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The Recruitment and Application of Scientific Information in Coastal and Marine Resources Management: Analog to the Galápagos Islands

by

Scott McCreary

May 1985

Technical Report

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INFORMATION IN COASTAL AND MARINE
RESOURCES MANAGEMENT:
ANALOGS TO THE GALAPAGOS ISLANDS

by

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Approved for distribution:

David A. Ross
Director, MPOM

ABSTRACT

This report discusses the recruitment and use of scientific information for coastal resources management in archipelagos, the Cape Verde Islands and the Republic of the Seychelles, that share certain features with the Galápagos Islands of Ecuador. Three international coastal resources management programs -- the UNESCO Man and the Biosphere Program (MAB), the Eastern Caribbean Natural Areas Management Program (ECNAMP), and the UNEP Regional Seas Programs -- are also examined for relevance to the Galápagos case. For each archipelago, the report presents a brief national profile, summarizes major resource issues, describes the roles scientists have played in coastal management, assesses the outcomes of scientific involvement, and outlines possible barriers to the use of information.

The scientific community has had a limited presence in Cape Verde, except in the fisheries sector where fish landings and export values have climbed in response to technical assistance and innovation. There has been very little progress on species protection, designation of natural areas, or integration of environmental concerns in development sectors.

The Seychelles have many features in common with the Galápagos. Integration of scientific information there has been strongest in species protection, special area designation, and preparation of resource inventories. A mutual exchange of information between the Seychelles and Ecuador may benefit both countries.

The three international programs vary in their geographic scope, formality, and precision. ECNAMP has made impressive contributions to site planning, but is not likely to be a promising model for archipelago-wide management. The Southeast Pacific Regional Seas Program, a general and voluntary consortium of nations under UNEP sponsorship, may present a useful framework in which to cooperate with Ecuador's neighbors. The MAB program has sponsored designation of dozens of biosphere reserves worldwide and specific projects emphasizing tourism/endemic species interaction. MAB may provide a useful network for information exchange.

PREFACE

The fascinating Galápagos Islands of Ecuador, isolated 1,000 kilometers west of the Ecuadorian mainland, have long been the object of worldwide scientific interest as a unique and instructive ecosystem. In recent years, they have also become the site of growing tourist activities and of a rapidly expanding resident population. In its efforts to plan for the long-term management of this special environmental asset, while serving the economic needs of the islands' residents, the Government of Ecuador in early 1983 invited the Woods Hole Oceanographic Institution, through its Marine Policy and Ocean Management Center (MPOM), to conduct studies of coastal and marine resources management in the Galápagos Islands.

MPOM comprises a multidisciplinary group of social and natural scientists who conduct research into topics concerning use of the world's oceans and coastal areas. Findings of the initial MPOM research effort in the Galápagos are reported in J. Broadus, I. Pires, A. Gaines, C. Bailey, R. Knecht, and B. Cicin-Sain, Coastal and Marine Resources Management for the Galápagos Islands (October, 1984) WHOI Technical Report No. WHOI-84-43. That report briefly describes coastal and marine resource uses and problems in the Galápagos, discusses general principles of coastal zone management (CZM) and marine resources management (MRM), examines the current status of CZM and MRM in the Galápagos Islands, and offers observations on possible avenues for improvement.

Through the cooperation of the Government of Ecuador and the support of the Tinker Foundation, scholars from MPOM are engaged in ongoing studies that build on the earlier Galápagos research. One area on which these studies focus is the recruitment and use of scientific and technical information in management of the archipelago's coastal and marine resources. For comparative purposes, it is useful to examine how such information is employed in analogous situations. That is the function of this technical report. The two cases selected for study are the Cape Verde Islands and the Republic of the Seychelles. The study was conducted, and this report authored, by Mr. Scott McCreary, an advanced Ph.D. candidate in the urban studies and planning department of the Massachusetts Institute of Technology (MIT) with extensive scholarly and practical experience in the planning and management of coastal areas. The work was accomplished by Mr. McCreary while he was a Guest Investigator at Woods Hole working under the supervision of Dr. Arthur G. Gaines, Marine Science Advisor in the Woods Hole Sea Grant Program, and myself, Social Scientist in MPOM. The document was prepared based on a literature review and interviews with coastal managers and scholars. It is our hope that this report will prove useful to Ecuador in its management of the Galápagos Islands and to others facing similarly delicate problems of coastal and marine resources management.

James M. Broadus
Co-Principal Investigator
Woods Hole April 1985

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TABLE OF CONTENTS

Abstract.....	i
Preface.....	ii
Acknowledgements.....	iii
Table of Contents.....	iv
List of Acronyms.....	vii
Introduction and Key Findings.....	1
Part I: Archipelago Case Studies	
Cape Verde Case Study.....	5
Cape Verde Profile.....	5
History and Politics.....	5
Overview of Cape Verde Social and Economic Indicators.....	8
Gross Development Product.....	8
Exports and Balance of Trade.....	10
Major Resource Issues.....	10
Endemic Species and Biological Communities.....	11
Governmental Units Responsible for Aspects of Ocean and Coastal Resources.....	11
Science in the Cape Verde Islands.....	12
Development of Coastal-Dependent Sectors.....	14
Roles of Scientists in Coastal Resources Management in Cape Verde.....	15
Outcomes of Scientific Involvement in Cape Verde Coastal Management.....	16
Barriers to the Use of Scientific Information In Cape Verde.....	17
Seychelles Case Study	
Seychelles Profile.....	18
Geography and Climate.....	18
History and Politics.....	22
Overview of Seychelles Social and Economic Indicators.....	23
Gross Development Product and Per Capita Income.....	23
Balance of Trade and Contribution of Fish Exports.....	23
Economic Contribution of Tourism.....	23
Major Resource Issues.....	25
Native and Endemic Flora and Fauna.....	26
Sponsors of Research.....	26
Roles of Scientists in Coastal Resources Management in the Seychelles.....	27
Advisors.....	27
Decision Makers.....	28
Outcomes of Scientific Involvement in Seychelles Coastal Management....	28
Identification of Applied Research Topics.....	29
Designation of Research Reserves and Protected Areas.....	29

Aldabra Research Reserve.....	32
Designation of Other Protected Areas.....	35
Preparation of Resource Inventories.....	36
Establishment of Programs for Species Protection.....	37
Preparation of Plans for Tourism Sector Development.....	38
Preparation of Land Use Plans.....	39
Development of Water Quality and Watershed Management Programs.....	40
Preparation of Plans for Fisheries Sector Development.....	41
Mechanisms to Incorporate Scientific Information in Resources Management.....	42
Barriers to the Application and Use of Scientific Information in the Seychelles.....	43
Weak Enforcement.....	43
Insufficient Integration of Resource Management Activities.....	44
Lack of Access to Natural Resources.....	44
Lack of Funding for Basic Natural History Research and Monitoring.....	44
Need for an International Approach to Protect Migratory Species.....	45
Part II: Program Summaries	
Man and the Biosphere Program (MAB).....	46
Background.....	46
Roles of Scientists in the MAB Program.....	46
Outcomes of Scientific Involvement in the MAB Program.....	47
Barriers to the Recruitment and Use of Scientific Information in the MAB Program.....	47
Eastern Caribbean Natural Areas Management Program (ECNAMP).....	48
Background.....	48
Roles of Scientists in ECNAMP.....	49
Outcomes of Scientific Involvement in ECNAMP.....	49
Barriers to the Recruitment and Use of Scientific Information in ECNAMP Programs.....	49
Regional Seas Program.....	50
Background.....	50
Joint Group of Experts on Scientific Aspects of Marine Pollution (GESAMP).....	51
Roles of Scientists in the Regional Seas Programs.....	51
Outcomes of Scientific Involvement in Regional Seas.....	51
Barriers to the Recruitment and Use of Scientific Information in Regional Seas.....	52
Epilogue: Application of Research Findings to Coastal and Marine Resources Management in the Galápagos Islands.....	53
References.....	59
Cape Verde.....	59
Seychelles.....	63

Man and the Biosphere Program.....	69
Eastern Caribbean Natural Areas Management Program.....	70
Regional Seas Program.....	71
Appendices.....	73
A: Comparison of Cape Verde, the Galápagos, and the Seychelles Islands	
A1 Geographic Characteristics.....	74
A2 Importance of Endemism.....	75
A3 Tourist Visitation.....	76
B: Chronology of Seychelles Research.....	77
C: Chronology of Major Events in Coastal and Marine Resources Management in the Seychelles.....	79

List of Tables and Figures

Figure 1: The Cape Verde Islands in Relation to the West Coast of Africa.....	6
Figure 2: The Cape Verde Islands.....	7
Table 1: Overview of Cape Verde Economic Indicators.....	9
Figure 3: The Seychelles Islands in Relation to the East Coast of Africa.....	19
Figure 4: Location of Aldabra Atoll in Relation to the Main Islands of the Seychelles and the East Coast of Africa.....	20
Table 2: Overview of Seychelles Economic Indicators.....	24
Table 3: Existing and Proposed Marine and Coastal Protected Areas in the Seychelles.....	30
Figure 5: Location of Aldabra Atoll in Relation to the Main Islands of the Seychelles and the East Coast of Africa.....	33
Figure 6: Natural Features of Aldabra Atoll, the Seychelles.....	34

LIST OF ACRONYMS

AID	United States Agency for International Development
BIOT	British Indian Ocean Territory
CECAF	Committee for Eastern Atlantic Fisheries
CV sc	Cape Verde escudo
ECNAMP	Eastern Caribbean Natural Areas Management Program
EEC	European Economic Community
EIA	Environmental Impact Assessment
FAO	United Nations Food and Agriculture Organization
GDP	Gross Development Product
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Pollution
GNP	Gross National Product
IAEA	International Atomic Energy Agency
ICBP	International Council for Bird Preservation
IMCO	See IMO
IMO	International Maritime Organization
INGALA	Galápagos National Institute
IUCN	International Union for the Conservation of Nature and Natural Resources
MAB	Man and the Biosphere Program
mn	million
MPOM	Marine Policy and Ocean Management Program
ORSTOM	Office de la Recherche Scientifique Outre-Mer
PAICV	Partido Africano da Independencia de Cabo Verde
PAIGC	Partido Africano da Independencia do Guine e Cabo Verde
QER	Quarterly Economic Review
SDP	Seychelles Democratic Party
SIF	Seychelles Island Foundation
SPUP	Seychelles People's United Party
Sr	Seychelles rupee
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHO	World Health Organization
WMO	World Meteorological Organization
WWF	World Wildlife Fund

THE RECRUITMENT AND APPLICATION OF SCIENTIFIC INFORMATION IN
COASTAL RESOURCES MANAGEMENT: ANALOGS TO THE GALAPAGOS ISLANDS

Introduction and Key Findings

This report presents the findings of an analysis of the recruitment and application of scientific and technical information for coastal resources management. The focus for this analysis consists of archipelagos which are analogous to the Galápagos Islands, and several programs which share some similarities to the programs now being formulated to guide coastal resource use in the Galápagos. Initially, for Part I of this report (Case Studies), three archipelagos were chosen for review based on their physiographic similarity to the Galápagos: the Republic of Cape Verde, the Republic of the Seychelles, and the Canary Islands of Spain. In view of the difficulty of obtaining detailed information within the time available, only Cape Verde and the Seychelles were selected for analysis. In Part II of this report (Program Summaries), three programs for coastal resources management are briefly summarized: the United Nations Education, Science and Cultural Organization's (UNESCO) Man and the Biosphere (MAB) program, the Eastern Caribbean Natural Areas Management Program (ECNAMP), and the United Nations Environment Program's (UNEP) Regional Seas Program.

For each of the archipelagos, the discussion begins with a brief profile of the island's geography, political history, and economy. Next, major resource issues are introduced and the history of scientific research is presented. The discussion emphasizes, in turn, the role of scientists in developing resource management programs and any specific management strategies that resulted from this scientific involvement. The discussion concludes by identifying some of the barriers that may impede recruitment and use of scientific information.

The discussion of the respective programs presents a summary of program goals, roles of scientists within the program, and outcomes of the application of scientific information. Again, the discussion concludes by identifying barriers to the application and use of scientific information.

A key finding of this report is that in the lower income nation of Cape Verde, the only significant application of research on coastal and marine

resources has been in development of the fisheries sector to feed a drought-stricken country better and to reverse an adverse balance of trade. The Portuguese colonial history in Cape Verde does not appear to have provided a very significant data base or tradition of research funding. Nations such as Norway, Germany, and the United States have had a more significant research presence. The programs that most directly benefit from scientific involvement are the research efforts on fisheries sponsored by the U.N. Food and Agriculture Organization (FAO). Within the structure of Cape Verde government itself, there is little evidence of mechanisms to specify research needs, fund. The Cape Verde case suggests that recruitment and application of technical information in a lower income nation or archipelago may be constrained by at least five factors: (1) the lack of perceived economic benefits; (2) the extent of an existing data base or research tradition; (3) the limited technical capacity of national agency staff to carry on work begun by donor agencies; (4) the limited institutional capacity of national governments to set goals, establish research agendas, and translate information into meaningful policy; (5) the barriers of language and culture.

In the Seychelles, a robust middle income nation, a far different picture emerges. The recent experience of the Seychelles should be of special interest to resource managers in the Galápagos for two reasons: the two archipelagos share several features in common, and Seychellois resource management has directly benefitted from scientific involvement. Among the common features are:

- o a high proportion of endemic species;
- o many unusual species (including the giant tortoise) which are vulnerable to disturbance;
- o a national policy calling for protection of special habitats;
- o an important tourism sector with the potential for significant growth;
- o a scientific research facility whose affiliates have a history of advising on coastal issues;
- o a long history of international cooperation in coastal research and species protection.

In the Seychelles, the English and other United Kingdom researchers have left a legacy of natural history investigation and research dating back over a century. Not surprisingly, the first direct and effective application of research findings was in the designation of protected areas and the establishment of programs to protect important species. Over time, the intervention of scientists provoked changes in policy on the part of the British colonial government or the independent Seychelles government.

The work of the international scientific and conservation community and government decision makers has been well integrated in species protection and critical area designation, and now the Seychelles government is taking steps to assume greater responsibility for management of reserves and other protected areas.

Some of the institutional arrangements used in the Seychelles may be applicable in Ecuador. The Seychelles Island Foundation, in particular, may represent a useful model for the Galápagos. The organization is dedicated to promotion of natural history research, and it also manages the island of Aldabra as a leaseholder. The Foundation draws its board members from leading international research and conservation organization, including IUCN. In addition, the Seychellois President, France Albert René, has a seat on the Foundation board.

Another successful linkage of science and policy is reflected in the work of scientific administrators for Aride and Cousin Islands. These individuals perform research and monitoring as part of their regular duties. Then, they collaborate with local advisory committees to jointly interpret their findings and draw up and implement appropriate management strategies.

Integration of the various coastal dependent sectors--fishing, tourism, water quality management, and species protection--has not been strong, but the government is acting to improve this situation. One positive step is the recent creation of the Seychelles National Environment Commission, created under the Ministry of Environment to receive information and coordinate research policy.

Each of the three resource management programs reviewed--UNESCO's Man and the Biosphere Program (MAB), the Eastern Caribbean Natural Areas Management (ECNAMP) and the Regional Seas Program--call for involvement of scientists in applying research findings to resource policy. The ECNAMP program, featuring

strong linkages with local resource managers on Caribbean islands, has been strongest in promoting action at site-specific locations. ECNAMP does not appear to offer a model for archipelago-wide resource management, however.

Both the Regional Seas and the MAB programs have ambitious global mandates. The Southeast Pacific Regional Seas program is a general and voluntary consortium of nations under UNEP sponsorship. It may offer a useful framework in which to exchange information and perhaps gain support from Ecuador's neighbors. MAB has sponsored the designation of about 200 biosphere reserves, and has sponsored some research on tourism/endemic species interactions. Biosphere Reserve designation could enhance international support and cooperation for integrated coastal management in the Galápagos, while the MAB program itself may offer a useful forum for information exchange.

PART I: ARCHIPELAGO CASE STUDIES

REPUBLIC OF CAPE VERDE CASE STUDY

Cape Verde Profile

The Republic of Cape Verde lies 619 km (385 mi.) off the coast of Senegal in the Indian Ocean (Figure 1). Ten islands and five islets constitute the 4033 km² (1557 mi.²), which is scattered over 58,275 km² (22,500 mi.²) of ocean (Figure 2). The Ilhas do Barlaveto (windward islands) in the north are Santo Antao, Sao Vincente, Santa Luzia, Sao Nicolau, Sal and Boa Vista. The southern Ilhas do Sotavento (leeward islands) include Santiago, Maio, Fogo, and Brava. Total population is 329,000 or 81.4 persons per km² (211 per mi.²).

Most islands in the Cape Verde archipelago are mountainous and rugged, dominated by durable igneous and volcanic formations. Fogo supports an active volcano. Mountains also occur on Santiago, Santo Antao, and Sao Nicolau. In contrast to Fogo and Santiago, the islands of Sal, Boavista, and Maio have white sand and broad curving beaches. Dunes of calcareous sand on those islands derive from coral reefs.

Cape Verde is the Atlantic extension of a broad region of arid and semi-arid conditions that crosses Africa. The amount and regularity of rainfall is strongly dependent on elevation. Up to 100 cm (39 inches) of rain falls at the highest elevations, but most of the islands have been in the grip of a drought for the past sixteen years (QER 1984 S). Permanent lakes and streams are totally absent (USAID, 1980).

History and Politics

The ethnic roots of Cape Verdeans can be traced to Europeans of southern descent and African slaves. Intermarriage of these groups has produced a population in which 60% of individuals are of mixed descent. The spoken language is Crioulo, an archaic form of creole Portuguese influenced by African vocabulary; Portuguese is the official language.

Cape Verde attained its independence from Portugal in 1975, as a result of the successful campaign by the Partido Africano da Independencia do Guine e Cabo Verde (PAIGC). The PAIGC strategy since the 1950s had been to secure

Figure 1: The Cape Verde Islands in Relation to the West Coast of Africa. (Published by permission of Transaction, Inc. from AFRICA REPORT, V. 29, No. 4, copyright (c) 1984 by the African-American Institute).

Figure 2: The Cape Verde Islands. (Source: Quarterly Economic Review of Angola, Guinea Bissau, Cape Verde, Sa Tome, Principe. Annual Supplement, 1984.)

Cape Verdean independence, and then campaign for federation of the archipelago with the Guinea Bissau mainland. Work began on a council of unity in 1976, but these efforts were abandoned with the 1980 coup in Guinea Bissau. The Cape Verdean wing of the PAIGC was abandoned and a new Cape Verdean party, the Partido Africano da Independencia de Cabo Verde (PAICV), was established in its place (QER, 1983 S; Davidson, 1983).

The national constitution, first adopted in 1980, was amended in 1981 to establish the PAICV as "the leading force in society". The Cape Verdean government has legislative, executive, and judicial branches, but major decisions are made by the party leadership, and to a lesser extent by the Prime Minister, the Council of Ministers, and the Secretaries of State. The Prime Minister oversees internal administration of the country. For administrative purposes, Cape Verde is divided into 14 concelhos (districts) which are further subdivided into 31 ferguesias (parishes) (QER, 1983 S; Davidson, 1983).

Overview of Cape Verde Economic and Social Indicators

Literacy rates in Cape Verde now stand at just 30-40% (AID, 1983) and a majority of national government efforts in education are concentrated at the primary and secondary level. All children must attend school between the ages of seven and fourteen. More than a fifth of the population is now at school (QER 1984 S).

Although two-thirds of the labor force has traditionally worked in agriculture, the drought caused thousands of people to lose their traditional livelihood. The result has been twofold: an extensive public works program employing 29% of the labor force, and massive emigration to the U.S., Portugal, France, the Netherlands, and Senegal. Remittances from emigrants are a major source of national revenue (QER 1984 S).

Gross Development Product

The Gross Development Product (GDP) is a fundamental indicator of a nation's economic productivity. In 1981, the most recent year for which data are available, Cape Verde's GDP was 3.179 billion Cape Verde escudos (expressed as CVE 3.179 sc), or about \$US 63 million. (For more detailed information, see Table 1.)

TABLE 1: OVERVIEW OF CAPE VERDE ECONOMIC INDICATORS

Year	GNP*	GDP**	Tourism Receipts	Contribution to GDP	Value of Exports
1983	NA ⁺	NA	Minimal	Minimal	
1982	\$US 102	NA			\$US 2.8mn (B)
1981	\$US 97	3279 (A)			\$US 4.4mn (B)
1980	\$US 90	2595 (A)			\$US 3.1mn (B)
1979	\$US 84	2251 (A)			\$US 1.9mn (B)
1978	\$US 78	1900 (A)			\$US 1.0mn (B)

* GNP expressed in \$US mn

** GDP expressed in millions of current Cape Verde escudos (CVE sc mn).

+ NA: Not Available

Year	Trade Balance ⁺	Value of ⁺⁺ Fish Products	Contribution to GDP	Contribution to Exports
1983	NA	NA	NA	
1982	-67.3 mn (B)	NA	16%(C)	"Principal Exports" (C)
1981	-69.5 mn (B)	NA	NA	
1980	-95.9 mn (B)	NA	NA	
1979	-58.5 mn (B)	CVE 123 sc mn (A)	5.4%	
1978	-51.3 mn (B) \$US-51.3 mn	CVE 82 sc mn (A)	4.3%	

⁺ Expressed in US mn

⁺⁺ Expressed in CVE sc mn

(A) Quarterly Economic Review of Angola, Guinea Bissau, Sao Tome and Cape Verde 1984 Supplement.

(B) Quarterly Economic Review of Angola, Guinea Bissau, Sao Tome and Cape Verde 1984 No. 3.

(C) World Bank, East African Region, Estimate. July, 1984.

Exports and Balance of Trade

The value of Cape Verde's exports have ranged from \$US 1 mn to \$4.4 mn since 1978, with the drought taking a severe toll on agricultural exports. In the most recent year of record, 1982, fisheries accounted for the large majority of exports (QER 1984 S). This represents a slightly lower range of exports than the Seychelles, but Cape Verde lacks the infrastructure and amenities to build a strong tourism industry. The island nation must import a sizable share of its food, as well as machinery and other goods, resulting in a trade deficit of \$US 67 to \$US 95 mn.

Major Resource Issues

The major resources issues in Cape Verde revolve around meeting basic human requirements for food, water, and energy. Coastal and marine resources per se take a secondary position on the government's agenda. In years of plentiful rainfall, only 15% of the land area of Cape Verde is suitable for agriculture, due to the predominance of mountainous terrain. Chronic rainfall shortages and high temperatures together have produced periodic droughts. When superimposed on the narrow resource base and the fast-growing population, malnutrition and famine have resulted. Since 1773 eight droughts have been responsible for the death of 250,000 people. Thus, the major resource issue--feeding the people--is an island-wide problem (QER, 1983 S).

There is an overwhelming need for more water in Cape Verde, particularly to supply agricultural uses. The U.S. Agency for International Development (AID) (1980) estimated that supplies could be increased five-fold by increasing surface water storage, inducing groundwater recharge, and tapping groundwater resources through wells. A related problem is the need for improved soil conservation. The European Economic Community (EEC) recently announced a grant for a system of dikes, terraces, and dams, together with tree-planting and small machinery (QER, 1984 S).

A third major resource problem is the need for energy resources. Gathering of firewood has depleted forests and accelerated watershed erosion and downstream sedimentation (Freeman et al., 1978).

In the coastal and marine sector, the dominant issue on the public agenda is wise fisheries development to reduce pressure on agriculture, supply basic protein needs, and generate export earnings. At best, the Cape

Verdean fisheries sector is rudimentary. In the industrial portion of the sector (described liberally as motorized boats with closed hulls) the tuna fleet consists of three well-equipped boats and 21 vessels which were not originally intended to serve as tuna boats. Standardization of engines does not exist, making repairs difficult. Many boats have wooden hulls, again rendering maintenance costly. The artisanal sector includes about 3000 individuals, of whom 75% are employed exclusively in fisheries. Most have unmotorized boats ranging from 3.5 to 12 m (12 to 36 ft.) in length. Distribution of fish is difficult, due to lack of an adequate distribution networks, and a shortage of refrigeration facilities (Cape Verde Government, 1982).

Endemic Species and Biological Communities

The dual pressures of dense populations and scarce usable land have combined to reduce or alter natural plant communities and populations of endemic species on Cape Verde. Freeman et al. (1978) found that almost all native plant life within a half day's walk of agricultural villages had been eliminated.

The first rigorous botanical survey (Chevalier, 1935) documented 600 species of vascular plants, including 92 endemic species, and about 300 species of cultivated plants or weeds. This is a small complement of endemics compared to the 480 species documented in the Canaries. Native vegetation is adapted to erratic rainfall and xeric conditions. Many species survive in drought-resistant dormant stages. During the drought, grazing and trimming of woody species for firewood has severely reduced vegetation communities.

Native terrestrial fauna includes ten endemic species of lizards (skinks), including the giant skink (Macroscincus coctei), listed as endangered species by the International Union for the Conservation of Nature and Natural Resources (IUCN). Thirty-eight species of birds breed on Cape Verde, including two endemic terrestrial species: the Cape Verde warbler (Acrocephalus brevipes) and the raso lark (Alvada razae). The latter species is listed by IUCN as endangered due to its restricted distribution.

Governmental Units Responsible for Aspects of Ocean and Coastal Resources

In Cape Verde there are seven units of government with actual or potential responsibility for ocean and coastal resources management. However, precise

definition of their roles is hard to discern from the available literature.

Major agencies with potential concern for the coast are outlined below:

- o In October 1983, a new secretariat was created for fisheries (QER 1, 1984). The Secretariat subsumes the Direcao Nacional das Pescas (DNP).
- o The Secretariat for trade, tourism, and crafts is concerned with hotel development on the Cape Verdean shoreline.
- o The Secretariat for cooperation and planning also has a potential role in coastal resource management.
- o The Ministry for Rural Development supports a Bureau of Conservation and Use of Natural Resources (Freeman, 1978).
- o The Ministry for Environment and Public Works should carry major responsibility for the coast.
- o Finally, the Ministry for Education and Culture could conceivably promote research on ocean and coastal resources.

Science in the Cape Verde Islands

Given Cape Verde's acute shortage of food, water, and energy, a national infrastructure to support Cape Verdean research and development has been slow to develop. There are no national universities, and there is no formal university preparatory curriculum. The Agrarian Research Center appears to be the only research institution in Cape Verde (E. Santos, personal communication, 1984; Boston Globe, 1983).

Cape Verdeans who seek higher education attend universities in the United States, the Soviet Union, Portugal, France, and West Germany. Recent State Department figures indicate that since independence, 150 Cape Verdeans have received training in the United States, about 450 have gone to the Soviet Union for higher education, and 900 have studied in Portugal (U.S. Senate Foreign Relations Committee, 1983). Many of these Cape Verdeans work abroad, but there are no readily available figures to show what proportion of university-educated individuals return to Cape Verde.

Foreign research on Cape Verdean natural resources dates back to at least the 1930s when a review of Cape Verdean flora appeared in a French botany journal (Chevalier, 1935). Vertebrates were described in the 1940s (Bertin, 1946), and the first comprehensive reviews of bird life appeared in the 1950s

and 1960s (Bourne, 1955; Bannerman and Bannerman, 1968). A series of articles on aspects of Cape Verdean geology appeared in the literature beginning in the 1970s. Issues addressed include stratigraphy (Cita, 1971), petrochemistry (Burri, 1973), magmatism (Klerkx and de Paepe, 1976), geophysics (Dash, 1976), the composition of black shales (Bogolyubova and Timofeev, 1978), and abyssal benthonic foraminifera (Bremer, 1983).

Recent biological research in Cape Verde has focussed on the description of new species of lichens (Krog and Osthagen, 1978), insects (Ribeiro et al., 1979; Puthz, 1980), molluscs (von Cosel, 1981), flowering plants (Dittrich, 1981), and reptiles (Gruber and Schleich, 1982).

Norwegian fisheries investigators (Stroemme, et al., 1982) conducted one of the few scientific investigations in Cape Verde with a direct application to resource policy. The cruise of the R/V Dr. Fridtjof Nansen was staffed by two Cape Verdean biologists, five Norwegians (including both scientists and technicians), and one specialist each from the Committee for Eastern Atlantic Fisheries (CECAF) and FAO. Four goals motivated the cruise:

- o completing an acoustic survey of the distribution and abundance of pelagic and demersal resources;
- o net sampling of the size and distribution of main species;
- o mapping bottom conditions;
- o documenting major hydrographical conditions.

The findings were documented in a report published in English by the Institute of Marine Resources, Bergen, Norway, and is referenced in later FAO studies.

The literature review did not reveal any articles with an explicit focus on species protection or natural area conservation in Cape Verde.

Foreign institutions which have sponsored research in Cape Verde are the following:

- o the Zoological Institute Museum University in Hamburg, Germany;

- o the Institute of Hygiene and Tropical Medicine in Lisbon, Portugal (Rebeiro et al., 1979);
- o the Max Planck Institute of Limnology in Germany (Puthz, 1980);
- o the Institute of Marine Research, Bergen, Norway (Stroemme, et al., 1982);
- o the Norwegian Resource Council for Science and Humanities and the University of Oslo Botanical Museum (Krog and Osthagen, 1978);

A majority of applied research underwritten by donor agencies in the Cape Verde Islands has concentrated on the provision of water and energy supplies and food production, including fisheries development. AID commissioned a survey of the agricultural sector (Freeman et al., 1978), as well as a study of energy supply alternatives. A major conference was convened in 1969 by the Food and Agriculture Organization (FAO) and the International Council for Exploration of the Sea (ICES) based in Charlottenlund, Denmark, on the living resources of the African continental shelf between the Straits of Gibraltar and Cape Verde (FAO, 1969).

Subsequent FAO-sponsored projects in Cape Verde have investigated catch and fish abundance (FAO, 1979), fishery resource management and development (FAO, 1980), fish landings and other statistics (FAO, 1981; and FAO, 1982). FAO recently completed a project in the archipelago to promote the formation of fisheries cooperatives. Another project now underway concentrates on planning and monitoring of artisanal, semi-artisanal, and industrial fisheries. The objective is to increase the availability of fish products locally, and increase exports and foreign exchange earnings. Expertise recruited for the project includes a French "fish technologist," a Canadian "conseiller technique principal," an Italian consultant to prepare identification sheets, a Belgian economist, and a fishery legislation consultant. Total costs for the 4 1/2 year project are estimated at \$8,809,000 (FAO, 1984).

Development of Coastal-Dependent Sectors

Since the late 1970s, Cape Verde has taken several steps to develop and finance the fisheries sector and lesser efforts to develop tourism.

Investment has been substantial, but innovation has been slow. Among the major highlights are:

- o extension of the Exclusive Economic Zone to 200 miles in 1977 (QER 2, 1978);
- o announcement of plans to build a fish refrigeration plant (QER 2, 1978);
- o creation of a government-run company, the Sociedade Comercializado e Apoio a Pesca Artesanal, to assist the nation's 3000 artisanal fishermen (QER 4, 1978);
- o announcement of a \$2.4 million loan from the Arab Bank for Economic Development in Africa to help achieve a goal to raise export earnings to \$2 million, or 7% of GNP (QER 3, 1979);
- o announcement of plans to expand tuna trawler capacity of the Cape Verdean company Fricap, and launch a crayfish fishery (QER 3, 1979);
- o negotiation of an agreement with Iceland to send a trawler to Cape Verde to train tuna fishing crews in 1980 (QER 1, 1980);
- o announcement of plans to construct a 57 room hotel in Praia and a 420 bed hotel on Sal, along with a hotel training school (QER 2, 1980). (The Sal hotel was to be completed in 1982; the timeline for completion has been pushed back and a revised scenario would include French financial participation at a level of Fr 30-35 mn.)(QER 2, 1984);
- o the 1982-1985 National Development Plan calls for an investment of 1,020 CVE sc (US\$10 million) in the fisheries sector (QER 4, 1984).

Roles of Scientists in Coastal Resources Management in Cape Verde

Scientific involvement in Cape Verdean resources management, with the exception of fisheries management, has been limited to fundamental research on Cape Verdean natural history and island biogeography. There is no evidence that scientists either proposed research topics or made specific conservation recommendations. Organizations dedicated to the preservation of genetic diversity and natural areas--IUCN, the World Wildlife Fund, the International Council for Bird Preservation (ICBP), and UNESCO--appear to have exerted almost no influence over Cape Verdean coastal resources.

Fisheries experts sponsored by the Norwegian Institute of Marine Resources and FAO's CECAF program have served as advisors to the Cape Verdean fisheries

industry. The National Development Plan emphasizes developing infrastructure for the fishing industry, suggesting that the advisors have had some influence on development of that sector. However, the scarce treatment of natural resource characteristics of the fisheries suggests that much of the information gathered by FAO was not fully used in informing government policy.

Whether scientists have been active in setting resource policy is also not obvious from the available literature. The National Development Plan element on the fishery sector calls for the recruitment of 120 "specialists" in fisheries, but the number of specialists already employed and their level of technical training are unclear.

Outcomes of Scientific Involvement in Cape Verde Coastal Management

Despite the significant number of scientific articles concerning Cape Verde, there is little evidence to suggest that the findings of foreign investigations are employed in public policy formulation by the government of Cape Verde. In contrast to the literature for the Seychelles, none of the scientific articles on Cape Verde include suggestions for future research or specific policy recommendations for resource development or conservation. No documentation points to the application of any of the research on endemic species by or on behalf of the government of Cape Verde. Neither the literature search nor personal communications revealed programs for natural area designation, impact assessment, or methods to develop resource-conserving tourism.

One possible exception to this pattern is a conference convened in 1981 under the sponsorship of the Ministry for Rural Development and the Gulbenkian Foundation with the aim of "formulating a scientific plan for the development of Cape Verde over two decades." Scientists from various disciplines attended, as did the United Nations Development Organization (UNDP), FAO, and the United States Agency for International Development (AID) (Lewis, 1982). However, the literature search did not produce any reference to proceedings of the conference.

Cape Verde's attention to the fisheries sector could be viewed as the logical extension of fisheries research carried on in the 1960s and 1970s. That work was intended to establish the size and composition of fish stocks and to judge the efficiency of existing fisheries and processing methods (FAO

1969, 1979, 1980, 1981, 1982, 1984; Stroemme et al., 1982). However, review of the National Development Plan reveals no citations to the FAO or other scientific literature which reported early findings. A more plausible explanation for the emphasis on fisheries development is the repeated failure of agriculture to sustain basic protein needs and the feedback of scientific information within the donor agencies. The donor agencies set much of the agenda for resource development within Cape Verde. The most obvious forum for utilization of scientific information is within FAO itself.

Barriers to the Use of Scientific Information in Cape Verde

The most significant barrier to the application of scientific and technical information in Cape Verde appears to be the lack of a national infrastructure for research and policy development. Many research and development functions and goal setting mechanisms are de facto the responsibility of donor agencies and governments (Peter Freeman, personal communication, 1984).

Another difficulty faced by Cape Verde is a "brain drain" from the small cadre of college-educated individuals to other nations. The combined effects of drought, poverty, emigration, and need for outside remittances to shore up the negative trade balance works against building a critical mass of local experts who could manage coastal and marine resources.

Still another barrier to application of scientific and technical information is the fact that coastal-dependent sectors are only poorly developed. Provision of food, water supplies, and energy, and creation of opportunities for primary and vocational education head the national agenda. Although the oceans represent a potentially important source of food, more attention has been paid to developing agriculture and obtaining land-based food contributions.

Finally, language is likely to present a very real barrier in translating scientific findings into a form useful to policy makers. Crioulo is the spoken and Portuguese the official language of Cape Verde. Most Cape Verdeans do not speak German, Russian, English, Norwegian, or other languages in which research has been reported.

REPUBLIC OF THE SEYCHELLES CASE STUDY

Seychelles Profile

Geography and Climate

The Seychelles archipelago is located in the Indian Ocean about 2540 km (980 mi.) off the coast of Mauritius, and about 3659 km. (1410 mi.) south of Aden (Figure 3). The 150 islands, islets, and cays that comprise the 444 km² (171.4 mi.²) archipelago occur in two distinct groups: the compact granitic group and the sprawling coralline group (Figure 4). The total population of the islands has been estimated at 66,000 (U.S. State Department, 1984) to 68,750 (Seychelles Government, 1979). The most recent figure represents a density of 148 persons per square kilometer (385 persons per mi.²).

The granitic islands are rocky, featuring steep topography and a narrow littoral zone. Mahe is the largest island in the granitic group, measuring 225 km² (87 mi.²). The peak of Morne Seychellois rises 905 m (2969 ft.) above sea level. Praslin, another major island, is located 33.8 km (21 mi.) from Mahe, and covers an area of 40.9 km² (15.8 mi.²). La Digue (19.7 km²/7.6 mi.²) is the third major island in the group. Curieuse and Cousin Island, two smaller islands, are west of Praslin (Figure 4). Rainfall on the granitic islands ranges about 165 to 284 cm (65 to 112 in.) per year with an average of 234 cm (92 in.) at Victoria, Mahe.

The 60 Seychelles coralline islands extend over a large area of the Indian Ocean. Occurring individually or in groups, the distance of these islands from the island of Mahe ranges from 145 to 1583 km (60 to 612 miles). Aldabra, one of the most important islands from the standpoint of natural history, research, and resources management, receives 80 cm (50 in.) of rainfall annually. Despite its proximity to the equator, the archipelago's climate is moderated by oceanic influences. Peak shade temperatures throughout the archipelago range from 70 to 88 degrees Fahrenheit.

History and Politics

Historically, the first inhabitants of the Seychelles archipelago were European traders and explorers. The first well-documented voyage to the Seychelles was led by the English Seaman Alexander Sharpeigh in 1609, under

Figure 3: The Seychelles Islands in Relation to the East Coast of Africa. (Source: Quarterly Economic Review of Madagascar, Mauritius, Seychelles, and Comoros. 1984 Supplement.)

Figure 4: The Major Islands of the Seychelles (Source: Quarterly Economic Review of Madagascar, Mauritius, Seychelles, and Comoros. 1984 Supplement.)

commission of the East India company. Lazare Picault, an explorer, led an expedition to claim the Seychelles in 1742, marking the beginning of French presence in the archipelago. Poivre, a French minister charged with finance and agriculture, settled the first colony on St. Anne's Island in 1770. By the 1790s, French pirates based in the Seychelles were wreaking havoc with British shipping in the Indian Ocean. In response, a British squadron appeared off Victoria, Mahe, to demand surrender of the island. A peace was signed, but hostilities broke out again in 1804. The French colony capitulated on terms favorable to trade based on Mahe. By 1810, Britain had defeated French forces in Mauritius and made it clear that slavery was to be phased out. Many French left the Seychelles with their slaves and France ceded its territories in the area to Britain.

From 1814 to 1903 Britain managed the Seychelles as a dependency of Mauritius. The Seychellois gained a progressively greater role in self-government during this period, leading to full declaration of independence from Mauritius when the Seychelles were declared a Crown colony in 1903. Following attainment of this status, a Governor and two Councils were appointed. Initial elections for four seats in the legislature were held in 1948. In 1960 a new constitution was established, expanding the Legislative Council.

Two political parties formed in 1964: the Seychelles Democratic Party led by James Mancham and the Seychelles People's United Party (SPUP) led by France Albert René. A new constitution came into effect in 1967, which resulted in a vastly increased electorate but also left extensive discretion for policy making with the Governor. Pressed by both Mancham and René, the British government acceded to a request to formulate a "Western style" government with a small ministerial executive branch responsible to the executive. The 1970 elections endorsed a third constitution providing for an 18 member legislature and an advisory Council of Ministers. With the SDP claiming a clear victory in the Legislative Assembly, James Mancham became the first Chief Minister.

In the 1974 elections both parties ran on an independence platform, with the SDP polling a slight edge in votes. A new constitutional convention in 1975 produced an Electoral Review Commission to proceed towards full independence. The new constitution took effect on midnight June 29, 1976. Key provisions were (1) the creation of the Legislative Assembly as the House

of Assembly, with an additional five members drawn from each major party; (2) creation of a coalition cabinet of 12 members, with eight drawn from SDP members of the legislature and four from SPUP members; (3) assumption of the Presidency by the Prime Minister.

A major outcome of the conference was an agreement to return the islands of Aldabra, Farquhar, and Des Roches--transferred from the Seychelles in 1965 to form part of a new British Indian Ocean Territory--to the Seychelles. (Representatives of both Great Britain and the United States, which had signed a treaty giving the U.S. control of the islands for defense purposes, agreed that return of the islands would benefit the Seychelles.) A major factor in the decision was the pending Law of the Sea proposal to give archipelagos sovereign status over their own archipelagic waters (Government of the Seychelles, 1976).

The New York Times (September 28, 1975) observed that "the Seychelles are heading for independence without any of the rancor or bitterness other countries have experienced." This conciliatory posture seems to have benefitted the Seychelles in gaining scientific, technical, and material assistance for their coastal and marine resources efforts.

Today, the Seychelles is a well-integrated, multi-racial society. In the 19th century the original population of settlers and servants was augmented with freed slaves. More recently people from India and China, and individuals of French origins from Mauritius, have made Cape Verde their home. The most common language is Creole, while the official languages are English, French, and Creole. Most official government documents are published in English.

After independence, James Mancham served for several years as President. A 1971 coup brought France Albert René to the Presidency. The former parties have become merged in the Seychelles People's Progressive Front (SPPF), which is now the only significant party.

Overview of Seychelles Social and Economic Indicators

The vast majority of the population (88%) is concentrated on the island of Mahe, and another 10% lives on the neighboring islands of Praslin and La Digue (World Bank, 1980). The rate of population increase in the Seychelles has dropped sharply since the late 1960's, and stood at 2.1 percent/year in 1980, while life expectancy is nearly 70 years. The quality of health and nutrition

is particularly good, and the quality of housing stock is excellent for a middle income nation (World Bank, 1980).

Seychellois government efforts in education have been characterized as "probably the best in Africa" by the Quarterly Economics Review, published by the Economist Intelligence Unit (QER 1, 1984). About 18% of the federal budget is devoted to education, the largest allocation for any sector (QER 1, 1984). Since the late 1970's close to 98% of the children have completed at least six years of education and about 30% reached the secondary level (World Bank, 1980). Now almost a third of the population is in full-time education: 3700 in creches (nursery schools), 15,000 in primary school, and 1,000 in the polytechnic (QER 1, 1984). The Seychelles secondary system culminates with two years of pre-university training for studies abroad (World Bank, 1980). However, plans are underway to convert the polytechnic into a full university (Seychelles Consulate, 1985).

Gross Development Product and Per Capita Income

The Gross Development Product for the Seychelles has been growing steadily since the late 1970's. In 1981 the figure was SR 964.1 mn (about \$US 143.9 mn). The following year the GDP was about SR 965.1 mn (\$US 144 mn.) This represents a GDP about 2.3 times larger than Cape Verde, yet Cape Verde's population is about five times as large. Per capita income reached \$US 1,300 in 1980 (World Bank, 1980). (For more detailed information, see Table 2.)

Balance of Trade and Contribution of Fish Exports

In 1983, exports in the Seychelles reached SR 25.2 mn, up from SR 20.3 mn in 1982, but still less than the SR 32.9 mn recorded in 1980. Fisheries have accounted for about 30% of export value and about 1% of GDP in recent years. The trade deficit remains high at SR 456.9 mn (about \$US 80 million), but has generally been declining in recent years.

Economic Contribution of Tourism

Tourism became an important part of the Seychelles economy in 1971 when the Seychelles International Airport opened. Indicators of tourism show striking increases through the late 1970's with receipts peaking in 1980 at SR 331 mn (about \$US 49 mn) when they accounted for 36.5% of total GDP. Since

TABLE 2: OVERVIEW OF SEYCHELLES ECONOMIC INDICATORS

Year	GDP*	Tourism Receipts	Contribution to GDP	Value of Exports
Seychelles				
1984 (est.)	N/A	SR 300 mn (B)	N/A	N/A
1983	N/A	SR 233 mn (B)	N/A	SR 25.2 mn
1982	SR 965.1mn (A)	SR 220 mn (A)	23.4%	SR 20.3 mn (C)
1981	SR 964.7mn (A)	SR 289 mn (A)	30.4%	SR 27.5 mn (C)
1980	SR 941.9mn (A)	SR 331 mn (A)	36.5%	SR 32.9 mn (A)
1979		SR 295 mn (C)		
1978		SR 243 mn (C)		

*GDP expressed in current Seychelles Rupees. The SR exchange rate has fluctuated between SR 6.5 = \$US 1.0. and SR 7.0 = \$US 1.0 in recent years.

Year	Trade Balance	Value of Fish Exports	Contribution to GDP	Contribution to Exports
1984 (est.)				
1983	SR -456.9 mn (A)	SR 9.2 mn (A)	1%	36.5%
1982	SR -541.4 mn (A)	SR 7.3 mn (A)	.7%	35.9%
1981	SR -480.6 mn (A)	SR 4.3 mn (A)	.5%	15.6%
1980	SR -496.2 mn (A)	SR 9.6 mn (A)	1%	29.2%
1979				
1978				

(A) Quarterly Economic Review of Madagascar, Mauritius, Seychelles, and Comoros, 1984 Supplement.

(B) Quarterly Economic Review of Madagascar, Mauritius, Seychelles, and Comoros, 3, 1984.

(C) Quarterly Economic Review of Madagascar, Mauritius, Seychelles, and Comoros, 2, 1984.

1980, tourism has contributed 25-30% of the nation's GDP. Now a new upsurge appears to be occurring. (See "Preparation of Plans for Tourism Sector Development").

Major Resource Issues

The leading issues on the Seychelles national agenda are reversing a negative trade balance, increasing local food production (including fish landings), organizing new development to increase tourism receipts, and generally guiding development in a way that maintains both the biological and aesthetic integrity of the islands. In contrast to Cape Verde, the Seychelles have gained the upper hand on the issues of health care, housing, and education.

In the tourism sector, the government is pressing to expand the number of annual tourist visits, and the contribution of tourism to the national economy. While new development is planned, ceilings have been imposed on the quantity of accommodations that may be built on outer islands, in order to prevent harm to resources. For the fisheries sector, the government is working to gain greater control over its 400,000 square-mile exclusive economic zone. Among the tools being used to fish in exchange for research investment, and greater use of reconnaissance aircraft to identify and apprehend "unauthorized" fishing interests.

Seychellois efforts in species protection and special area management are struggling to make the transition from program design to conscientious execution. Land use planning and integration of coastal-dependent economic sectors are major occupations of the government, but much is still to be done. Institutional development has been proceeding fairly rapidly in the Seychelles. A new laboratory, the National Environmental Control Center is being established to conduct pollution monitoring and provide research services to other agencies. Another, related task is the transition of the polytechnic to a full, four year university. This step should better equip the Seychelles to produce its own cadre of strong resource managers.

Native and Endemic Flora and Fauna

The Seychelles are richly endowed with many endemic forms of flora and fauna, perhaps because of diverse habitats, range of rainfall, relative proximity to mainland Africa, and complete isolation from resident human populations until the late 1700s. Baker's 1877 Flora of Mauritius and the Seychelles documented 338 species of native flowering plants. More recently, IUCN (1982) has found that the Seychelles supports 23 (62%) of the 32 coastal habitat types found in the entire Western Indian Ocean. These habitats in turn harbor nearly 40% of the endemic coastal and marine animals documented in Eastern Africa. There are two species of mammals (including the Seychelles flying fox), 21 species of birds, two endemic species of reptiles, 31 species of fishes, one insect, and the screw pine (IUCN, 1982). (See Appendix A2).

Sponsors of Research

Foreign sponsors of research on important species and habitats in the Seychelles include the following universities and conservation organizations:

- o New York Zoological Society (Whale Fund) (Frazier, 1979);
- o Edward Grey Institute (de Brooke and Garnett, 1983);
- o University of Aberdeen (Evans, 1979);
- o Royal Society for Nature Conservation (Warman, 1984);
- o British Museum of Natural History (Eason, 1979);
- o International Council for Bird Preservation (Diamond, 1976);
- o International Union for the Conservation of Nature and Natural Resources (IUCN, 1982);
- o Natural Environmental Research Council (Feare, 1976);
- o In the fisheries sector, the Governments of Spain, Germany, France, Iraq, Kuwait, and Abu Dhabi, and the Food and Agriculture Organization have all sponsored research or technical training programs (QER 1, 1981; QER 2, 1981; QER 3, 1981; QER 1, 1984);
- o The government of France has underwritten projects to improve the quality of the tourism industry (QER 1, 1984).

Domestic sponsors of research have included:

- o Seychelles Island Foundation (Stoddart et al., 1984);
- o Royal Society/Aldabra Research Station (Sloan, 1979; Reville, 1983);
- o Ministry of Agriculture and Ministry of Overseas Development (Haines and Haines, 1978).

Emerging sponsors of research within the Seychelles government include the National Environment Control Center and the Seychelles National Environment Commission (Seychelles Government, 1982).

Roles of Scientists in Coastal Resources Management for the Seychelles

Since the late 19th century, scientists have served in the dual roles of primary investigators and advisors on natural resources management for the Seychelles archipelago. The voluntary advocacy of natural scientists for protection of valuable species and habitats dates to 1874 when Charles Darwin joined Joseph Hooker, T.H. Huxley and Richard Owen in appealing to the Governor of Mauritius to guard against extinction of the Aldabra tortoise. This marked the beginning of a long tradition of "intervention" in natural resource policy that has been continued by the English Royal Society, Jacques Cousteau, and more recently the World Wildlife Fund and IUCN. In the past few years, technically trained individuals have moved into major decision-making responsibility. (See Appendix B for a chronology of Seychelles research).

Advisors

Several foreign biologists have offered advice on management of important species in the context of reporting their research in journals such as Environmental Conservation and Biological Conservation.

Feare (1976) investigated sooty tern ecology in the Seychelles and recommended that harvesting be limited to two islands with vigorous tern recruitment and good egg collecting facilities, in order to protect tern populations on other islands. These recommendations were more restrictive than earlier suggestions advanced by Ridley and Percy (1966) that egg collecting be limited by quotas on each island.

Evans (1979) recommended a policy of leaving dead Albizia and Acacia trees as nesting sites for the Seychelles black parrot. Reville (1983) offered some general suggestions about reducing the disturbance of nesting frigate birds on Aldabra resulting from intrusive research and tourism. Gochfeld (1983) recommended conservation of a viable population of roseate terns in each of several regions, including the Seychelles.

In an investigation of the reproductive success of hawksbill turtles, L. de Brooke and Garnett (1983) found that Cousin Island is often used extensively by "remigrant" turtles--those visiting the island in multiple breeding seasons. Remigrants breed more often and produce more young than other turtles. Consequently, the authors recommended that protection concentrate on important breeding sites rather than a diffuse program of restrictions and enforcement.

Decision Makers

Since the Seychelles gained independence in 1975, a small cadre of technically trained experts has taken positions within national and international agencies responsible for coastal resource management. These individuals exercise substantial discretion in policy making and often work directly with academic scientists in aspects of resource management. These close linkages are exemplified in Dr. Maxime Ferrari's positions as both Minister of Development and External Relations, and President of the Seychelles Island Foundation. Dr. Ferrari recently authored an article (Ferrari, 1983) detailing the lead role of the Seychelles in an Indian Ocean Whale Sanctuary. Lindsay ChongSeng, staff member of the Ministry of Agriculture, co-authored a major report with an IUCN staff scientist describing the formation of the East Africa Regional Seas Program with reference to the Seychelles (IUCN, 1982).

Outcomes of Scientific Involvement in Seychelles Coastal Resources Management

The most direct results of scientific involvement in the Seychelles are (1) identification of applied research topics, (2) establishment of programs to conserve wildlife populations, and (3) designation of specific islands or portions of islands as reserves for research and resource preservation. Scientific involvement has also been central to the completion of resource inventories. Plans for land use and development of the tourism sector have received limited scientific input, while technical advice has been important to the fisheries sector.

Identification of Applied Research Topics

Several natural scientists working in the Seychelles have recommended research to inform the management of important species of turtles, lizards, and birds. When the Seychelles government considered relaxing the protection of green turtles (Chelonia mydas), the World Wildlife Fund and IUCN pointed out that "an extensive survey was needed before any such steps were taken and accordingly promised their aid" (Jackson, 1976).

Writing on the status of hawksbill turtles, Diamond (1976) suggested that inadequate records had been kept on their populations in the Seychelles and indicated that a more rigorous census was needed. Frazier (1979) made a similar argument, urging that a decision to restart the periodic culling of turtles should depend on finding out whether populations have recovered to their former levels of abundance. The recommendations of Diamond and Frazier were addressed to some extent by the recent study of hawksbill reproduction reported by de Brooke and Garnett (1983).

Evans and Evans (1979) reported on the ecology of lizards in the Praslin Islands and suggested that further information on taxonomic character, ecological requirements, and predation pressures would provide useful insights into lizard evolution. Evans (1979) recommended tests of the suitability of nest boxes to protect the Seychelles black parrot. Gochfeld (1983), in assessing the status of the roseate tern, recommended collection of additional census data for several regions worldwide, including the Seychelles.

Warman and Todd (1984), in their report on the biology of Aride Island, recommended that the feeding ranges, non-breeding distribution, and other biological requirements of seabirds be established.

Designation of Research Reserves and Protected Areas

As of 1982, the Seychelles had designated 21 coastal and marine nature reserves, parks, and resource reserves. Twelve additional reserves had been proposed (IUCN, 1982). The designated and proposed reserves are listed in Table 3. Within the ten nation East African Region, almost half of all marine protected areas are in the Seychelles, while about a quarter of the region's coastal protected areas are found in that archipelagic nation (IUCN, 1982). Kenya leads the developing world in the proportion of land area with a protected status, but the Seychelles is second only to Indonesia among developing nations in the number of coastal/marine reserves proposed or established (Salm, personal communication, 1984).

TABLE 3: EXISTING AND PROPOSED MARINE AND COASTAL PROTECTED AREAS IN THE SEYCHELLES (Source: IUCN, 1982).

<u>Existing Marine Protected Areas</u>			
<u>Category*</u>	<u>Name</u>	<u>Area in Hectares</u>	<u>Notable Features</u>
I. Strict Nature Reserve	Aldabra Atoll Special Reserve	35,000	undisturbed coral atoll with endemic birds, giant tortoises, large green turtle population
II. National Park	Ste Anne Marine	1,423	islands, coral reefs, seagrass beds
	Port Launay MNP	158	sandy beach, coral reef, sheltered bay.
	Baie Ternay MNP	80	coral reefs, algal flats
	Curieuse MNP	1,370	coral reefs, deep sheltered sand habitat
VI Resource Reserve	Ile Seche Nature Reserve	1.6	nesting seabirds
	Ile aux Fous NR		nesting seabirds
	Les Mamelles NR	8.8	nesting seabirds
	Ile aux Vache Marines	5.2	nesting seabirds
	Lamperiaire NR		nesting seabirds
	Boudeuse NR	1.6	nesting seabirds
	Etoile NR	1.6	nesting seabirds, green and hawksbill turtles
	Brulee-Point au Sel Reserve		marine mollusc protection
	Northeast Point Reserve		marine mollusc protection
	La Passe-Grosse Roche Reserve		marine mollusc protection
	Ansaie Boudin-Pointe Zanguilles Reserve		marine mollusc protection
<u>Existing Marine Protected Areas</u>			
I Strict Nature Reserve	Ile aux Vaches	69.6	nesting seabirds
	African Banks	32	nesting seabirds and hawksbill turtles

* For a detailed explanation of reserve categories, see McNeely and Miller, 1983.

Existing Marine Protected Areas (Cont.)

<u>Category</u>	<u>Name</u>	<u>Area in Hectares</u>	<u>Notable Features</u>
I. Strict Nature Reserve (Cont.)	L'Ilot (Fregate) La Plaine Mangrove Reserve		nesting seabirds mangroves
II National Park	Aride Island MNP Reserve Ile Cocos MNP		extension to Aride coral reefs
IV Managed Nature Reserve	Desnoeufs Nature Reserve	34.4	nesting sooty terns other seabirds

Existing Marine Protected Areas

I Strict Nature Reserve	Cousin Island Special Reserve Aride Island	28 70	endemic birds, seabirds, coral reef Seychelles black paradise flycatcher
IV Managed Nature Reserve	La Digue Veuve Reserve	8.3	nesting frigatebirds
VI Resource Reserve	Cousine Nature Reserve	25.2	nesting seabirds
VIII Multiple Use Reserve	Morne Seychellois NP	3,045	rocky shore to 905 m in altitude

Proposed Coastal Protected Areas

I Strict Nature Reserve	Recifs NR Police Bay Freshwater Marsh NR La Digue Freshwater Marsh NR		freshwater marsh freshwater marsh
II National Park	La Digue NP		coastal plain
VIII Multiple Use	Felicite	268 201.6	birdlife and endemic flora Seychelles magpie robin

Aldabra Research Reserve

The single most noteworthy result of scientific involvement in Seychelles resource management is the change in status for the island of Aldabra from a potential air base to a research reserve.

Aldabra atoll is a remote island, much of it formed by an ancient coral reef, located (800 km) 500 miles from the capital island of Mahe (See Figure 5). The atoll's surface is riddled with holes and pits, and dense thickets cover the ground in many areas. The coastline consists of undercut limestone cliffs, overlooking a broad reef flat. A shallow lagoon measuring 150 km² in area is enclosed by the atoll and surrounded by mangroves (Figure 6). Aldabra's habitats have been colonized by a diverse assemblage of plants and animals, mostly derived from Madagascar and mainland Africa. Many species once shared with neighboring islands are now limited to Aldabra--a result of its remoteness and lack of human population. The 152,000 giant land tortoises (Geochelone gigantea) are the most striking animal inhabitants. This tortoise population is an order of magnitude larger than that in the Galápagos Islands, and it represents the world's most concentrated population of reptilian herbivores. Bird populations include 5000 flightless white throated rails, frigate birds (Pryolimnas cuvieri), a large colony of terns and two endemic species: the Aldabra warbler (Nesillas aldabranus) and the Aldabra drongo (Dicrurus aldabranus).

Aldabra was afforded very limited protection by a series of ordinances beginning in 1901. In 1953 Jacques Cousteau visited the island and proposed that it be devoted to science. The British and the Seychelles colonial governments declined to pursue the idea, and the island was leased to a private party. By 1962, the British Ministry of Defence had completed surveys leading to proposals to construct an airstrip and accompanying capital works on Aldabra. A first step was detachment of Aldabra and two neighboring islands to form the British Indian Ocean Territory (BIOT). This was followed by the negotiation of a secret treaty to lease the islands to the United States for fifty years.

The scientific community, through the Royal Society, sent an expedition to Aldabra, published a special Memorandum on Aldabra Atoll, and convened a conference on the atoll. The Royal Society expressed its concern and announced plans for a major expedition while Nature condemned the airstrip in

Figure 5: Location of Aldabra Atoll in Relation to the Main Islands of the Seychelles and the East Coast of Africa. (Source: Stoddart and Ferrari, 1983.)

Figure 6: Natural Features of Aldabra Atoll, the Seychelles
(Source: Stoddart and Ferrari, 1983.)

an editorial. British Defence planners dropped the plan in 1967, as part of a major policy shift to abandon a military presence east of the Suez.

The Royal Society, following its announced intention to pursue research at Aldabra, decided in 1968 to build a research station. Aldabra Research Station was opened near an old fishing settlement on the Ile Picard in June 1971, and the lessee vacated his lease in favor of the Royal Society.

After the initial decision not to develop Aldabra, both research and conservation programs have flourished on the atoll. The Royal Society's initial expedition produced 50 scientific papers and consumed 14 person-years of investigation in a full inventory of island resources. By 1983 the research effort amounted to 50 person-years, and over 200 published papers.

Aldabra was declared a strict nature reserve in 1976 under the terms of the 1970 Protection and Preservation of Wildlife Ordinance. A formal mechanism to recruit and apply appropriate technical information for Aldabra management was created with the establishment of the Seychelles Island Foundation (SIF) in 1979. The board of the SIF is drawn from international scientific and conservation organizations, as well as prominent Seychellois. Members include the Royal Society, Smithsonian Institution, the Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM) and the Ministre de la Cooperation in Paris, IUCN, and the Royal Society for Nature Conservation. When the SIF was firmly established, the Royal Society transferred the Research Station and the lease to the Foundation.

Two other conservation measures assisted by the scientific community were (1) the adoption of the Aldabra Special Reserve Regulations to give the Foundation's warden powers to manage the atoll; and (2) the Seychelles' adherence to the World Heritage Convention and subsequent designation of Aldabra as a World Heritage Site (Stoddart, 1979; Stoddart and Ferrari, 1983).

Designation of Other Protected Areas

The International Council for Bird Preservation (ICBP), acting on the information it had gathered on the populations of three species of endangered birds, collaborated with the British appeal of the World Wildlife Fund to raise funds to purchase Cousin Island (Curry-Lindahl, 1974).

It appears that the designation of the La Digue Veuve Reserve was motivated in part by Watson's early study of the paradise flycatcher (IUCN,

1982; Watson, 1977). It is not clear whether the designations of National Parks at Morne Seychellois or Baie Ternay were heavily influenced by scientific information or the involvement of scientists.

Preparation of Resource Inventories

The Seychelles archipelago has been the subject of nationwide inventories and studies that document the resources of individual islands. Topographic and engineering surveys of most islands were completed in 1981 (Seychelles Government, 1982).

IUCN conducted a thorough inventory of coastal endemic species, including habitat types and their representation in protected areas and reserves in the East African Region, both to advance its own objectives and to fulfill an agreement with the East African Regional Seas Program. The results are published in IUCN's Contribution to the Development of the Action Plan for the Protection and Development of the Marine and Coastal Environment of the East African Region. The document is based on the field investigation of Rod Salm, an IUCN scientist, and Lindsay ChonSeng, of the Seychelles Department of Agriculture. It draws heavily on published scientific literature and Seychelles government documents.

The two most thorough terrestrial and nearshore resource inventories conducted in the Seychelles appear to have covered the islands of Aldabra and Cousin. The Aldabra inventory was motivated by the proposed airbase, while the Cousin Island inventory was prepared after Aride Island was dedicated to nature preservation. Curieuse Island is also the subject of an ongoing inventory of vegetation communities to gauge the effect of the establishment of a "daughter" tortoise population (Stoddart et al., 1982).

Several other protected areas have also been the sites of scientific surveys. An ongoing survey covering most of the flora and fauna at Cousin Island Special Reserve is being undertaken by the resident scientific administrator. Baie Ternay National Park was surveyed by a group from Galway University (IUCN, 1982). At La Digue Veuve, Dr. J. Watson has continued research on the ecology of the paradise flycatcher (Watson, 1981). A program has been underway since 1981 to tag hawksbill turtles and count tracks (IUCN, 1982).

Establishment of Programs for Species Protection

The conservation, and in some cases, sustainable use of tortoises, sea turtles, and bird species has been a direct outcome of scientific involvement in the Seychelles.

A report on green turtles, prepared for the Division of Forestry and Nature Conservation, (Frazier, 1974a) was used as the basis of the government's 1976 regulations (Frazier, 1979). These rules establish an eight month open season from 1 March to 1 November. The law forbids taking female turtles under 76 cm carapace length, but legalizes the taking of males. Frazier (1979) observed that further refinements are needed: a closed period would be desirable during peak breeding season, and the minimum size limit is ecologically unsound because it does not protect the few individuals that have grown to maturity.

The Local Advisory Committee of the International Council for Bird Protection (ICBP) for Cousin Island had a direct effect on the Seychellois policy for the hawksbill turtle. Noting concern over hawksbill exploitation, the Committee recommended that the National Parks Committee ban the sale of stuffed turtles. Upon the Committee's appeal, the government made it illegal to trade in preserved hawksbill turtles without a Ministry of Agriculture and Land Use permit (Frazier, 1979).

The Aldabra Research Committee of the Royal Society functioned as an effective advisor to the government of the Seychelles in a scheme to establish a daughter population of giant tortoises (Geochelone gigantea) on Curieuse, Island, near the main island of Mahe. This scheme was initially conceived for the dual purposes of avoiding tourism development on Aldabra itself and providing tourists with an opportunity to view tortoises in their natural surroundings. Scientists from the Aldabra Research Station proposed a series of criteria for choosing a site for a tortoise colony, reviewed five candidate islands, and chose Curieuse. Working in cooperation with Seychelles government representatives, these scientists collected 10 tortoises on Aldabra. The tortoises were held briefly in quarantine and released on Curieuse. Government officers monitored the tortoises' growth, environmental effects, and the breeding success of the daughter population. The research team established a target of 500 tortoises to sustain tourism without exceeding the capacity of the island. The Curieuse experiment was noteworthy

in that it addressed two goals, species protection and tourism, and earned the complete support of the Seychelles President (Stoddart et al., 1982).

Preparation of Plans for Tourism Sector Development

As noted above, tourism plays a central role in the nation's economy. In 1970, there were 140 overnight accommodations (hotel beds) and 1622 recorded tourists. By 1975, there were 1800 beds and 37,321 visitors (Seychelles Government, 1976). This increase continued through 1979 when 78,900 visitors came to the Seychelles (QER 4, 1981). The years 1980 to 1983 saw a slight decline from 71,800 to 55,867 tourists, partly as a result of aggressive marketing by competing tourist resorts. Some of the government's policies on tourism appear to consider the sensitivity of natural habitats. For instance, limits were established for new hotel development on outer islands, but it is not clear how technical information entered the decision process for setting these limits. (Ceilings are 1000 beds for Praslin, 150 for La Digue, and 50 to 80 for other islands.)

For 1984, the Tourist Board projected 65,000 visitors and estimated the Seychelles "capacity" to accommodate tourists at 100,000 per year (QER 2, 1984). Some biologists suggest that tourism could reach 150,000 visitors per year (Stoddart et al., 1983). The majority of the accommodation capacity is on Mahe. That picture will change slowly, since ceilings have been placed on the ultimate development of the outer islands. In 1981, the proportions of available lodging were 71% on Mahe, 22% on Praslin, and 7% divided among the outer islands.

Plans for tourism development take account of the scientific evidence of the sensitivity of the Seychelles natural environment. For example, Proctor's 1973 analysis of opportunities to encourage tourism by promoting resource conservation has been integrated into park and reserve development. Similarly, the establishment of a daughter tortoise population on Curieuse responds to the economic desirability of natural history-based tourism and to the vulnerability of Aldabra.

Several nations regulate tourism development by requiring structures to be set back from the shoreline to conserve biological resources or to avoid hazards (Sorensen, McCreary, and Hershman, 1984). The literature does not address the use of this strategy in the Seychelles.

Major events in the development of the tourism sector are outlined below:

- o Proctor's 1971 analysis of threats to endemic wildlife, and his companion review of opportunities to encourage tourism in the context of a resource-conserving policy for natural resources, served as the basis for a government white paper (Seychelles Government, 1971). Two years later, Proctor (1973) reported that substantial progress had been made. Three National Parks had been established, four sites were in the early stages of survey, and seven sites were advancing toward designation as Special Reserves or Strict Nature Reserves.
- o The government-sponsored Compagnie Seychelloise pour la Promotion Hoteliere (Cosproh) acquired the Flying Dutchman hotel on Praslin and the Northolme hotel at Glacis. Cosproh announced plans to build a luxury-class training hotel, Hotel des Palmes, next to the hotel training school at Carana Beach (QER 1, 1981).
- o A Seychelles Tourism Marketing Board, dedicated to the maintenance of very high standards, was created in 1981 to coordinate the efforts of the public sector and the private sector (QER 4, 1981).
- o By 1983, Tourist Board officials predicted 65,000 tourists for 1984 and projected a ceiling of 100,000 visitors per year (QER 1, 1984).
- o An agreement between France and the Seychelles to bring aid worth Fr 1.45m for two hotel projects was signed in late 1983 (QER 1, 1984).
- o Promotional flights of Air Seychelles were initiated to increase tourism (QER 1, 1984).
- o In 1984, Cosproh acquired the 184-room Beau Valon Bay Club and the 14-room Cote d'Or Lodge on Praslin to bolster the sagging quality of service (QER 1, 1984).

Preparation of Land Use Plans

The influence and participation of natural scientists in land use planning appears to be less significant than their role in species protection, natural area designation, and development of the fisheries sector. However, there does appear to be some effort to recruit additional specialists. The 1982-1986 National Development Plan notes that a shortage of skilled staff has hindered plan completion in some areas. Nevertheless, the Seychelles was the first nation in Eastern Africa to launch comprehensive land use planning with the Town and Country Planning Act of 1972. The plan is dedicated to ensuring a safe, healthy living and working environment for Seychellois people. A 1978 revision of the Act was designed to curb residential land speculation.

More detailed specific plans were also completed: the Greater Victoria Master Plan and the Bel Ombre District Plan. Now a District Plan for Anse Aux Pins/Point Larue is underway.

Finn (1983) characterized the Seychelles land use plans as generally effective, but found that plans are not regularly updated (Seychelles government, 1980; 1981). He found that in the Seychelles and neighboring Mauritius, land use decisions reflect strong pressures for economic development, and may miss opportunities for optimal use and allocation. The overriding importance of economic development was clearly articulated by Seychelles President René in a 1982 interview with the UNESCO Courier, subtitled "Everything is now geared towards development" (UNESCO, 1982).

Government policies in the Seychelles do not favor wetlands conservation. The National Development Plan calls for "drainage and rehabilitation of swamp land," and increasing "the stock of land through reclamation." None of the literature describes the biological character of the areas to be reclaimed, nor the likely biological consequences. One problem left unaddressed by sound land use planning is a garbage dump located next to a national seashore and marine park (Osore, 1983).

Development of Water Quality and Watershed Management Programs

Sewage pollution does not appear to be a major problem in the Seychelles even though only a small proportion (25%) of the population of the capital city is served by sewers (Osore, 1983).

Finn (1983) identified scarring of hillsides as an environmental problem. Ironically, the problem arose when the Seychelles government took steps to protect remaining agricultural land. Salm (personal communication, 1984) reports that rules now in effect prohibit development from protruding over the 35 foot tree canopy--primarily to protect the visual qualities of the Seychelles. The National Development Plan also calls for terracing hilly land to avoid negative consequences of building on hillsides (Seychelles Government, 1982).

The government is stepping up water quality monitoring with the creation of the National Environmental Control Center. Their priorities for research and monitoring cannot be discerned from available literature.

The government also recognizes silt-laden runoff as a significant environmental problem. A hard engineering solution has been selected over careful watershed management. The National Development Plan calls for construction of six coastal outfalls.

Preparation of Plans for Fisheries Sector Development

The one area where the Seychelles appear to have received less attention than Cape Verde is in fisheries research sponsored by the Food and Agriculture Organization (FAO). Only two studies on the Seychelles were produced by the FAO--one on oyster development (FAO, 1973) and another on fish drying (FAO, 1982). Seychellois are thought to consume more fish than almost any other people in the world (QER 4, 1981). While the Seychelles has an exclusive economic zone extending over 400,000 square miles, most of the fishing in these waters is by unlicensed boats whose operators are not required to provide any revenues to the Seychelles (QER 4, 1981).

A number of Western European and Asian nations have assisted in development of the Seychelles fisheries:

- o In 1981, France provided aid with a value equal to 750,000 French francs for two companies that will operate the new tuna industry: the Seychelles National Fishing Company (Snafic) and the Societe de Gestion Thoniere (Soget) (QER 1, 1981).
- o An ice making plant funded by the Abu Dhabi development fund was completed in 1981 (QER 1, 1981).
- o Research on fisheries and water supply was also funded in 1981 by the Kuwait Fund for Arab Economic Development (QER 1, 1981).
- o West German research ships began work on pelagic species in early 1981 (QER 2, 1981). The SR 30 mn project is funded by the German government.
- o Integration of the fisheries sector with resource protection is contemplated in the outer island development program. On Cosmoledo, an important turtle breeding ground, fisheries development will be emphasized (QER 2, 1981).
- o Illustrating its political independence (or pragmatism), Seychelles acquired reconnaissance aircraft from Britain, France, and Libya and began to license foreign fishing vessels (QER 4, 1981).
- o A new National Maritime School opened in 1981 (QER 4, 1981).

- o By 1984 the Seychellois government had adopted the goal of making Mahe a leading fishing port. The Seychelles negotiated an agreement with France, allowing 18 boats to fish territorial waters in exchange for \$765,000 in cash and a \$210,000 research investment.
- o A development consortium including the Norwegian Norplan Company and the African Development Bank is backing construction of two massive new fishing ports on the east coast of Mahe island.
- o In the offshore mining sector, the Coaveshani, an Indian research ship, has carried out 20 days of scientific exploration of the Seychelles EEZ. The cruise found promising deposits of manganese nodules near the Amirantes group of islands and industrially-useful mineral sands on the continental shelf (QER 1, 1984).
- o The 1982-1986 National Development Plan calls for an investment of SR 170 mn for long pier redevelopment, increasing demersal fish catches to 5500 tons/year, fisheries surveillance, and research training. An investment of SR 22.1 mn for one year was proposed to assess fish stocks, quality of fish, refrigeration and marketing.
- o The plan also recognizes the need for "a comprehensive and integrated fisheries policy to achieve coordination of...the various fields of the fisheries sector."

Mechanisms to Incorporate Scientific Information in Resources Management

Both private- and government-sponsored programs have been established in the Seychelles to promote research and integrate scientific findings in natural resource policy making. Cousin Island, a nature reserve owned by the International Council for Bird Preservation, supports a year-round scientific administrator (Diamond, 1976; de Brooke and Garnett, 1983). Over the past 6-8 years, administrators have been actively involved in surveying populations of the hawksbill turtles. In effect, scientific administrators are empowered to take action based on their own findings, following consultation with a local advisory committee.

A similar mechanism is at work on Aride Island nature reserve. The Royal Society for Nature Conservation has overall responsibility for Aride. Routine administration is delegated to an island manager who confers with a local committee in the day-to-day running of the island.

The Seychelles Island Foundation (SIF) also represents a potentially strong mechanism to specify research needs, fund and complete investigations, and apply the findings in public policy. Its mandate calls on the Foundation

to instigate research on Seychellois natural history to inform resource management. The board members of the SIF provide a direct link between the scientific community and resource managers.

The 1982-1986 National Development Plan calls for the creation of a new laboratory (to be called the National Environment Control Center) to undertake pollution baseline studies and provide research services to other agencies under the auspices of the National Research and Development Council. Research to be performed by the new laboratory is intended to address the fragmentation of government research that now exists (Seychelles Government, 1982).

A new Seychelles National Environment Commission is also proposed for creation under the Ministry of Planning and Development. The Ministry of Planning and Development is taking portfolio responsibility for coordination of the full range of government policies on the environment. This move should facilitate the direct application of technical information in resource policy. The first task of the newly formed Commission is a "radical and comprehensive policy review" and preparation of a National Environment Strategy.

Barriers to the Application and Use of Scientific Information in the Seychelles

While the the Seychelles generally have been well-served by a strong relationship between the scientific community and policymakers, some important barriers still persist. The government is taking steps to overcome several of these barriers.

Weak Enforcement

Poaching and lack of enforcement frustrates resource policy guided by well-intentioned recruitment and application of scientific information. Diamond (1976), writing on the protection of hawksbills, noted that enforcement was rare outside Cousin because of lack of staff, ignorance of the law, and lack of an appreciation of the importance of resource protection. Diamond also observed that protecting immature turtles (and not adults) was biologically unsound. Frazier (1979) notes "I have previously [Frazier, 1974a; 1975a] reported that poaching occurs virtually everywhere there are turtles--regardless of whether or not there are permanent settlements." He goes on to point out that "... those who inhabit or frequent the remote islands are custodians of their resources; and the actions of these people, no matter how few, affect all Seychellois."

Insufficient Integration of Resource Management Activities

Historically, institutional fragmentation has frustrated coordination and application of research efforts in the Seychelles. Excessive reliance on donor agencies and international conservation organizations (such as IUCN) may postpone necessary capacity-building within the Seychelles. Some outside support should be viewed as a complement to local measures for resource management, not a substitute (Frazier, 1979; Seychelles Government, 1982).

Salm (personal communication, 1984) does not believe there has been an overwhelming benefit from scientific information in Seychellois resource management--perhaps because resource protection goals are often relaxed or pushed aside by strong development pressures. As an example, Salm cited the proposed port/fishing facilities on the East Coast of Mahe that would displace mudflats and other wetland habitats. This decision suggests that while the Seychelles has made major strides in protection of key species and habitats, it still has not fully integrated its policy making for coastal resources.

Lack of Access to Natural Resources

Lack of access to Seychellois natural resources is seen as an important barrier to public support for resource protection. Without direct contact or exposure to the natural history of protected resources, many citizens either do not understand the rationale of prevailing ordinances or may not perceive any benefits of regulation and government management.

Lack of Funding for Basic Natural History Research and Monitoring

Lack of funding hampers basic surveys of important species and ongoing monitoring of their status (Frazier, 1979). Without ongoing measurement of the environment, it will be difficult to assess how well existing coastal management strategies have performed. In the 1982-1986 National Development Plan, a number of research programs are enumerated for funding. However, most funding is allocated to applied subjects such as pollution research, rather than monitoring of protected species and reserves.

Need for International Approach to Protect Migratory Species

The Seychelles government specifically recognizes that it cannot succeed alone in protecting migratory marine species such as sea turtles, whales and stocks of pelagic fish (Ferrari, 1983). International fora must often be convened, and agreements must be implemented through treaties or conventions. A prime example of transitional migratory species management was the action of the Seychelles to line up 50 African and Indian Ocean nations in support of an Indian Ocean Whale Sanctuary. The result was favorable action by the International Whaling Commission and creation of a sanctuary in 1979 (Ferrari, 1983; Holt, 1983).

PART II: PROGRAM SUMMARIES

MAN AND THE BIOSPHERE PROGRAM

Background

UNESCO operates the Man and Biosphere (MAB) Program, an international effort dedicated to the study of human interaction with each of the earth's major regions, in order to provide an improved information base for environmental decision making. MAB grew out of the International Biological Program (IBP) and was conceived at the UNESCO Biosphere Conference convened in 1968. The program began work in 1971 and received the endorsement of the UN Conference on the Human Environment at Stockholm (de Castri et al., 1981).

Initially (1971-1973), four goals were set for MAB: production of new information of intrinsic scientific value, application of research results to land management, development of research capacity of developing countries, and elimination of institutional barriers to the conduct and application of interdisciplinary research.

Subsequently, MAB evolved through three phases:

- o planning at the national and regional levels (1973-1975);
- o initial field activities (1975-1977);
- o establish operational programs (1977-present).

MAB's emphasis also evolved from an initial preoccupation with modelling whole ecosystems to a more pragmatic emphasis on "human use systems" (di Castri et al., 1981).

MAB activities are divided into 14 projects. Project 7 involves the ecology and rational use of island ecosystems, and Project 8 concerns the development of an international network of biosphere reserves--protected areas for conservation, research, and monitoring.

Roles of Scientists in the MAB Program

The principal roles of scientists in MAB have been to help establish the basic framework for the programs, conduct applied research, and provide general guidance on the policy implications of the research. Three research efforts were the initial focus of Project 7: management of environmental resources by island populations; the impact of external forces on islands,

with special reference to tourism; and the impact of alien plants and animals on island ecosystems (UNESCO, 1973).

In the United States, the role of scientists in establishing the framework for the Biosphere Reserve project was particularly extensive. An expert panel of marine scientists and wetlands ecologists was convened in 1981 to devise a process for selecting reserves. The steps in the process are as follows: (1) candidate sites are nominated; (2) candidates are evaluated for their species diversity, representativeness, and research; (3) the U.S. MAB directorate endorses, amends, or rejects candidates; (4) the directorate offers a recommendation to the U.S. Committee on MAB; (5) the U.S. committee reports its finds to the MAB headquarters in Paris; (6) UNESCO renders a final decision (Ray et al., 1981).

Outcomes of Scientific Involvement in the MAB Program

A major research product of Project 7 is a seven-volume study on the carrying capacity of the Lau island group in Fiji (MAB, 1981; Brookfield, 1980; Brookfield, 1981). Towle and Teytaud (1982) characterized the work as "a high budget approach to the problems of small tropical islands, utilizing a complex simulation model". The actual application of research findings to Fijian resource management has been limited to preparation of general development guidelines.

The outcomes of Project 8, the Biosphere Reserves, are much more tangible. In the U.S., over 40 sites have been designated Biosphere Reserves. Worldwide, 192 biosphere reserves have been designated in 49 countries. In addition, by 1981 some 963 field projects had been initiated in 77 countries, with an average duration of 2-5 years.

Barriers to the Recruitment and Use of Scientific Information in the MAB Program

Since the MAB program embraces over a dozen discrete projects--each of which is really a program--it is difficult to generalize accurately about recruitment and use of information. However, it appears that the sheer scale and complexity of the Brookfield opus for Fiji overwhelmed the capacity of Fijian officials to make good use of the material. Even Brookfield's own review (1981) indicates that the results were restricted to some indirect influence on resource policy.

The participation of scientists in the selection of Biosphere Reserves appears to be working well. That program is noteworthy in that scientists were involved at each step of the way, from framing the program, to nominating initial sites, to reviewing sites, and on through final approval in the U.S. and Paris. The Paris UNESCO Biosphere staff consists of professional biologists with extensive experience in reserve management and genetic conservation.

While MAB has consistently stressed the need for cooperation among disciplines, and among scientists of different nations, many projects have in fact been dependent on the presence of an outside expert. Departure of the expert may end the project, since many developing countries lack the personnel and structure to sustain scientific research.

A shortage of research funds has also hampered ongoing research and has induced many scientists to leave their own nations for better opportunities. Other researchers may be pressured to work in applied sectors of the government or in private market, thus breaking the continuity of long-term research efforts.

Sectoral fragmentation has also worked against optimal use of research findings. Traditional divisions between university disciplines and government agencies are not easily bridged by the presence of a MAB project in the country. Fundamental weaknesses in institutional development and in integration of narrow sectors into a larger vision of coastal and marine policy have not been readily corrected by MAB. A final institutional barrier to the current efforts of the MAB program arises from apparent mismanagement within portions of UNESCO. Criticism of these problems in turn sours new MAB initiatives (Bell, personal communication, 1984.)

EASTERN CARIBBEAN NATURAL AREAS MANAGEMENT PROGRAM

Background

The Eastern Caribbean Natural Areas Management Program (ECNAMP) is a nongovernmental organization made up of a small cadre of scientists and technicians from the University of Michigan Wildlands Management Program and the Caribbean Conservation Organization. ECNAMP has received funding from the Rockefeller Brothers Fund and the World Wildlife Fund. ECNAMP has a pragmatic, grassroots style. Its hallmark is the recruitment and

training of local scientists and technicians to assist in small construction, planning and resource management tasks.

Roles of Scientists in ECNAMP

Primary scientific research is not a significant part of ECNAMP. Within the ECNAMP framework, scientists function principally as advisors and grassroots educators. ECNAMP staff members do not function in a decision making role, although domestic scientists collaborating with staff have decision making responsibility in some cases.

Outcomes of Scientific Involvement

The organization's work has spanned a variety of coastal management activities. Resource atlases have been prepared for several Caribbean Islands (Towle, in press), and staff have prepared maps of hurricane damage in Dominica (ECNAMP, 1983a) and the French Antilles (ECNAMP, 1983b). ECNAMP has been involved in creation of marine protected areas by drawing up proposals for marine parks programs in the British Virgin Islands (ECNAMP et al., ECNAMP, 1983a). A third product of the organization is a set of development guidelines for the Southeast Coast of St. Lucia (ECNAMP, 1983b), and more general guidelines for marine resource management in the Eastern Caribbean (Putney, 1979).

Another focus of the organization addresses a need found in the Galápagos: development of ecologically sensitive tourism in Dominica and Guadeloupe (ECNAMP, 1983b). This effort marks ECNAMP's most explicit effort to assist in the development of a coastal-dependent sector.

ECNAMP's influence on marine policy for the Caribbean may increase since the organization's principal investigator, Alan Putney, serves on a team involved in IUCN's Conservation Plan for the Caribbean during the period 1984 to 1987 (ECNAMP, 1984).

Barriers to the Recruitment and Use of Scientific Information in ECNAMP Programs

The most significant barriers to recruitment and use of scientific information in ECNAMP projects are probably the currently limited capacities of domestic governments in the Eastern Caribbean and the limited staff and

budget of the organization itself. In most cases, ECNAMP provides a product (i.e. data atlas, marine park proposal, development guidelines) that must be implemented or used by the cooperating island or national government. There is little doubt that in completing these tasks, the technically-trained members of the ECNAMP program have been quite successful in bringing projects to completion.

REGIONAL SEAS PROGRAM

Background

The institutional parent of the Regional Seas Program, the United Nations Environment Program, was created in late 1972, largely as a response of the Stockholm Conference on the Human Environment (Hulm, 1983; UNEP 1982a). UNEP's first governing council set the health of the oceans as its foremost concern in 1973, and it remains one of seven leading issues today. The Regional Seas Program was initiated by UNEP in 1974 to address several pressing issues, including scientific research in the oceans, trans-boundary pollution, ocean dumping, fisheries, and conservation.

Initially, four regions were chosen for emphasis: the Mediterranean, Kuwait and the Persian Gulf Region, the Caribbean, and West Africa. In the following five years, UNEP added four more regions, including the South East Pacific (which includes Ecuador).

UNEP's strategy consists of four steps (UNEP, 1982):

- o an Action Plan setting out activities for scientific research and cooperation;
- o a legally binding convention embodying general principles;
- o technical and specific protocols to deal with individual issues;
- o financial and institutional arrangement to implement the first three steps.

Regional Seas Action Plans usually contain four parts: assessment, environmental management, legislation, and support measures (UNEP, 1982b). Assessment, the first priority, is geared to evaluate sources and effects of pollution, the state of living and marine resources, and development practices.

JOINT GROUP OF EXPERTS ON THE SCIENTIFIC ASPECTS OF MARINE POLLUTION

One program linked to the Regional Seas effort is the Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). That effort was established in 1969 and cosponsored by UNEP and the International Maritime Organization (IMO), Food and Agriculture Organization (FAO), UNESCO, World Meteorological Organization (WMO), World Health Organization (WHO), the International Atomic Energy Agency (IAEA), and the United Nations Secretariat. GESAMP's current terms of reference outline program functions as follows:

- o provide advice relating to scientific aspects of marine pollution;
- o prepare periodic reviews of the state of the marine environment as regards marine pollution and identify problem areas requiring special attention (UNEP, 1984b; Pravdic, 1981).

Roles of Scientists in the Regional Seas Program

Within the framework of Regional Seas, scientists conduct primary research on coastal and marine processes (IMCO et al., 1980), staff monitoring programs (UNESCO, 1980b), and render advice to policy makers on coastal development (IMCO et al., 1980a) and on the terms of conventions and other agreements.

Outcomes of Scientific Involvement in Regional Seas

The most tangible products of the Regional Seas programs are execution of international treaties and conventions, completion of specific scientific investigations, and identification of key research topics.

In the Convention for Marine and Coastal Protection the South-East Pacific Regional Seas program adopted July 20-22, 1983 in Quito, Ecuador (UNEP 1984a), the contracting parties agreed to several provisions for exchange of information and scientific and technical cooperation.

Article 9 of that Convention calls for nations to identify existing research efforts and bureaus responsible for marine pollution, while Article 10 sets out responsibilities to promote programs of scientific and technical assistance, including training personnel and providing facilities and advice for research and monitoring. Further, Article 10 states:

the High Contracting Parties undertake, to the extent possible, to promote and coordinate their national research programs on all the types of pollution which exist within the geographical sphere of application of this convention, and to cooperate in the establishment of regional research programs.

It is difficult to gauge from available literature whether any substantial progress has been made toward these goals. It is even more difficult to predict whether they will have a direct effect on water quality policy in specific nations.

The most recent meeting of nations participating in the Southeast Pacific Action Plan, which convened February 8-10, 1984, produced a resolution opposing all radioactive dumping and a second resolution calling for intensified research on the El Niño phenomenon (UNEP, 1984d).

The major outcome of the GESAMP program has been to complete baseline monitoring for water quality, recommend water quality standards, present research findings, and identify gaps in current knowledge (UNEP, 1984b). An additional product of GESAMP's work has been to derive principles for developing coastal water quality criteria (1984b). The GESAMP effort does not appear to have made a substantial impact on other dimensions of coastal and marine resources management.

Barriers to the Recruitment and Use of Scientific Information in Regional Seas

The UNEP Regional Seas Program is a stellar example of recruitment of a vast network of scientists and research facilities in support of marine conservation. Dozens of specialists have served as members of GESAMP or its working groups (UNEP 1984a). Eighty-four marine laboratories participated in initial water quality monitoring for the Mediterranean Action Plan (Hulm, 1982). However, Regional Seas depends on the voluntary cooperation of member governments, so the translation of vigorous scientific findings into hard-hitting resource policy is frustrated by political strife, bureaucratic delay, and the slow pace of international diplomacy. In fact, none of the reports reviewed on UNEP's activities made reference to specific changes in national government policy which could be attributed to the Regional Seas program itself. It is probably more accurate to credit Regional Seas for creating a climate in which positive action is encouraged.

A second hindrance to full application of findings derived by UNEP is the program's heavy emphasis on the water side of the coastal zone. Individual studies have examined land based pollution, but the program does little to promote land use planning, impact assessment, shoreline setbacks, and other land-based management strategies (Sorensen, McCreary, and Hershman, 1984).

EPILOGUE:

APPLICATION OF RESEARCH FINDINGS TO COASTAL AND MARINE RESOURCES MANAGEMENT
IN THE GALAPAGOS ISLANDS.

The national and international efforts to manage coastal and marine resources reviewed in this report represent a range of sophistication, formality, and degree of success in recruiting and applying scientific information in public policy.

Cape Verde has sustained a series of setbacks in its resources management, as a consequence of a protracted drought, a narrow resource base, and limited institutional capacity to reverse persistent trends. The international scientific community has had a limited presence in Cape Verde. While new kinds of fauna and flora have been described, and two species have been classified as endangered, there has been no progress on species protection or special area protection. Meanwhile, the Cape Verdean population has pushed to extract additional benefits from agriculture and grazing, thus worsening erosion and siltation. Promising results are beginning to emerge from demonstration projects in wind energy production, small-scale dam construction, and especially fishing industry modernization. Both fish landings and export values have climbed in response to financial and technical assistance from donor agencies.

In Cape Verde, the fisheries sector is the one coastal-dependent activity where infusion of technical information is demonstrably linked to immediate economic improvement. Still, current efforts are preoccupied with the nuts and bolts of refrigeration, distribution, and engine repair. Stock management and the integration of fishing with other sectors are not yet part of Cape Verde's national agenda.

The Cape Verde case suggests that recruitment and application of technical information in a lower income nation (or archipelago) may be constrained by five factors:

- o the perceived economic/national development benefits;
- o the extent of the research tradition and data base begun by colonial or other foreign researchers;

- o the technical capacity of national staff to carry on work begun by donor agencies;
- o the institutional capacity of national governments to set goals, establish research agendas, and translate information into meaningful action;
- o the barriers of language and culture.

Cape Verde offers one overriding lesson: current conditions in the archipelago represent a scenario with the worst consequences of overexploitation of scarce resources, coupled with inadequate efforts to integrate development of economic sectors in a larger policy for renewable resources.

The Seychelles share a number of important characteristics with the Galápagos Islands:

- o a high proportion of endemic species;
- o many unusual species (such as the giant tortoise) which are vulnerable to disturbance;
- o a national policy calling for protection of special habitats;
- o an important tourism sector with the potential for significant growth (see Appendix 3);
- o a scientific research facility with a track record of advice on marine and coastal issues;
- o a long history of international cooperation in coastal research and species protection.

Both the Seychelles and Ecuador are poised to assemble individual programs for coastal-dependent sectors into a coherent national policy for renewable resources and development. Both nations have a demonstrable problem arising from agency fragmentation in research and planning, and both have taken steps to better integrate bureaucratic functions. (Ecuador has created the Galápagos National Institute (INGALA) under the Office of the President to coordinate planning and development activities; the Seychelles has created the Seychelles National Environment Commission).

Several aspects of the Seychelles experience might provide helpful guidelines in formulating a program for the Galápagos.

First, the linkage between research and government resource policy is especially strong in the Seychelles Island Foundation. The organization is fundamentally dedicated to promoting natural history research, yet it has direct management responsibility for Aldabra and serves as leaseholder. The Foundation is devoted to the Seychelles' resources, but its Board draws from leading international research and conservation organizations, including IUCN and ORSTOM. Finally, it has forged direct links to the very highest level of government decision making by creating a Board position for President René. By all accounts, the Foundation has been a successful steward of Aldabra, and a worthy sponsor of academic research.

A second instance of effective translation of research into resource policy is the work of the scientific administrators on Aride and Cousin Islands. These individuals have performed research and monitoring with foreign investigators. They subsequently discussed findings with local advisory committees and prescribed new management policies within existing laws. Thus, on the scale of single island there is a strong thread of continuity from research to interpretation to policy setting.

A third possible model for the Galápagos is the Seychelles National Environment Commission, a bureau created under the Ministry of Environment to receive information and coordinate research policy. It may be useful to make a follow-up inquiry to discover how well the Commission is achieving its goals.

Given these positive experiences, it seems that the Seychelles and Ecuador could benefit from a mutual exchange of ideas and information. It may be useful to convene a workshop with the attendance of key agencies in Ecuador and the Seychelles, as well as from national research institutions. International organizations such as IUCN have already expressed interest in WHOI's Galápagos project and might also be invited. Alternatively, Seychellois officials could visit the Galápagos, or perhaps reciprocal visits could be arranged between the two archipelagos.

Moreover, the Galápagos and the Seychelles could represent the beginnings of an international network for applied research and management of Oceanic Islands--a more pragmatic successor to IUCN's now defunct Islands for Science Program. Individuals responding to correspondence sent as part of this

investigation have identified the need for such a network. Similarly, Sorensen, McCreary and Hershman (1984) have proposed the creation of a global issues index to facilitate joint problem solving and information sharing.

Neither Cape Verde nor the Seychelles have a program in place to assess and mitigate the impacts of coastal development. Yet, "environmental impact assessment" (EIA) could be one of the most important frameworks for incorporating scientific information in decision making. Environmental impact assessment refers to both a governmental process and an analytic method. As a process, EIA is usually imposed by the government to compel agencies or private development interests to disclose impacts, to coordinate aspects of planning, and to submit development proposals to review. As an analytic method, EIA is used to predict the effects of a project or program.

In a review of institutional arrangements for coastal management in the developing world, Sorensen, McCreary and Hershman, (1984) concluded:

"Virtually all coastal nations can benefit from the strategy of environmental impact assessment (EIA) of projects affecting renewable coastal resources. EIA can be a flexible procedure to identify, evaluate and help avoid the worst impacts of coastal development."

The coastal program for the Galápagos could benefit from incorporation of an impact assessment element.

The three international programs reviewed--Man and the Biosphere, ECNAMP, and Regional Seas--seem to bracket the Galápagos in their geographic scope, formality, and precision. ECNAMP has constructed facilities and written region-wide strategies, but it has not produced a comprehensive coastal and marine program for a single nation. ECNAMP's informality and direct presence on an island has helped to break down barriers between experts and nonexperts and between scientists of different disciplines. However, it carries neither the legal standing nor the clout to shape national resource policy on an ongoing basis.

Man and the Biosphere and Regional Seas, in contrast, are both formal international programs whose presence and influence varies with the disposition of the host nation. The Southeast Pacific Regional Seas Program may represent a useful framework to gain cooperation and support from neighboring nations in Galápagos management, but it does not appear to present

a model for Galápagos resource management. It could, however, represent a source of complementary management initiatives, such as the recent resolution opposing radioactive dumping.

Man and the Biosphere could be useful to the Galápagos effort in two ways. First, since it has sponsored creation of dozens of biosphere reserves worldwide, it may provide access to information on management of other protected areas. Second, completed projects emphasizing tourism/endemic species interaction might produce useful insights for the Galápagos. A further literature review or direct contact with UNESCO would be needed to identify the most pertinent studies.

Throughout the national and international programs, four major themes emerge. First, continuity of research and scientific advising seems to produce beneficial results in translating research findings into management action. Long-standing research on a single subject, or a continuous record of scientific investigation from an institution, seems to increase the odds that the findings and recommendation will work their way into national policy. Often this influence may be felt in marginal adjustments to the status quo, informed by the most recent research. The application of numerous findings on Seychelles wildlife, published in Environmental Conservation and Biological Conservation, underscore this point.

Second, the fragmentation of island development in discrete sectors--fisheries, tourism, housing, national parks--frustrates incorporation of research findings that bridge more than one sector. For instance, protecting an endangered species in a national reserve may not be effective if adjacent shorelines are used as garbage dumps, or upstream watersheds are developed unwisely. Island nations have a special stake in identifying and forecasting the effects of one sector on another. Integrated coastal resources management represents a more fruitful context for exchange and use of scientific findings (Sorensen et al, 1984).

Third, formal and informal mechanisms that bring decision-makers into face-to-face contact with researchers are likely to result in more extensive application of scientific findings. Programs such as GESAMP which limit discussions to technical debates among scientists are not typically successful in translating findings into direct action. The Seychelles Island Foundation, in contrast, benefits from direct interaction between top administrators and scientists.

Fourth, the level of scientific background and institutional sophistication in the archipelago should at least approach that of the donor agency or foreign university. Institutional capacity building has a major influence on effective use of scientific research. Resource management programs are less likely to collapse after the departure of the outside expert if local counterparts are conversant with the methods and findings of research.

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APPENDICES

- A - Comparison of the Galápagos, Cape Verde, the Seychelles and the Canary Islands
  - A1 Geographic Characteristics
  - A2 Importance of Endemism
  - A3 Tourist Visitation
- B - Chronology of Seychelles Research
- C - Chronology of Major Events in Coastal and Marine Resources Management for the Galápagos

Appendix A1: COMPARISON OF ANALOGS: GEOGRAPHIC CHARACTERISTICS

Archipelago	No. Islands & Islets	Land Area*	Population
Cape Verde	15 (10 isl. & 5 islets)	1557 (A) & 5 islets)	329,000 (A) ** density: 211
Seychelles	150	171.4 (B)	66,000 (A) 68,750 (B) ** density: 385
Galápagos	14 islands 65 islets (D)	7800 (D)	6000 (E) 8500 (F)

* in square miles

** average density of persons/square mile

- Sources (A) State Department Geographer, July 24, 1984 (John Olsen)
 (B) Republic of Seychelles Statistical Abstract, 1979
 (C) World Bank Estimate, West Africa Unit (Unpublished)
 (D) Perry, R., Ed. 1984. Key Environments: Galápagos. Pergamon Press.
 (E) Broadus, J., I. Pires, A. Gaines, C. Bailey, R. Knecht, B. Cicin-Sain. "Management of Coastal and Marine Resources for the Galápagos Islands." Woods Hole Oceanog. Inst. Tech. Rept. WHOI-84-43.
 (F) Unofficial estimate from most recent Ecuador census.

Appendix A2: IMPORTANCE OF ENDEMICISM

Archipelago	Total Endemics	Terrestrial Species	Coastal/Marine*	Proportion Endemics: Total
Cape Verde	N/A	92 Plants (C, D) 10 Lizards (C) 2 Birds (C)	N/A	N/A
Seychelles	58 Coastal/Marine (B)	N/A	1 plant (B) 2 mammals (B) 21 birds (B) 2 reptiles (B) 31 fishes (B) 1 insect (B)	N/A
Galapagos		250 Plants (F) 228 Plants (G)		250/700 Plants (F) = 40% 228/625 Plants (G) = 36.5% 100% of Reptiles 66% Resident Birds (G) 23/28 Land Birds = 82% (H)

* The coastal/marine designation is used by IUCN in its Regional Seas Work

- Sources: (A) Bramwell, D. 1979. Plants and Islands. Academic Press, 1979.
 (B) IUCN. 1983. IUCN's Contribution to the Development of an Action Plan for the East African Region.
 (C) U.S. Agency for International Development 1980.
 (D) Chevalier, A. 1935. Les îles du Cap-Vert, Flore de l' Archipel.
 (E) Bramwell, D. 1976. In: Kunkel (ed).
 (F) Kramer, P. "The Galapagos: Islands Under Siege." Ambio 12 (3-4): 186-190.
 (G) Putney, A. 1982. "Reformulation of the Galapagos National Park Management Plan." Servicio Nacional de Parques, Ministerio de Agricultura, Ecuador.
 (H) Perry, R., Ed. 1984. Key Environments: Galapagos. Pergamon Press.

Appendix A3: COMPARISON OF ANALOGS: TOURIST VISITATION

Archipelago	1970	1975	1977	1978	1979	1980	1983	1984*	Projected Capacity
Cape Verde				N E G L I G I B L E (A)					57 rooms in Praia 420 rooms on Sal (G)
Seychelles	1622 (C)	37,321 (C)	59,500 (D)	65,000 (D)	78,900 (D)	78,800	55,867 (E)	65,000 (E)	100,000 (E) 120,000 (B) 150,000 (F)
Galápagos (H)	4579	6100	7779	9719	10,461	17,666	17,766	--	

* Estimated

Sources:

- (A) World Bank East African Regional Office, July 24, 1984
 (B) UNESCO Courier 82: Nov-Dec. 1983
 (C) Seychelles Handbook, 1979
 (D) Quarterly Economic Review of Madagascar, Mauritius, Seychelles, and Comoros 4, 1981
 (E) Quarterly Economic Review of Madagascar, Mauritius, Seychelles, and Comoros 1, 1984
 (F) Stoddart et. al, 1982
 (G) Quarterly Economic Review of Angola, Guinea Bisseau, Cape Verde, Sao Tome, Principe, 2, 1980, QER 2, 1984
 (H) Garcés, Fausto, et al. Diagnóstico de la Actividad Turística de la Provincia de Galápagos y Sus Impactos Sociales y Ecológicos. Instituto Nacional Galápagos, 1984.

Appendix B: CHRONOLOGY OF SEYCHELLES RESEARCH

- 1868 Flora of the Seychelles first described (Wright, 1868).
- 1877 Flora of the Seychelles first described (Baker, 1877).
- 1908 M.J. Gardiner led 2 special expeditions to collect myriapods (centipedes and millipedes) in the Seychelles (Eason, 1978).
- 1940 Studies on Seychelles vegetation published (Vesey-Fitzgerald, 1940)
Studies on seabirds reported (Belts, 1940)
- 1947 Studies on reptiles and amphibians published (Vesey-Fitzgerald, 1947).
- 1958 Ridley and Percy (1950) undertook a short investigation of sooty tern biology and stressed that conservation measures were needed.
- 1962 Land birds of granitic islands documented (Cousteau-Latame, 1962).
- 1965 Bristol University ornithological expedition to the Seychelles (Proctor, 1973).
- 1966 Exploitation of seabird eggs documented (Ridley and Percy, 1966).
- 1967 First major study of Seychelles sea turtles (Hirth, 1967).
- 1968 Royal Society decides to build research station (Stoddart and Ferrari, 1983).
- 1969 Major study on endemic birds published (Gaymer et. al., 1969).
- 1971 June 30 Aldabra Station opens.
Lessee of Aldabra agrees to vacate in favor of Royal Society.
- 1973 Resources of the Vallee de May inventoried on Praslin (Polunin and Proctor, 1973).
- 1975 Two Oxford expeditions made first detailed study of Aride's ecology (Warman et. al., 1976; Warman and Todd, 1984).
- 1976 Status of hawksbill turtles reported (Diamond, 1976).
- 1978 New species of centipedes and millipedes described (Eason, 1978).
- 1979 Seychelles Island Foundation established to initiate research on the national life of islands
- 1980 Habitat utilization of rocky intertidal zones documented (Sloan, 1979).

1981 Aldabra designated Special Reserve by Seychelles National Parks and Nature Conservatory Act (Stoddart and Ferrari, 1983).

1983 Fifty man years of research; over 200 published research papers (Stoddart and Ferrari, 1983).

Status of roseate tern reported (Gochfeld, 1983).

Appendix C: CHRONOLOGY OF MAJOR EVENTS IN COASTAL AND MARINE
RESOURCES MANAGEMENT FOR THE SEYCHELLES*

1750-1900

- 1770 French settlers and their slaves, established themselves on St. Anne Island off Mahe (Warman and Todd, 1984).
- 1803 Praslin, the second largest island in the archipelago, is settled (Warman and Todd, 1984).
- 1861 First permanent inhabitants settle Aride Island (Warman and Todd, 1984).
- 1874 Charles Darwin joined Joseph Hooker, T.H. Huxley, and Richard Owen to appeal to the Governor of Mauritius to guard against extinction of the Aldabra tortoise (Stoddart and Ferrani, 1983).

Late 19th C: Private philanthropy of English naturalist Walter Rothschild protects turtles (Stoddart and Ferrani, 1983).
- 1880 A.R.L. Wallace documented decline of native flora on Mahe (Proctor, 1973).
- 1883 Seabirds captured on Aride Island for "pigeon pies ('very fishy')"
North, 1892).
- 1888 Aldabra leased for fishing, turtling, woodcutting (Stoddart and Ferrari, 1983).

1900-1950

- 1901 First turtle protection ordinance (Stoddart and Ferrani, 1983).
- 1903 The Seychelles gain Crown Colony status. Seychelles transferred jurisdiction for Aldabra (Stoddart and Ferrari, 1983).
- 1925 Turtles Ordinance protects the green turtle and the hawksbill (Frazier, 1979).
- 1941 Five species of birds protected by Wild Birds and Animals Protection Ordinance (Stoddart and Ferrari, 1983).
- 1947 Plumage Birds Exportation Ordinance of 1947: 12 birds protected (Stoddart and Ferrari, 1983).

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* For a parallel chronology of the Galápagos Islands, See "Twenty Years of Conservation in the Galapagos--Assessment, Lessons and Future Priorities," prepared by the Charles Darwin Foundation for the Galápagos Islands with assistance from the UNESCO Man and the Biosphere Program.

Seychelles Resource Protection

1951-1970

- 1953 Jacques Costeau visited Aldabra aboard the Calypso; proposed that the atoll be devoted to science and research (Stoddart and Ferrari, 1983).
- 1955 New 30-year lease of Aride Island for commercial exploitation of mangroves, shellfish and fish. Lessee required to prevent disturbance to wild birds and tortoises (Stoddart and Ferrari, 1979).
- 1957 Revisions to Seychelles law regarding turtles (Frazier, 1979).
- 1958 Government invited ornithologists to advise on exploitation of the sooty tern (Ridley and Percy, 1958; Proctor, 1973).
- 1962 Initial military surveys by British Ministry of Defence-airfield on Aldabra (Stoddart and Ferrari, 1983). Quota system for sooty tern egg cropping established (Feare, 1976).
- 1964 Revisions to Seychelles law regarding turtles (Frazier, 1979).
- 1966 Royal Society of London persuaded the British Defence Ministry to attach 2 scientists to survey party for Aldabra (Stoddart and Ferrari, 1983).
- 1967 Memorandum on Aldabra Atoll published by Royal Society; convention convened. Coppicing of major tree species stopped on Aride Island (Warman and Todd, 1984).
- 1968 Regulations against taking turtles in the British Indian Ocean Territories (BIOT) (Frazier, 1979; Stoddart and Ferrari, 1983). Purchase of Cousin Island by the International Council for Bird Preservation (Diamond, 1976), the most important hawksbill turtle nesting area in the western Indian Ocean.
- 1970 Commissioner of the British Indian Ocean Territories took powers for conservation of Aldabra Atoll under the Protection and Preservation of Wild Life Ordinance (Stoddart and Ferrari, 1983).
- Heirs of Paul Chenard declare the island of Aride a bird sanctuary (Warman and Todd, 1984).
- Ordinance imposing restrictions on sewage discharge (Seychelles Government, 1970).

1971-1980

- 1971 Publication of "Conservation in the Seychelles" by the government (Proctor, 1973).

- 1972 Town and Country Planning Act of 1972 (Seychelles Government, 1972).
- 1973 Seychelles government announces establishment of a series of national parks and special reserves (Proctor, 1973).
- 1975 Egg collecting outlawed for roseate terns (Cochfeld, 1983).
Management Plan drawn up for Cousins Island (Diamond, 1975).

Aride Island declared a special reserve by the Government of Seychelles. Oxford University begins expedition to complete a survey of flora and fauna (Warman and Todd, 1983).
- 1976 Revisions to regulations concerning green turtles (Frazier, 1976).

Aldabra declared Strict Nature Reserve; area free of interaction of outside factors extends 500 meters of perimeter reefs (Stoddart and Ferrari, 1983).
- 1977 Seychelles accession to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Frazier, 1979).
- 1978 Tortoises transferred to Curieuse, north of Praslin to establish a daughter population able to withstand tourism (Stoddart et. al., 1982).

Extension of planning control to curb land speculation.
- 1979 Seychelles Island Foundation is formed to initiate research on the natural life of islands and improve management (Stoddart and Ferrari, 1983).
Control of Foreign Fishing Vessels Decree; licenses cost SR 15,000 per month.
- 1980 Seychelles become party to World Heritage Convention (Stoddart and Ferrari, 1983).

Aldabra designated Special Nature Reserve (Stoddart and Ferrari, 1983).
- 1981 Aldabra Special Reserve Regulations give the Seychelles Island Foundation's warden powers to manage the reserve.
- 1982 Aldabra included in World Heritage list (Stoddart and Ferrari, 1983).

National Development Plan calls for Seychelles National Environment Commission to replace Natural Parks and Nature Conservancy Commissions; its terms of reference are the UNEP/IUCN World Conservation Strategy. Plans calls for creation of National Environment Control Center Laboratory.

Proposal for Seychelles to become the headquarters of the UNEP Indian Ocean Regional Sea Action Plan and the Indian Ocean Alliance.

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