | C | C |
| DICOTYLEDONAE | | | | | | | | |
| Acanthaceae | | | | | | | | |
| Pseuderanthemum carruthersii (Seem.) Guill. var. carruthersii | X | - | - | - | P* | L | - | - |
| Pseuderanthemum carruthersii var. atropurpureum (Bull) Fosb. (tirooj) | X | - | - | - | P* | - | - | - |

* 1/ status; Atolls and Islands; 2/ Taongi Atoll; 3/ Bikar Atoll; 4/ Taka Atoll; 5/ Jemo Island; 6/ Wocho Atoll; 7/ Rongerik Atoll; 8/ Erikub Atoll.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|--|---|---|---|---|----|----|----|----|
| Amaranthaceae | | | | | | | | |
| Achyranthes canescens R. Br. | N | - | - | L | L | - | - | O* |
| Apocynaceae | | | | | | | | |
| Neisosperma oppositifolia (Lam.) Fosb. & Sachet (kōjbar) | N | - | - | - | - | O | - | U |
| Plumeria sp. (meria) | X | - | - | - | - | P* | - | - |
| Asteraceae | | | | | | | | |
| Pluchea symphytifolia (Mill.) Gillis | X | - | - | - | - | - | U* | - |
| Vernonia cinerea (L.) Less. (jānaelōm-nan-aelōm) | X | - | - | - | U | - | - | - |
| Wedelia biflora (L.) DC. (markūbwebwe) | N | - | - | - | - | C | - | L |
| Boraginaceae | | | | | | | | |
| Cordia subcordata Lam. (kōno) | N | - | - | - | O | R | O | O* |
| Tournefortia argentea L. f. (kiden) | N | A | C | A | C | A | A | A* |
| Caricaceae | | | | | | | | |
| Carica papaya L. (keinabbu) | X | - | - | L | L | P* | - | - |
| Clusiaceae | | | | | | | | |
| Calophyllum inophyllum L. (jijo, lukwej) | N | - | - | - | L | U | L | U |
| Combretaceae | | | | | | | | |
| Terminalia samoensis Rech. (kkōm) | N | - | - | O | U | O | O | C |
| Convolvulaceae | | | | | | | | |
| Ipomoea batatas (L.) Lam. (piteto) | X | - | - | - | - | P | - | - |
| Ipomoea macrantha R. & S. (marpele) | N | U | - | R | C | O | O | O |
| Ipomoea pes-caprae ssp. brasiliensis (L.) v. Ooststr. | N | - | - | - | R* | - | - | - |
| Cucurbitaceae | | | | | | | | |
| Cucurbita pepo L. (baañke) | X | - | - | - | - | P* | - | - |
| Euphorbiaceae | | | | | | | | |
| Chamaesyce chamissonis (Boiss.) F. C. Ho (bedrol) | N | - | - | - | R* | L | - | - |
| Chamaesyce hirta (L.) Millsp. | X | - | - | - | L | O* | U* | - |
| Chamaesyce hypericifolia (L.) Millsp. | X | - | - | - | - | - | U* | - |
| Chamaesyce maculata (L.) Small | X | - | - | - | - | - | U* | - |
| Chamaesyce prostrata (Ait.) Small | X | - | - | - | L | - | - | - |
| Phyllanthus amarus Sch. & Th. (jiljino awa) | X | - | - | - | C | O* | - | - |
| Fabaceae | | | | | | | | |
| Caesalpinia sp. | N | - | - | - | - | - | R* | L |
| Canavalia cathartica Thou. (marlap) | N | - | - | - | A | C | R* | O |
| Entada phaseoloides (L.) Merr. | N | - | - | - | R* | - | - | - |
| Intsia bijuga (Colebr.) O. ktze (kabok) | N | - | - | - | - | R | - | O* |
| Vigna marina (Burm.) Merr. (markinenjojo) | N | - | - | - | - | O | - | U* |
| Goodeniaceae | | | | | | | | |
| Scaevola sericea Vahl (kōnnat) | N | C | O | C | C | A | A | C* |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|--|---|---|---|---|---|----|----|----|
| Hernandiaceae | | | | | | | | |
| Hernandia sonora L. (piñipiñ) | N | - | - | - | - | L | - | - |
| Lauraceae | | | | | | | | |
| Cassytha filiformis L. (kaōnōn) | N | - | - | U | L | C | C | O |
| Lythraceae | | | | | | | | |
| Pemphis acidula Forst. (kiej, kiejor, kōnē) | N | - | - | U | - | L | U* | - |
| Malvaceae | | | | | | | | |
| Sida fallax walp. (kio) | N | O | - | U | - | L | O | - |
| Moraceae | | | | | | | | |
| Artocarpus attilis (Pard. ex Z.) Fosb. (mā) | N | - | - | - | L | P | - | - |
| Artocarpus mariannensis Tree. | N | - | - | - | L | - | - | - |
| Nyctaginaceae | | | | | | | | |
| Boerhavia albiflora Fosb. | N | - | - | - | - | - | R | - |
| Boerhavia repens L. | N | - | C | C | - | U* | O | - |
| Boerhavia tetrandra Forst. f. (marmilliñ) | N | C | - | O | O | O | C | C |
| Bougainvillea spectabilis Wild. (ikdrelel) | X | - | - | - | - | P* | - | - |
| Mirabilis jalapa L. (emān-awa) | X | - | - | - | - | L | - | - |
| Pisonia grandis R. Br. (kañal) | N | U | C | C | O | C | C | O* |
| Portulacaceae | | | | | | | | |
| Portulaca australis Endl. (bujon) | N | - | - | - | - | L | U | - |
| Portulaca lutea Forst. f. (kūrañ) | N | C | O | A | - | L | O* | - |
| Portulaca oleracea L. (kūrañ) | X | - | - | L | - | O* | - | - |
| Rubiaceae | | | | | | | | |
| Guettarda speciosa L. (utilomar) | N | - | - | O | L | C | C | C |
| Morinda citrifolia L. (kalenen, nen) | X | - | - | U | O | O | O | O |
| Sapindaceae | | | | | | | | |
| Allophylus timoriensis (DC.) Bl. (kūtaak) | N | - | - | - | - | O | - | O* |
| Dodonaea viscosa (L.) Jacq. | N | - | - | - | - | O* | - | - |
| Simaroubaceae | | | | | | | | |
| Soulamea amara Lam. (kabwijiñ) | N | - | - | - | - | C | L | - |
| Solanaceae | | | | | | | | |
| Physalis angulata L. (kaōrōr) | X | - | - | - | C | - | - | - |
| Surianaceae | | | | | | | | |
| Suriana maritima L. (ñeñe) | N | - | - | U | - | O | O | U |
| Tiliaceae | | | | | | | | |
| Triumfetta procumbens Forst. f. (atat) | N | - | R | O | U | O | O | C |
| Urticaceae | | | | | | | | |
| Laportea ruderalis (Forst. f.) Chew (neen, Kōtkōt) | N | - | - | O | U | U* | O* | C |

NEW ATOLL RECORDS

Taongi

None--9 spp. known from the atoll--all seen.

Bikar

None--9 spp. known from atoll--all but Pandanus seen.

Taka

None--found a collection in Oct. 1964 by Kenneth Amerman.

Jemo

5 new records--Entada phaseoloides, Chamaesyce chamissonis, and Ipomoea pes-caprae--all native--and two varieties of Pseuderanthemum carruthersii--a planted ornamental.

Wotho

15 new records

cultivated: Musa xparadisiaca, Plumeria sp., carica papaya, cucurbita pepo, Bougainvillea spectabilis.

weeds: Cenchrus echinatus, Dactyloctenium aegyptium, Eustachys petraea, Chamaesyce hirta, Phyllanthus amarus, Portulaca oleracea.

Native: Paspalum distichum, Boerhavia repens, Dodonaea viscosa, Laportea ruderalis.

Rongerik

12 new records

weeds: Eragrostis scabriflora, Pluchea symphytifolia, Chamaesyce hirta, C. hypericifolia, C. maculata.

Native: Fimbristylis cymosa, Digitaria setigera, Canavalia cathartica, Pemphis acidula, Portulaca lutea, Laportea ruderalis, Caesalpinia sp.

Erikub

8 new records

Native: Achyranthes canescens, Cordia subcordata, Tournefortia argentea, Intsia bijuga, Vigna marina, Scaevola sericea, Pisonia grandis, Allophylus timoriensis

**PROPOSED PROTECTED AREAS AND SPECIES CONSERVATION LEGISLATION
FOR THE REPUBLIC OF THE MARSHALL ISLANDS.**

The following is a suggested outline of legislation which would enable the establishment of a legal and administrative framework for the co-ordinated development and implementation of policies and programmes for nature conservation and protected areas in the Marshall Islands.

- Title e.g. The RMI Nature Conservation Act.
- A Statement of Purpose e.g. to provide for the protection and conservation of representative examples of the natural ecosystems and diversity of the RMI, and the protection of its biological scenic and cultural heritage.
- Definitions of terms used.
- Part I. Administration of the Act
 - Identifies the Minister responsible.
 - Provides for establishment of the National Conservation Authority, representation, functions, powers and relationships with other agencies.
 - provides for the establishment of the Conservation Service and its staffing.
 - Provides for the establishment of other policy and management agencies e.g. Atoll Conservation Committees.
 - Empowers the negotiation of protected areas and signing of agreements by the Minister on the recommendation of the administering authority.
 - Provides for consultation with other agencies.
 - Identifies sources of revenue and resources needed for administration of Act.
 - Provides for delegations of power to the Director of Conservation and his staff and to Atoll Conservation Committees.
- Part II. Parks and preserves
 - Identifies categories of protected areas including the purpose and management objectives of each category. (See Part I, Section 3.2).
 - Defines the authority and procedures for establishing protected areas: i.e.
 - declaration of protected areas by Minister on completion of satisfactory negotiations with landowners and Atoll Conservation Committees.
 - definition of boundaries and legal description
 - public notification and provisions for objectives to be heard by administering authority.
 - registration of the negotiated agreements, leases, etc.
 - provisions for alteration of agreements, boundaries, and revocation of status or agreement.
 - Provisions for the preparation of management plans and public involvement in planning process.
 - Provisions for the permitting, control and accountability of commercial activities in parks and reserves.

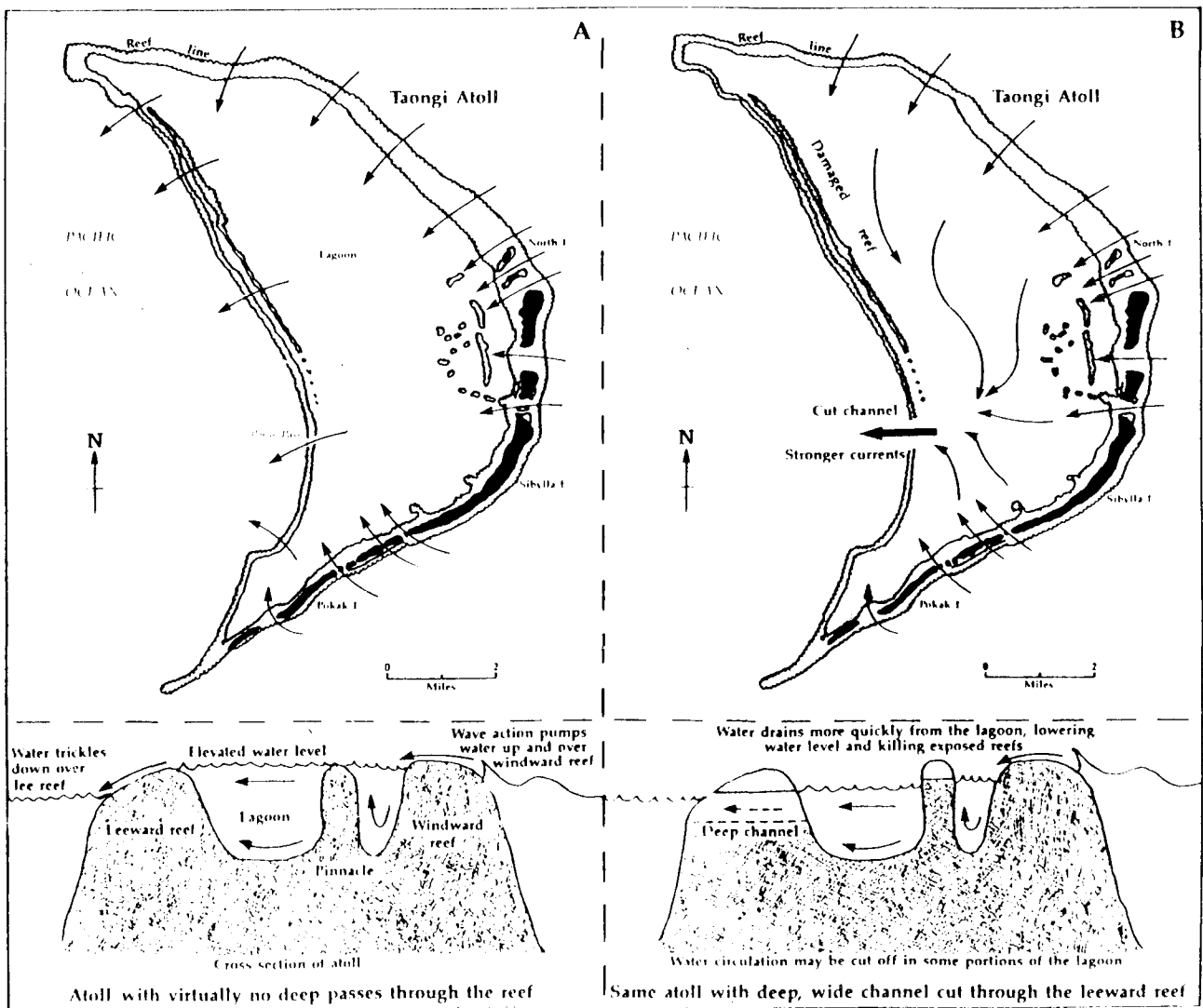
- Part III Species Conservation.
 - Provision of the authority to declare any living natural resource (plant or animal) protected e.g. Minister and/or delegation of that authority to the National Conservation Authority or Director of Conservation.
 - Provisions for the establishment of endangered or threatened species management agreements with local communities.
 - Provision for the public notification of protected species, locations and their inclusion on a schedule of protected species.
 - Provision for the notification of management controls relating to the protection of species e.g. seasonal hunting, catch limits or quotas.
 - Provision for the revocation of protected status.
 - Provisions for the control of trade in animal and plants including marine flora and fauna, licensing of exporters and issue of permits.
 - Provision for the management of biota and biotic research including permits for overseas researchers.
 - Provision for the prevention of the introduction of alien plant and animal species.

- Part IV. Public Education and General.
 - Provision for the administering agency to carry out nature conservation education activities in conjunction with other agencies.
 - Provision for the recognition of the relevance and application of international conventions and treaties e.g. World Heritage Convention, the Convention on Trade in Endangered Species (CITES).

- Part V. Enforcement, Offences and Regulations.
 - Provision for the enforcement of the Act including: delegation of powers of appropriate officers, including powers of arrest, search and seizure.
 - Offences against officers
 - Offences under the Act.
 - Provisions for disposal of confiscated equipment, vehicles, etc.
 - Power and authority to make regulations for the detailed management of the Act.

IMPACT OF CHANNEL MODIFICATION ON SEMI ENCLOSED ATOLL LAGOONS

The diagram illustrates the possible adverse effects of cutting channels through semi enclosed atoll lagoons. Many atolls (such as Taongi, which is pictured) have elevated lagoon water levels because of wave action pumping water over windward reefs and the lack of large, deep channels to drain the excess water. The reefs grow above normal ocean sea level because of constant water flow and in response to higher lagoon water level. Cutting a deep channel through such an atoll reef would cause waters to drain more quickly, lowering lagoon water level and killing emergent reefs (after J.E. Maragos, 1989).



Check list of corals observed in the North Marshall Islands, September 1988.

P = Pokak Atoll, B = Bikar Atoll, T = Taka Atoll, J = Jemo Island, W = Wotho Atoll, R = Rongerik Atoll, and E = Erikub Atoll (after J.E. Maragos, 1989)

Stony Corals

FAMILY ACROPORIDAE

- Acropora abrotanoides (Lamarck) - P, B
A. aculeus (Dana) - P, B
A. acuminata Verrill - P, B, T, W
A. austera (Dana) - P, W, E
A. cerealis (Dana) - P, B
A. cytherea (Dana) - T, J, W, R, E
A. danai (Edwards and Haime) - P
A. digitifera (Dana) - P, B, T, J, W
A. diversa (Brook) - B
A. formosa (Dana) - P, B, T, W, R, E
A. florida (Dana) - W, R, E
A. gemmifera (Brook) - P, B, W, E
A. grandis (Brook) - W
A. granulosa (Bernard) - B, W
A. glauca (Brook) - P, T, W
A. horrida (Dana) - W
A. humilis (Dana) - P, B, T, W, R, E
A. hyacinthus (Dana) - B, T, W
A. irregularis Brook - P, B, T, W
A. lovelli Veron and Wallace - P, B, W, E
A. microphthalma Verrill - P
A. millepora (Ehrenberg) - W
A. nasuta (Dana) - P, B, T, W, R, E
A. robusta (Dana) - E
A. nobilis (Dana) - P, W
A. polystoma (Brook) - P, B, T, W
A. selago (Studer) - P, B, T, W
A. surculosa (Dana) - P, B, T, W, R, E
A. syringodes (Brook) - W
A. squarrosa (Ehrenberg) - B
A. tenuis (Dana) - P
A. vauhani Wells - P, B, T, W
A. yongei Veron and Wallace - P, B, W
A. spp (6) - B, R, E
Acropora (Isopora) palifera (Lamarck) - P, B, J, R, E
A. (I) brueggemanni (Brook) - B
A. (I) cuneata (Dana) - W, R
Anacropora forbesi Ridley - P
Astreopora explanata Veron - P, T, R, E
A. gracilis Bernard - P, B, T, J, W, E
A. listeri Bernard - P, T, R
A. myriophthalma (Lamarck) - P, B, T, J, W, R, E
A. sp. (1) - T, R, E

Montipora aequituberculata Bernard - P, B, J, W, R, E
M. caliculata (Dana) - P
M. foliosa (Pallas) - P, B, T, J
M. foveolata (Dana) - P, B, T, J, W, R, E
M. hoffmeisteri Wells - P, B, T, W, R
M. informis (Bernard) - T, W, R
M. marshallensis Wells - P, B
M. monasteriata (Forskål) - B
M. tuberculosa (Lamarck) - P, B, T, J, R, E
M. venosa (Ehrenberg) - P, T, W
M. verrucosa (Lamarck) - P, B, T, W, R, E
M. spp (3) - P, T, R, E

FAMILY ASTROCOENIIDAE

Stylocoeniella armata (Ehrenberg) - P, B, T

FAMILY POCILLOPORIDAE

Pocillopora damicornis (Linnaeus) - P, B, W, R, E
P. brevicornis Lamarck - P
P. eydouxi Edwards and Haime - P, B, R
P. meandrina Dana - P, B, T, J, W, R, E
P. verrucosa (Ellis and Solander) - P, B, T, J, W, R, E
Seriatopora hystrix Dana - P, B, T, W, R, E
S. angulata Klunzinger - P, B, T, W, R, E
Stylophora pistillata (Esper) - P, B, T, W, R, E

FAMILY PORITIDAE

Goniopora lobata Edwards & Haime - P, E
G. columna Dana - T, W
Porites australiensis Vaughan - P, B, T, J, R, E
P. cylindrica Dana - P, B, T, W, R, E
P. lichen Dana - P, B, T, J, W, R, E
P. lobata Dana - P, B, T, J, W, R, E
P. lutea Edwards & Haime - P, B, T, W, R, E
P. murrayensis Vaughan - P, B, W
P. solida (Forskål) - B
P. superfusa Gardiner - P, R
P. vauhani Wells - T, W, E
P. spp (2) - R
Porites (Synaraea) rus (Forskål) - T, W

FAMILY SIDERASTREIDAE

Coscinaraea columna (Dana) - B, T, W, R, E
Psammocora haimeana Edwards & Haime - T
P. nierstraszi Van der Horst - P
P. profundacella Gardiner - P, B, T, E

FAMILY AGARICIIDAE

- Pavona clavus (Dana) - P, B, T
P. minuta Wells - P, B, J, W, R, E
P. varians Verrill - P, B, T, W, R, E
P. venosa Ehrenberg - B
P. maldivensis (Gardiner) - P, T
Leptoseris mycetoseroides Wells - P, B, T, E

FAMILY FUNGIIDAE

- Fungia fungites (Linnaeus) - P, B, W, E
F. (Danafungia) valida Verrill - P, B, T, W, E
F. (D) horrida Dana - E
F. (Pleuractis) paumotensis Stutchbury - T, W, R, E
F. (P) scutaria Lamarck - P, B, T, R, E
F. (Verrillofungia) concinna Verrill - B, W, R
F. (V) repanda Dana - P, W, R, E
Cycloseris sp - W
Halomitra pileus (Linnaeus) - W
Herpolitha limax (Houttyun) - P, B, T, W, E
Polyphyllia talpina Lamarck - W
Sandalolitha robusta (Quelch) - T, W

FAMILY MUSSIDAE

- Acanthastrea echinata (Dana) - B
Lobophyllia hemprichii (Ehrenberg) - P, B, T
L. hataii Yabe, Sugiyama and Eguchi - B
L. corymbosa (Forskål) - P, T, R
Symphyllia radians Edwards & Haime - P, B, W, R, E
S. recta (Dana) - P, B, J

FAMILY MERULINIDAE

- Hydnophora microconos Lamarck) - P, B, J, E
Scapophyllia cylindrica Edwards & Haime - P, B, T, W, R, E

FAMILY FAVIIDAE

- Favia spp (2) - B, T, J, W, R, E
F. matthaii Vaughan - P, B, T, W, R, E
F. pallida (Dana) - P, B, T, W, R, E
F. rotundata (Veron, Pichon, & Best) - B, T
F. speciosa (Dana) - P, B, T, W, R, E
F. stelligera (Dana) - P, B, T, W, E
Favites flexuosa (Dana) - P, B, T, W, R
F. halicora (Ehrenberg) - P, B, T, R
F. spp (2) - P, B, J, W, R
Ganiastrea edwardsi Chevalier - P, B, T, W
G. pectinata (Ehrenberg) - P, B, T, R
G. retiformis (Lamarck) - P, B, T, W, R, E
Leptoria phrygia (Ellis & Solander) - P, B, W
Plesiastrea versipora (Lamarck) - R
Oulophyllia crispa (Lamarck) - P, T, W, R
Platygyra daedalea (Ellis & Solander) - P, B, T, J, W, R, E
P. pini Chevalier - P, W
P. sinensis (Edwards & Haime) - P
P. lamellina (Ehrenberg) - P
P. sp (1) - E
Leptastrea purpurea (Dana) - P, B, T, J, W, R, E
L. transversa (Klunzinger) - B, R, E
L. sp (1) - B, T
Cyphastrea serailea (Forskål) - B, R
C. microphthalma (Lamarck) - P, B, T, W, R, E
Echinopora lamellosa (Esper) - P, B, T, R, E
E. sp (1) - R, E
Montastrea curta (Dana) - P, B, T, W, R, E

FAMILY HELIOPORIDAE

- Heliopora coerulea (Pallas) - P, B, T, J, W, R, E

FAMILY MILLEPORIDAE

- Millepora platyphylla Hemprich and Ehrenberg - P, T, J, W, R, E
M. exaesa (Forskål) - P, T, W, R, E
M. dichotoma (Forskål) - P, B, R, E

FAMILY PECTINIIDAE

- Pectinia lactuca (Pallas) - B

FAMILY TUBIPORIDAE

- Tubipora musica (Linnaeus) - P, W, R, E

FAMILY DENDROPHYLLIDAE

Turbinaria frondens (Dana) - B
T. stellulata Lamarck - P, B, T, W, R, E
T. sp (1) - R

FAMILY STYLASTERIDAE

Stylaster sp (1) - P, E
Distichopora violacea (Pallas) - B

FAMILY CARYOPHYLLIDAE

Euphyllia glabrescens Chamisso & Eysenhardt - E

SOFT CORALS

Sinularia sp (1) - P, B, T, J, W, R, E
Sarcophytum sp (1) - P, B, T, W, E
Xenia sp (1) - B, W
 colonial clownfish anemones - E
Palythoa sp (1) - R
 unidentified alcyonacean - E

TOTALS genera and (subgenera): 50 + 5 = 55
 species: 164

Relative diversity and distribution of major stony coral genera (and subgenera) and species observed in shallow water at seven northern Marshall atolls in Sep 1988. After Maragos (1989).

NUMBER OF SPECIES AT EACH ATOLL

| <u>NAME OF GENUS (OR) SUBGENUS</u> | <u>POKAK ATOLL</u> | <u>BIKAR ATOLL</u> | <u>TAKA ATOLL</u> | <u>JEMO ISLAND</u> | <u>WOTHO ATOLL</u> | <u>RONGERIK ATOLL</u> | <u>ERIKUB ATOLL</u> | <u>TOTALS</u> |
|--|------------------------|------------------------|-----------------------|------------------------|------------------------|---------------------------|-------------------------|---------------|
| Acropora | 22 | 21 | 17 | 10 | 26 | 11 | 12 | 40 |
| (Isopora) | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 3 |
| Anacropora | 1 | | | | | | | 1 |
| Astreopora | 4 | 2 | 5 | 2 | 2 | 4 | 4 | 5 |
| Montipora | 8 | 8 | 8 | 4 | 6 | 7 | 6 | 15 |
| Stylocoeniella | 1 | 1 | 1 | | | | | 1 |
| Pocillopora | 5 | 4 | 2 | 2 | 3 | 4 | 3 | 5 |
| Seriatopora | 2 | 2 | 2 | | 2 | 2 | 2 | 2 |
| Stylophora | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| Goniopora | 1 | | 1 | | 1 | | 1 | 2 |
| Porites | 7 | 7 | 6 | 3 | 7 | 7 | 7 | 11 |
| (Synaraea) | | | 1 | | 1 | | | 1 |
| Coscinaraea | | 1 | 1 | | 1 | 1 | 1 | 1 |
| Psammocora | 1 | | 2 | | | | 1 | 3 |
| Pavona | 3 | 4 | 3 | 1 | 2 | 2 | 2 | 5 |
| Leptoseris | 1 | 1 | 1 | ? | | | 1 | 1 |
| Fungia | 1 | 1 | 1 | | 1 | | 1 | 1 |
| (Danafungia) | 1 | 1 | 1 | | 1 | | 2 | 2 |
| (Pleuractis) | 1 | 1 | 2 | | 1 | 2 | 2 | 2 |
| (Verrillofungia) | 1 | | 1 | | 2 | 2 | 1 | 2 |
| Cycloseris | | | | | 1 | | | 1 |
| Halomitra | | | | | 1 | | | 1 |
| Herpolitha | 1 | 1 | 1 | | 1 | | 1 | 1 |
| Polyphyllia | | | | | 1 | | | 1 |
| Sandalolitha | | | 1 | | 1 | | | 1 |
| Acanthastrea | | 1 | | | | | | 1 |
| Lobophyllia | 2 | 2 | 2 | | | 1 | | 3 |
| Symphyllia | 2 | 2 | ? | 1 | 1 | 1 | 1 | 2 |
| Hydnophora | 1 | 1 | ? | 1 | | | 1 | 1 |
| Scapophyllia | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| Favia | 4 | 5 | 5 | 3 | 4 | 4 | 5 | 7 |
| Favites | 2 | 3 | 2 | 1 | 3 | 3 | 1 | 4 |
| Goniastrea | 2 | 3 | 3 | ? | 2 | 2 | 1 | 3 |
| Leptoria | 1 | 1 | ? | | 1 | | | 1 |
| Plesiastrea | | | | | | 1 | | 1 |
| Oulophyllia | 1 | | 1 | | 1 | 1 | | 1 |
| Platygyra | 3 | 3 | 1 | 1 | 3 | 1 | 2 | 4 |
| Leptastrea | 1 | 3 | 2 | 1 | 1 | 2 | 2 | 3 |
| Cyphastrea | 1 | 1 | 1 | | 1 | 2 | 1 | 2 |
| Echinopora | 1 | 1 | 1 | | | 2 | 2 | 2 |
| Montastrea | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| Heliopora | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Millepora | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 3 |
| Pectinia | | 1 | | | | | | 1 |
| Tubipora | 1 | | | | 1 | 1 | 1 | 1 |
| Turbinaria | 1 | 2 | 1 | | 1 | 2 | 1 | 3 |
| Stylaster | 1 | | ? | | ? | | 1 | 1 |
| Distichopora | | 1 | ? | | ? | | | 1 |
| Euphyllia | | | | | | | 1 | 1 |
| TOTALS: 49 | 38 | 35 | 35 | 15 | 36 | 29 | 35 | |
| GENERA, & SPECIES PER ATOLL | 93 | 93 | 93 | 33 | 88 | 74 | 75 | 158 |