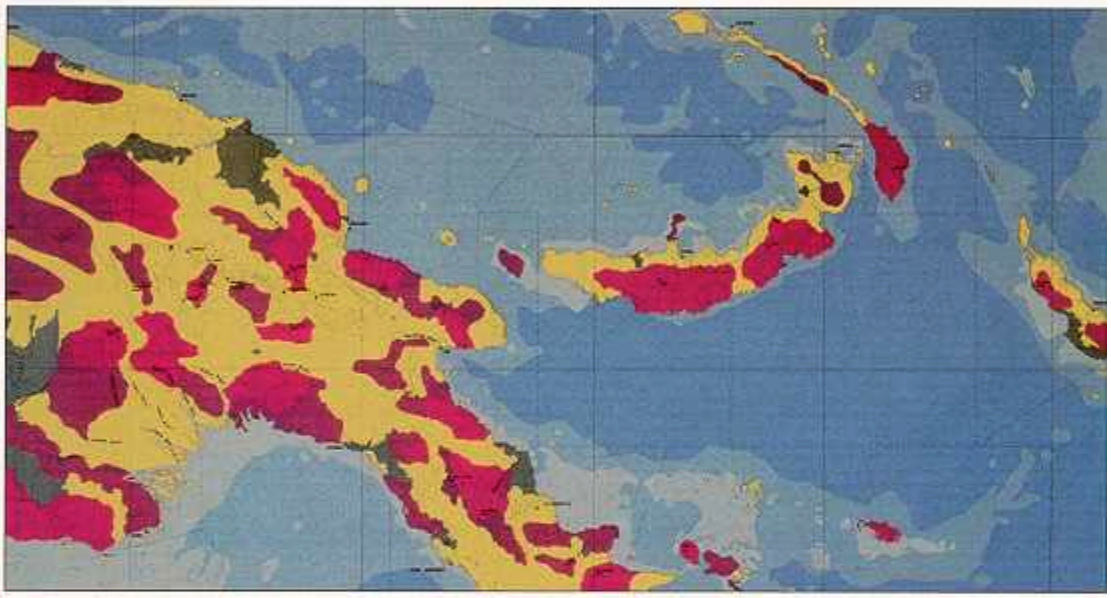
Papua New Guinea
Conservation Needs Assessment
Synopsis Report



Government of Papua New Guinea
Department of Environment
and Conservation

Papua New Guinea Conservation Needs Assessment

Synopsis Report

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by J.F. Swartzendruber

Biodiversity Support Program
A USAID-funded Consortium of
World Wildlife Fund,
The Nature Conservancy, and
World Resources Institute
Washington, D.C.

Government of Papua New Guinea
Department of Conservation and Environment
Boroko, Papua New Guinea

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FOREWORD

The Five Directive Principles of Papua New Guinea's Constitution provide the vision and tools to enable our society to achieve the concept of sustainable development/sustainable living in the 21st century.

Many of our village societies continue to live sustainably as our people have for hundreds of years, living a life balanced and in harmony with the environment.

The past 17 years since independence have been a challenging time for our country. The path for economic growth has been to short-term benefits, not long-term sustainable growth. Short-term economic growth, I believe, challenges much of the fundamental values of Melanesian society, such as community responsibility and environmental responsibility.

It is now apparent that Papua New Guinea's (PNG's) major asset is its wealth of environmental resources. The forests, the mangroves, the reef, and the ocean are abundant with a richness that is desired by peoples and corporations for their monetary value. For PNG these resources are a life source for current and future generations. Managing our resources in this century, when many of our people want the benefits of a modern economy, is an even greater challenge. Leaders in PNG have a grave responsibility in meeting the needs of our communities and taking PNG into a modern life with the benefits of good health facilities, education, and economic opportunities.

In the desire to progress we endanger the very sources of our physical and spiritual existence. We have been endowed greatly by the Creator with the richness of our islands. Our country is indeed bountiful. Yet now our environment is threatened. Greed has motivated the exploitation of our resources. Once our environment is gone, there is nothing, absolutely nothing, left for us as a people. We will be scavengers. I do not want to be responsible for that loss. Many men and women in PNG do not want to be responsible either.

Therefore, in this time of choice and decision, the challenge is to ensure that every effort that is humanly possible is made to direct the development of our country on a sustainable pathway.

I have read the Constitution often, yet I must now admit that 17 years hence I have finally come to understand and draw guidance in my work from the Five Directive Principles.

1. **Integral Human Development**
   Every person should be dynamically involved in the process of freeing himself or herself from every form of domination or oppression so that each man and woman will have the opportunity to develop as a whole person in relation with others.
2. **Equality and Participation**
   All citizens should have an equal opportunity to participate in and benefit from the development of our country.
3. **National Sovereignty and Self-Reliance**
   Papua New Guinea should be politically and economically independent and our economy should be basically self-reliant.
4. **Natural Resources and Environment**
   Papua New Guinea's natural resources and environment should be conserved and used for the collective benefit of all and should be replenished for future generations.
5. **Papua New Guinea Ways**
   Papua New Guinea should achieve development primarily through the use of Papua New Guinea forms of social, political, and economic organizations.

It could not be clearer that our Constitution embodies man/woman, development, equality, nationhood, environment, and our traditional structures for consultation to enhance and give substance to our way of life.

As we address the issues that are now critical for our future, the future of generations to come, and for the future of our country, we will enter into dialogue with each other and friends from other nations to find ways to sustain life for all peoples. It is an enormous but achievable task. The Conservation Needs Assessment (CNA) is one such task.

CNA was implemented through a process that stimulated collaboration between non-governmental organizations (NGOs), government, landowners, and scientists.

Throughout the CNA, process was as important as product. And the CNA itself was the first step in a process. Now a national discussion is needed to use the CNA information to empower people to weigh their choices and to initiate awareness of decisions being made/open to be made. This will enable PNG to develop a national consensus on appropriate conservation and development projects as well as to develop local consensus about land/resource-use options open to communities.

The CNA maps are "works in progress. The mapping process does not end with the publication of these maps; instead, the maps should be used as starting points for further research.

The maps should also be used, with the other CNA information, to begin and expand participatory approaches to conservation. The social legend presented on each of the CNA maps underscores the point that conservation in Papua New Guinea cannot be separated from the needs and priorities of the local people.

The CNA maps are intended to be distributed not only to scientists and government planners, but also to NGOs and local resource owner groups ("landowners") through the proposed Natural Resources Options Centre and existing channels. It is hoped that these maps can serve as tools for more participatory decisions about conservation and development in Papua New Guinea.

The fact that areas do not fall within the circles on the CNA maps does not mean that they do not contain valuable biodiversity. Nor does it mean that environmental impact assessments should not be done on development projects or extractive enterprises proposed in those areas outside the circles. Local biodiversity is always important locally, and local assessment of biodiversity importance should have precedence.

This document, then, is a tool that will assist PNG in the critical choices for our future.

-THE HONORABLE MARGARET TAYLOR
Ambassador to the United States from Papua New Guinea

EXECUTIVE SUMMARY

The Conservation Needs Assessment (CNA) for Papua New Guinea was requested by the government of Papua New Guinea and funded by the U.S. Agency for International Development (USAID). The CNA was implemented by the Biodiversity Support Program, a USAID-funded consortium of World Wildlife Fund, World Resources Institute, and The Nature Conservancy, in collaboration with local and international nongovernmental organizations (NGOs), museums, and academic institutions.

The assessment compiled an extensive body of the available scientific literature on the biological diversity (biodiversity) of Papua New Guinea and assessed the present state of knowledge, conditions, trends, and environmental threats. Special maps were produced identifying sites of particularly high endemism, high species richness, and unusual ecosystems and habitats.

A CNA workshop was conducted in Madang, Papua New Guinea, in April 1992, to discuss the findings of the scientific assessments, to finalize the maps of terrestrial and marine biodiversity, and to consider a range of recommendations for conservation initiatives. Workshop participants included representatives of the government of Papua New Guinea, USAID, numerous scientific and research institutions and museums, social scientists and legal scholars, NGOs, and local landowners, groups.

The workshop developed a process for information sharing and consensus decision-making and resolved that this model should be used in future development planning and conservation initiatives in Papua New Guinea. The loss of biological resources in Papua New Guinea, as elsewhere, is driven primarily by non-biological factors, and conservation actions must take account of social and political realities. The CNA process emphasizes such issues as communication, rights adjudication, modes of conflict resolution, and attitudes toward biodiversity. The process is intended to be a starting point for participatory approaches to conservation.

There is an urgent need to begin building stronger relationships between Papua New Guinean landowners and others who are involved in natural resource use and management, conservation, and research, including government, NGOs, the private sector, and scientists. In addi-

tion, social scientists should be fully involved in analyzing, designing, monitoring, and implementing conservation activities in Papua New Guinea.

Key recommendations from the CNA include:

- Establish a Natural Resources Option Center;
- Implement the National Environment and Conservation Plan;
- Strengthen government capacity for environmental monitoring, impact assessment, and enforcement;
- Distribute the CNA Biodiversity Maps as widely as possible to scientists, conservation groups, NGOs, and local landowners' groups;
- Reform existing legislation to strengthen environmental management and customary tenure systems;
- Develop participatory conservation & development models appropriate to Papua New Guinean culture and conditions;
- Support research focused on priority sites within Papua New Guinea, in collaboration with local scientists and landowners;
- Provide training in environmental planning, monitoring, and management for government and NGOs, and local resource users;
- Strengthen relationships between government, NGOs, and local landowners in Papua New Guinea;
- Consider establishing an independent environmental trust fund to support and fund conservation activity in Papua New Guinea.
- A social legend should be placed on the CNA biodiversity map so all potential users recognize the need to consult landowning clans before taking action based on the map's information.

The Conservation Needs Assessment points the way forward for those concerned with environmental conservation and sustainable development in Papua New Guinea. The report's recommendations should be seen as guidelines for designing, funding, and implementing activities that affect the country' rich natural resources. Some of these guidelines are directed toward government, others to NGOs, scientists, the private sector, and foreign donors and investors. In turn, it is important that all of these groups work more closely with Papua New Guinean resource owners, or "landowners."

The common theme underlying the set of CNA recommendations is the urgency of building stronger relationships between Papua New Guinean landowners and those who are, in various ways, responsible for changing their natural environment and, therefore, their traditional ways of life. The need to work more closely with local groups applies not only to those who extract natural resources for commercial gain but also to those who initiate activities intended to protect the environment and bring about economic development and even to researchers.

Papua New Guinea represents an unusual combination of circumstances making it a globally important site for conservation efforts. As the CNA report makes clear, Papua New Guinea is one of the world's most significant centers of biodiversity, with many unique ecosystems and species. Although much of the landscape has thus far escaped serious degradation, many of the country's terrestrial and marine ecosystems face growing threats, and urgent preventive action is needed.

At the same time, Papua New Guinea represents a unique opportunity for supporting conservation initiatives that build upon a rich base of indigenous knowledge and participatory models of decision-making. Melanesian land and resource tenure traditions, which have evolved over thousands of years, are explicitly recognized by the modern legal framework of the state. This situation, which is rare in global terms, provides an unusual opportunity for conservation action. By building upon this heritage and strengthening it where appropriate, Papua New Guinea can begin to retain responsibility for the long-term health of the environment and join landowners in a partnership for making economic development more sustainable.

The people of Papua New Guinea will ultimately decide the outcome of conservation initiatives in their country. Their genuine participation in the processes that affect them is not only desirable but essential to the conservation of one of the world's great remaining centers of biological and cultural diversity.

BACKGROUND

At the request of the government of Papua New Guinea, the U. S. Agency for International Development (USAID) has provided technical assistance to the Department of Environment and Conservation under the National Forestry and Conservation Action Plan. This assistance was in the form of a Conservation Needs Assessment (CNA), which has been funded by USAID and implemented by the Biodiversity Support Program, a USAID-funded consortium of World Wildlife Fund, World Resources Institute, and The Nature Conservancy. The support of DEC Secretary Iamo Ila at every stage of the CNA was critical to its success.

The Conservation Needs Assessment was carried out in collaboration with local and international nongovernmental organizations (NGOs), museums, and academic institutions. Nongovernmental organizations that participated in the CNA include World Wildlife Fund, World Wide Fund for Nature, World Resources Institute, Wildlife Conservation International, Conservation International, Greenpeace, IIED, Experiment in International Living, CARE, and National Alliance of Nongovernmental Organisations of Papua New Guinea.

Other institutions that participated in the CNA include USAID, Bishop Museum, Royal Botanic Gardens at Kew, University of Western Sydney, Smithsonian Institution, University of Papua New Guinea, The Papua New Guinea University of Technology, Christensen Research Institute, Papua New Guinea National Museum, and Wau Ecology Institute.

Teams of internationally recognized experts compiled and analyzed the existing base of scientific information on the country's terrestrial and marine ecosystems and the biodiversity they support. In collaboration with Papua New Guinean scientists, the international teams prepared draft reports and maps detailing areas of known biodiversity concentration, unusual ecosystems and habitats, and environmental threats, and also identified regions for which there is almost no scientific information available.

A CNA workshop was then held in April 1992 in Madang, Papua New Guinea, to discuss the draft reports and biodiversity maps, and to consider recommendations for conservation ini-

tiatives. At the CNA workshop, the natural scientists were joined by teams of social scientists, legal scholars, information management specialists, and representatives of nongovernmental organizations and Papua New Guinean landowners' groups. In addition, government representatives from the Department of Environment and Conservation, the Department of Forests, the Department of Agriculture and Lands, the Department of Fisheries and Marine Resources, the Department of the Prime Minister, and the Department of Finance participated in the CNA workshop.

The CNA workshop produced a set of recommendations, representing the consensus of the participants, on strategies and priorities for sustainable development based on Papua New Guinea's natural resources and conservation of its biological heritage. These recommendations reflect a consensus derived from wide array of viewpoints and opinions about development and conservation in Papua New Guinea and mark a commitment to participatory modes of planning and decision-making. During the CNA workshop, a process was developed for broadly based consultation with all who share a stake in the future of Papua New Guinea's biological resource endowment. This process is perhaps the most important result of the Conservation Needs Assessment.

A CNA wall map of biodiversity priorities of Papua New Guinea and the full CNA Report is available in two volumes from the Papua New Guinea Department of Environment and Conservation, the National Alliance of NGOs, and from the Biodiversity Support Program in Washington, D.C. The first of these volumes contains reports on conservation issues and opportunities in Papua New Guinea and includes assessments written by legal experts, social scientists, NGOs and landowners' groups, as well as an assessment of information management needs. It also includes a summary of the material presented and discussed at the CNA workshop in Madang and the maps of biodiversity in Papua New Guinea, the points of agreement among participants, issues remaining to be resolved, and a detailed set of recommendations for action.

Volume 2 presents the technical reports of the natural scientists on the biological diversity of Papua New Guinea, including taxonomic reviews of the flora, warm-blooded vertebrates, cold-blooded vertebrates, and analysis of freshwater wetlands, marine environments, and forests. This volume includes extensive documentation of the available scientific literature on Papua New Guinea's biota.

This report presents a synopsis of the material contained in the full two volume publication and presents in reduced scale the CNA consensus maps of the high biodiversity areas in Papua New Guinea.

CONSERVATION IN PAPUA NEW GUINEA:

Global Anomaly, Global Paradigm

> "We are here to state what our rights are. People haven't been teaching people in the village about these things. Maybe it happens in other places, but not in Madang."
>
> "We do not want to hear about global issues. Forget about global issues if you are going to forget about the landowners."
>
> "Young people before had something. But then outsiders came and gave us nothing. When the meat cannery came in, we were given promises, but we have gotten nothing."
>
> "Don't mess up our land. We had good land before. Then other people came and sneaked around and took things from us."[1]

The nation of Papua New Guinea, which became independent in 1975, is unusual in many respects. Rich in natural resources, and containing an unparalleled concentration of ethnolinguistic diversity – more than 700 languages are spoken by a population of about four million people – Papua New Guinea also is home to one of the few remaining tropical forests in which deforestation and habitat loss remain at comparatively low levels. According to one projection, by the end of this century or shortly after, only four blocs of the world's tropical moist forest biome are likely to remain more or less intact: western Brazilian Amazonia, the Zaire basin, the Guyana shield of northern South America, and Papua New Guinea (Myers 1988a).

Together with neighboring Irian Jaya (belonging to Indonesia), Papua New Guinea supports the largest area of mature tropical moist forest in the Asia/Pacific region (McNeely et al. 1990). Most of this forest remains relatively undisturbed, in part due to historically low human population density, as well as a rugged topography which impedes access in many places.

The country's unusual legal framework explicitly recognizes customary Melanesian land and resource tenure systems, thus giving and natural resource exploitation to an extent that may be globally unique. These customary property indigenous kinship groups control over land use rights extend over as much as 97 percent of the

[1] Local landowners' statements to participants of the Conservation Needs Assessment Workshop, 6 April 1992

These grand tropical forests are home to a rich and varied Australasian biota that boasts tree-dwelling kangaroos, the huge flightless birds known as cassowaries, the world's largest pigeons and butterflies, the world's longest lizard, nearly three thousand species of orchids, and as many as 15,000 species of flowering plants.

- Beehler 1992

country's land area, and over most of its forest.

In the past, these customary rights have sometimes been undermined through lack of knowledge on the part of local people about their options and about the long-term consequences of their actions. In recent years, however, landowner groups have become increasingly active in asserting their rights to determine what forms of development will be permitted within their ancestral domains-a trend that is exemplified by the landowners' statements cited at the beginning of this section.

In recent years, there has been growing pressure upon the ecosystems of Papua New Guinea's mainland and its associated islands, and on the nation's vast interspersed marine ecosystems. Foreign investment, notably in logging and mining, has sometimes resulted in serious environmental degradation, with minimal economic benefit for local people.

Local activism is opening up a wealth of opportunities for the introduction of new approaches to natural resource management, for it is clear that most Papua New Guineans are determined to have natural resource-based economic growth, but that this growth must take place on terms acceptable to local people. Along with other island nations of Oceania, Papua New Guinea represents a unique opportunity for environmentally sustainable natural resource development that is based upon empowerment and participation at the grassroots level. In most developing countries, forest areas and other natural resources are state property, and the movement toward greater local participation in natural resource management has often been more theoretical than real.

In Papua New Guinea, in contrast, the tradition of local control remains unbroken, a tradition that is now reflected in government policy and in constitutional law. Landowner groups, local NGOs, and international information and decision-making channels for sustainable natural resource use. If successful, these new approaches will help to protect the country's environment and its biological diversity while bringing lasting benefits to its people. It is in this respect that Papua New Guinea has the potential to become an important model for sustainable development.

CASSOWARIES AND BANDICOOTS: BIOLOGICAL DIVERSITY AND CUSTOMARY LAND TENURE

Papua New Guinea, whose mainland occupies half of the world's largest and highest tropical island, is a rugged country of high rainfall, with more than 5,000 lakes, extensive river systems, and more than 34 million hectares of closed tropical forest (Mittermeier 1988). The species-rich mainland coastline includes over 5,000 miles of mangrove swamps, lagoons, wetlands, coral reefs and atolls, plus island archipelagos and hundreds of offshore islands. The country's jurisdiction extends over an expanse of some 800,000 square kilometers of ocean, including 40,000 km2 of coral reefs.

A geologically young region, lying at the collision line of the Australian and Pacific tectonic plates, Papua New Guinea is remarkably diverse in terms of landscapes, ecosystems, and species. An estimated two-thirds to three-fourths of the land area is undisturbed tropical moist forest. According to one source, New Guinea's forests contain some 11,000 plant species, of which 90 percent may be endemic (Myers 1988b). Other estimates place the number of plant species in Papua New Guinea much higher, with perhaps 15,000 to 20,000 species of vascular plants, but with the rate of endemism somewhat lower, perhaps closer to 60 percent.

Lowland forests, montane forests, and alpine flora are found, and coastal areas contain some of the most extensive pristine mangrove areas in the world. Endemic animal species include 76 species of birds, 56 species of mammals, and some 365 endemic species of freshwater fishes, amphibians, and reptiles. In addition, 84 genera of animals are endemic to Papua New Guinea. Of the 10 major forest types in the country, one-the lowland moist forest biome-is home to more than 1,200 known tree species (Government of Papua New Guinea 1992).

It is important to note, however, that there are large gaps in the scientific knowledge of Papua New Guinea's biodiversity. Birds, rhododendrons, mammals, and birdwing butterflies are relatively well documented, but most invertebrates and plant groups are little known, with many species still undescribed. Large areas of the country have not been systematically studied, and the marine biological resources for subsistence. Melanesian societies have developed an extensive resources are perhaps the least surveyed of all.

> In New Guinea…flora assembled from components which had left the Australian main land 40 million years earlier, or had traveled with it, were arranged on a vigorously changed landscape, increasing in height tectonically, sub ject to earthquake and vulcanism ... and almost all perennially wet. Here were physical conditions which offered opportunities particu -larly appropriate to speciation of the original rain forest stock with which the island was endowed.
>
> -Walker 1982

People have depended heavily upon Papua New Guinea's plentiful and diverse biological resources for subsistence. Melanesian societies have developed an extensive and detailed knowledge of Papua New Guinea's flora and fauna, and some 1,035 different plant species are known to be used for various purposes (Powell 1982). Wildlife plays an important part in traditional diets, supplying the primary intake of proteins and fats in many highland areas and other isolated areas of the country. In coastal areas a wide variety of seafood, including fish, mollusks, and turtles, dominate local diets.

Subsistence agriculture has also been practiced in Papua New Guinea for at least 9,000 years2, and traditional techniques have been able to sustain high levels of food production without causing environmental degradation (Unisearch 1992). Subsistence systems practiced in Papua New Guinea exhibit specific adaptations to the particular environmental, demographic, and climatic characteristics of different parts of the country (Powell 1982).

The sweet potato is a central component of the Papua New Guinean diet, and an estimated 5,000 cultivars of this staple are found within the country (Government of Papua New Guinea 1992). Numerous other plant species have tradi-

[2] Recent archeological evidence suggests taro cultivation began as early as 12,000 years ago (pers. comm., P. Swaddling & C. Ballard, 1991).

…Papua New Guineans draw heavily on the forest plants for cordage, bark, ornaments, fish poisons, magic potions, medicine, narcotics, food and carrying vessels, tools, weapons, art supplies, dyes, and for food – insects, fungus, nuts and seeds, fruit, game, edible roots and greens. Life without these adjuncts would be miserable, if not impossible, for the average forest community.

- De'ath 1982

tionally been cultivated, including more than 30 root crops, 21 legume species, 40 leafy green vegetables, 60 other vegetables and roots, 43 varieties of nuts, 102 fruits, and 89 other plants used for food or for seasonings (Unisearch 1992). This traditional knowledge has already been tapped by the outside world: the winge-bean (*Psophocarpus tetragonolobus)*, which is nutritionally similar to the soybean and is an important part of the diet in Papua New Guinean forest regions, is now cultivated in some 50 developing countries (Spears 1988).

Although the commercial potential of Melanesian crop germplasm. resources has not yet been seriously studied, these could represent an important biological asset, not only for Papua New Guinea, but for other tropical countries as well. For several food crops of global importance, Papua New Guinea is a center of germplasm diversity, notably sweet potato, yams, taro, and the already-mentioned winged bean. In addition, it is the center of origin for such ubiquitous crops as banana and sugar-cane (Powell 1982).

We declare our fourth goal to be for Papua New Guinea's natural resources and environment to be conserved and used for the collective benefit of us all, and to be replen-ished for the benefit of future generations.

We declare our fifth goal to be to achieve development through use of Papua New Guinean forms of social, political and economic organisation.

-The Constitution of Papua New Guinea National Goals and Directive Principles.

The rich ethnic and linguistic diversity of Papua New Guinea is an important factor in understanding traditional patterns of resource use and ownership. Depending on which measures and definitions are used, estimates of the number of distinct ethno-linguistic groups within Papua New Guinea range from 700 to 850 and higher (King and Ranck 1982; Wurm and Hattori 1981). In general, land and resource rights are based upon kinship affiliation, and membership in the relevant clan or sub-clan groupings is hereditary, although adoption of outsiders may also occur on occasion.

Customary patterns of natural resource rights, particularly to land and forests, have become formally recognized within the legal framework of the modern nation state-a situation that is unique to Oceania. The Constitution of Papua New Guinea, which came into effect at independence in 1975, "vests local people with ownership of these resources, irrespective of any documentation or registration. "[3]

In effect, Papua New Guinean law acknowledges that land is not a commodity to be bought and sold; on the contrary, the vast majority (as much as 97 percent) of the nation's terrestrial domain is under customary Melanesian land and resource tenure systems. These customary systems differ in various ways from one group to another (for example, control over use of land may in one case be decided at the level of a clan, in another case by a sub-clan, and in a third case at the lineage level). In general, however, they have in common the idea that land and resource ownership is vested in groups rather than individuals and that decisions about the use of land and natural resources should arise through consensus.

Traditional ways have increasingly come under pressure in Papua New Guinea, particularly as the country develops more extensive economic linkages and as local people feel the growing need for cash incomes to meet consumer needs. Particularly in the logging industry, timber sales have often been made with individual landowners, in ways that violated traditional consensus practices. In many cases, local landowners are ignorant of

[3] Although the Mining Act of 1972 ostensibly vests the state with ownership of mineral resources, the constitutionality of this legislation is in dispute (Unisearch 1992)

their options or are not fully informed about the consequences of the agreements they are entering into.

An influential Commission of Inquiry into the timber industry in Papua New Guinea, known as the Barnett Report, documented numerous abuses, and noted that social disruption as well as environmental degradation were often the result:

> In many cases the timber industry has made life harder for the landowners at A levels. Not only do they have to face destruction of their environment, but they face the destruction of their society.
> -Commission of Inquiry, 1990

On the other hand, even relatively well-intentioned investors have sometimes been confused as to whom they should be negotiating with, and under what terms. Some of the difficulties encountered by mining and oil companies, for example, include complex procedures for registration of land titles, different inheritance customs between local groups, and problems in defining long-term compensation measures that will satisfy different landowner groups.

Yet despite such problems, the determination of local groups to assert their traditional rights, now enshrined in constitutional law, affords an unusual opportunity to test contemporary concepts about sustainable development and environmental conservation, by giving more control over resource allocation to local groups who have the most to gain from appropriate modes of development and the most to lose from inappropriate ones.

MELANESIAN CONSERVATION: 9,000 YEARS OF TRADITIONAL KNOWLEDGE

Traditional Melanesian modes of subsistence living have effectively conserved the natural environment for millennia-without the need for specially designated conservation zones from which human use was excluded or limited.

> The company has taken timber from part of my land, but from another part…it has not taken timber. I stopped them from taking that part because they did not pay me enough. I use that forest to find greens to eat, or other things like birds, lizards, bandicoots, cuscus, flying fox which we can cook with taro and eat.
>
> -Wezip Aloloum
> Jobto Village, Madang District

While there is some evidence of land degradation having occurred in prehistoric times in certain parts of the country, Melanesian societies evolved agricultural techniques that have proven to be sustainable. In areas of Papua New Guinea that still have levels of population density as low as eight persons per square kilometer, there appears to be little sign of environmental degradation (Unisearch 1992).

As a result, a large proportion of the natural environment, especially the lowland forest and marine ecosystems, remains largely unaffected by modern forms of human exploitation. However, population growth, rising economic expectations, and expanding linkages with the rest of the world are resulting in greater pressures on the environment. In some areas, increased population density is bringing about changes in the traditional cropping and fallow cycles, and cases of soil erosion and deforestation have begun to be observed (Unisearch 1992).

More importantly, logging, mining, and commercial agriculture have begun to transform parts of the Papua New Guinea landscape, resulting in permanent conversion of primary forest and other environmental effects such as soil compaction, erosion, watershed disturbance, and loss of species (Unisearch 1992). Urban expansion and commercial fishing are also creating sources of pressure on Papua New Guinea's ecosystems.

Many aspects of Papua New Guinea's biological endowment remain poorly understood. Yet it is rapidly becoming clear that action is needed to anticipate and redirect current development trends threatening biological diversity. Expansion of the protected area system is one option for responding to this situation; among other initiatives pending is the designation of

several potential sites within Papua New Guinea as World Heritage conservation sites.

The protected area approach in Papua New Guinea, as elsewhere, needs to be adapted to local circumstances and complemented with other strategies. Protected areas that exclude traditional resource owners have not proven to be an effective means of conserving intact ecosystems or of protecting endangered species in Papua New Guinea. Papua New Guinean legislation provides for development of protected areas such as Wildlife Management Areas and Conservation Areas that are based on land remaining under customary owner-

Photo: Jack Stein Grove/WWF-I

ship and involving landowners in management. However, existing protected areas in Papua New Guinea fall short of adequately protecting biodiversity, and need to be strengthened and supported with additional strategies (WWF 1992).

Conservation organizations are increasingly focusing their efforts on developing options that require not a change of tenure, but a change of management strategy by landowners. Since publication of the World Conservation Strategy in 1980, new methods have been developed that combine conservation activities with measures to bring economic benefits to nearby communities. Strengthening local participation in conservation planning and management is another idea gaining currency in many countries. Although these principles have often proved difficult to put into practice, in the long run there is probably no substitute for giving local residents a tangible stake in the management of natural resources (Wells and Brandon 1992; Brown and Wyckoff-Baird 1992).

Many opportunities for economic development in Papua New Guinea are derived from the natural resource base. Extractive industries and other resource-based forms of investment will continue to play a major role in the country's economy for the foreseeable future. Mining, oil exploration, logging and commercial fishing are the most significant, although agro-industries are also important, particularly oil palm and sugar.

Alternative strategies for sustainable use of the natural resources are also needed. Papua New Guinea needs to build upon traditional practices proven to be environmentally benign yet flexible enough to accommodate a growing population and need for cash income. This is the great challenge, and the base of traditional knowledge within Melanesian societies may hold clues as to how this can be done.

THE CONSERVATION NEEDS ASSESSMENT WORKSHOP

During the course of the CNA, teams of international and Papua New Guinean experts reviewed the known data on Papua New Guineis biological diversity, identified priority topics for fiirther research, and mapped areas known to be especially rich in species diversity. In addition, teams of social scientists, legal experts, information management specialists, and local NGOs and landowner groups gathered and analyzed a wide range of information relevant to conservation action in Papua New Guinea.

This information was then reviewed and discussed during a special workshop held in Madang, Papua New Guinea, in April 1992. The CNA workshop brought together a wide range of viewpoints. The purpose of the workshop was to:

1. Understand the current status of biodiversity, policy, and social information available for conservation and land-use planning and identify significant information gaps;
2. Develop dialogue and working relationships among biologists, NGOs, landowners, and government;
3. Develop maps of biodiversity information useful for natural resource planning;
4. Identify constraints and opportunities for conservation;
5. Propose culturally appropriate processes and options to conserve biodiversity; and
6. Propose ways to address remaining issues.

The workshop participants reflected the full spectrum of perspectives on conservation in Papua New Guinea, yet all shared a commitment to the future health of the country's environment and its natural resource base. The workshop participants focused on the geographic dimensions of biodiversity in Papua New Guinea, as well as the social dimensions of conservation. Most importantly, the workshop initiated a process of communication between different stakeholder groups in order to lay the foundations for long-term conservation planning and implementation that takes into account the different perceptions, interests, and priorities of different groups. An important workshop assumption was that commitment to inclusive processes is vital if development in Papua New Guinea is to become more sustainable and if the country's rich biological heritage is to be preserved for the benefit of future generations.

The maps produced by the CNA workshop began with a series of technical assessments of Papua New Guineas biological diversity, teams of international and local scientists identified known areas of species richness or otherwise significant sites, and also designated zones for which very little scientific information is currently available. Biologically important areas were identified in seven categories: warm-blooded vertebrates, cold-blooded vertebrates, invertebrates, plants, forests, freshwater habitats, and marine habitats.

This information was transcribed onto maps, and the specific location of priority areas for conservation and research was thoroughly discussed by a wide variety of participants in addition to the scientists who had produced the initial maps. The maps were modified to some extent, in order to take into account sociological, political, and other factors that would be relevant in implementation of conservation activities within these priority sites.

The final maps produced by the CNA workshop represent a consensus of most participants and a synthesis of different kinds of information considered in the course of the proceedings. The three synthesis maps include:

1. A map of 16 biologically unknown areas that merit immediate survey and study;
2. A map of 30 marine and coastal high biodiversity areas and 5 watersheds critical to the health of those marine and coastal areas;

Social Legend to appear on CNA
Consensus Maps of High Biodiversity Areas

1. The Constitution of Papua New Guinea promotes equality and participation, the wise use of natural resources, and Papua New Guinean forms of development.
2. Ninety-seven percent of Papua New Guinea is owned according to customary tenure;
3. This map was prepared by biological scientists and, based on available knowledge, identifies areas richest in biodiversity;
4. This map is not intended to, nor should it be used to, exclude any areas of any landowners from conservation programs and initiatives; and
5. When identifying appropriate conservation strategies and areas, local initiative is as important a criterion as biodiversity.

3. A map of 42 terrestrial high biodiversity areas and 13 important wetland habitats.

Although the attached maps represent a consensus of the CNA workshop participants, many were concerned that the maps could be misused by people unaware of the complex socio-political realities existing in Papua New Guinea. Their concern was addressed by the social legend that was adopted by consensus at the workshop's final plenary session and that is to be printed on the front of the final CNA maps (see box page 7). The legend will alert future readers of the CNA maps that the information contained in them reflects a dynamic social context that needs to be kept in mind when designing conservation initiatives in Papua New Guinea.

Geographically based information is an essential tool for monitoring the loss of biodiversity and for establishing conservation and development priorities and policies. The CNA maps are intended to help those interested in conservation and development planning in Papua New Guinea by bringing together-in many cases for the first time-a wide range of information about the country's biological resources and about the threats to its environment.

CNA maps are different in several important respects from vegetation maps, for example, or maps showing a country's topography or its distribution of population, mineral resources, or other features. Such maps indicate the location of forests, major population centers, or mineral deposits; in areas not marked these characteristics can be presumed not to be present. This, however, is not the case with the CNA maps.

The CNA maps identify areas in Papua New Guinea that are important centers of species richness and endemism, that represent unusual ecosystems facing serious environmental threats, or for which there is a serious lack of scientific information. *The fact that other areas are not marked on the CNA maps does not mean that they are not rich in biodiversity or that they are unimportant.* On the contrary, the CNA maps present a sample of sites drawn from a much larger set of potentially important areas for biodiversity conservation action.

The CNA sampling and selection process involved participants from many disciplines and backgrounds, and in their present form the maps represent a consensus reached after much discussion and consideration of alternatives. The areas delineated on the maps are, in the final analysis, human judgments based upon different sets of information presently available and suppositions about areas for which there are almost no scientific data. Furthermore, landowners were not consulted in the process of selecting areas identified on these maps. In this sense the CNA maps are "works in progress."

The loss of biological resources is driven primarily by non-biological processes, and the conservation of biodiversity must take account of

CNA Workshop Findings

1. Papua New Guinea has a unique and rich repository of biodiversity;
2. Papua New Guinea's biodiversity is under immediate threat from development activities and action is needed;
3. Action must be appropriate to Papua New Guinean ways and systems of resource ownership;
4. Government, scientists, NGOs, landowners, and donors must cooperate if the conservation goals are to be achieved, but such cooperation is only beginning;
5. Information and better means of information dissemination are needed for making decisions and setting priorities at local and national level;
6. There is insufficient funding and government support for conservation action;
7. Landowners and government need better means of communication about conservation and development options;
8. Innovative options that link conservation with local economic benefits are needed; and
9. All landowners should be encouraged to undertake conservation actions for sustainable use of their natural resources.

social and political realities. Yet these realities cannot be adequately represented on a two-dimensional map. Communication, rights adjudication, modes of conflict resolution, and attitudes toward biodiversity are, like most social phenomena, complex and changing; they cannot be plotted on maps by technicians for the use of planners and policy-makers. These issues can only be addressed on the ground, with local people.

Throughout the CNA, process was as important as product. The CNA process does not end with the publication of these maps; instead, they should be used as starting points for The social legend printed on each of the CNA maps underscores the point that conservation in Papua New Guinea cannot be separated from the needs and priorities of the local people.

The CNA maps are intended to be distributed not only to scientists and government planners, but also to NGOs and local resource owner groups ("landowners") through the proposed Natural Resources Option Center (see Recommendations section). It is hoped that these maps, developed by means of consensus, can serve as tools for more participatory decisions about conservation and development in Papua New Guinea.

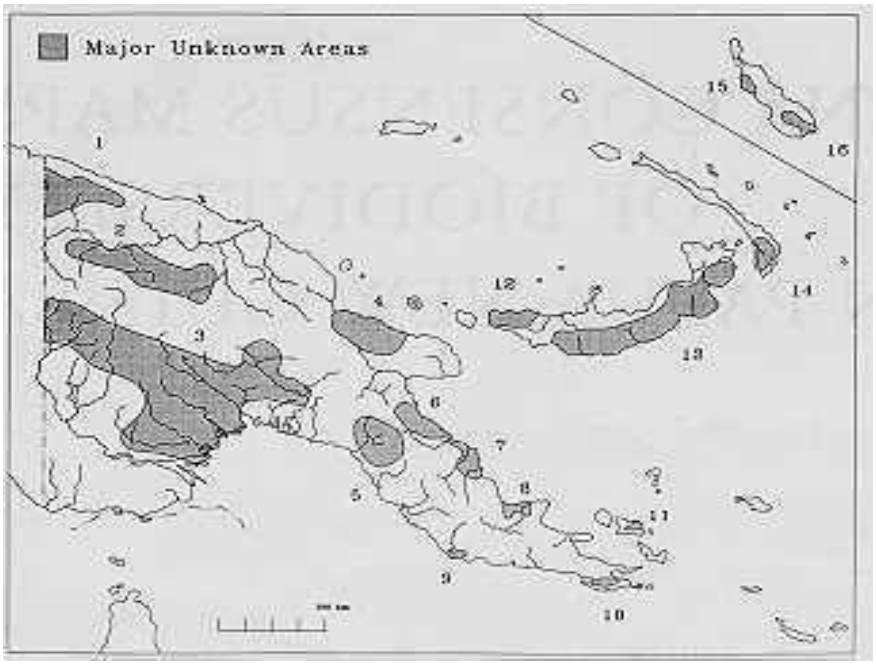
THE CNA CONSENSUS MAPS OF BIODIVERSITY IN PAPUA NEW GUINEA

SYNTHESIS MAP #1: MAJOR TERRESTRIAL UNKNOWNS

This map indicates the location of 16 major geographic areas within Papua New Guinea for which the present lack of scientific information is particularly serious. While this does not mean that the rest of the country is adequately surveyed, the sites listed here are considered important areas for future study.

1. **Benwani Mountains.** The low coastal range that reaches westward to the Irian border, and the humid lowlands south of this range, are little studied and apparently biologically rich. Recent discoveries include montane endemic mammals and a lowland bird of paradise formerly known only from Irian Jaya.
2. **Central Range.** The high range that rises south of the Sepik basin is little studied and largely forested.
3. **Southern Scarp Wet Zone.** This is Papua New Guinea's great wilderness area – low-lands, low hills, and old Pleistocene volcanoes, with a high annual rainfall yet sparsely populated and little known.
4. **Finisterre Range.** The highlands and hills of the western Huon Peninsula are virtually unstudied.
5. **Lakekamu/Chapman.** Like the Finisterre Range, this area is relatively close to population centers yet is little developed and virtually unknown biologically. The region varies from humid lowland forest to subalpine highland zones in the Chapman Range.
6. **Bowuto Ultrabasics.** This area of rugged hills and mountains dropping to the coast of Morobe Province is botanically unusual and virtually unsurveyed.
7. **Ioma/Mambare Lowlands.** An isolated lowland area that merits study.
8. **Musa Basin.** Important wetlands and lowland swam forest that are unknown.
9. **Kemp-Welch River Lowlands.** A remnant wetland area representative of the dry lowlands of Central Province, not yet surveyed.
10. **Cloudy Mountains.** An isolated range, as yet unsurveyed, in the southern region of mainland Papua New Guinea.
11. **Fergusson Highlands.** Zoologically unsurveyed highlands on one of the most complex high islands in Melanesia.

Synthesis Map #1



12. **West New Britain.** Little known mountains and lowlands west of the island's population centers.
13. **Central and Eastern New Britain.** Unsurveyed high ranges and southern scarp lowlands.
14. **Southern New Ireland.** Biologically unknown highlands.
15. **Bougainville Bamboo Forests.** The only known bamboo forests in Melanesia; unstudied biologically.
16. **Mt. Takuan/Lake Lorolu.** Little surveyed wet highland forests.

SYNTHESIS MAP #2: MARINE SYSTEMS AND CRITICAL WATERSHEDS

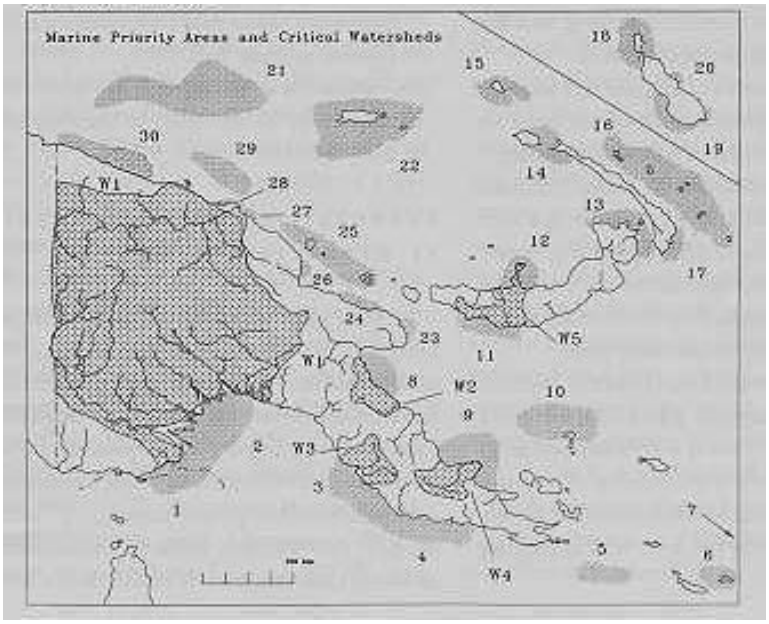
This map identifies 30 coastal and marine ecosystems, and 5 watersheds, which are sites of high biodiversity important for study and conservation action.

Marine Areas

1. **Maza/Fly Delta.** Mangrove and associated nursery habitats with seagrass beds, green sea turtle foraging habitats, and dugong habitat. Possibly threatened by overfishing and river-borne pollutants.
2. **Gulf.** Shallow intertidal and soft bottom habitats, with mangrove communities that comprise important nursery areas for prawns, barramundi, and other commercially important species. Possible threats from overfishing, oil exploration, and pipeline.
3. **Galley Reach.** A highly productive area of mangrove forests, wetlands, and reef, threatened by development and exploitation based in nearby Port Moresby.
4. **Papuan Barrier and Lagoon.** Barrier reef, coastal lagoon, and mangrove – habitat for hawksbill turtles, reef fishes, corals, and marine invertebrates. This area of high diversity faces threats from dynamiting, overfishing, and eutrophication from sewage effluent emanating from development near Port Moresby.
5. **Dumoulin.** A reef in proximity to the southern drop-off (potential upwelling), which is largely unknown; habitat for giant clams.
6. **Rossel Island.** Reef systems, lagoons, isolated island areas, and an upwelling area, are largely unknown biologically and face possible threats from foreign poaching.

7. **Pocklington Reef.** An extensive reef system, thought to be relatively pristine, and isolated by deep water from all other reef systems in Milne Bay. This reef may show affinities to the New Georgia reef system.
8. **Morobe Coast.** An area of mangroves, sea walls, leatherback turtle nesting beaches, and fringing reefs, with the potential for community-initiated conservation action. An area of high beta diversity facing threats from nearby Lae town, especially logging of coastal hill forests.
9. **Tufi Coastal Fjords.** Coral fjords, fringing reefs, mangrove, sea walls, thermal vents in an environment unique in Papua New Guinea, with high potential for nature tourism.
10. **Trobriand Reef and Drop.** Extensive coral reefs, habitat for hawksbill. turtle, beche-de-mer, giant clams, dugongs, green sea turtles, coral reef fishes, and invertebrates. Largely unsurveyed, but thought to be highly productive reef systems.
11. **Fullerborne.** Raised limestone islands, mangrove and associated nursery areas, and seagrass beds, with high habitat and structural
12. **Talasea.** Reef and soft bottom marine habitats, nesting beaches for leatherback turtles.
13. **Rabaul/Duke of York.** Mangrove, seagrass, reef, and offshore deepwater areas with thermal vents. Threats arise from proximity to Rabaul town and from timber operations in watersheds above the coast.
14. **Tigak Islands**. Mangroves, seagrasses, reef, and deepwater mangrove lagoon, which are highly productive fishery areas. Beta diversity is very high, and threats arise from dynamite fishing.
15. **Mussau Island**. This marine system includes reef systems and seagrasses, some parts of which are relatively pristine due to traditional practices of islanders, but now threatened by dynamite fishing.
16. **Tanga/Tabar/Feni Islands**. Subsea volcanic formations, mineral-rich areas, and isolated island systems that may be very important for endangered vertebrates such as sea turtles. This is an area of diverse habitats and unusual geomorphology, possibly threatened by nearshore and offshore overfishing.
17. **Southern New Ireland.** An area of fringing reefs.

Synthesis Map #2



18. **Buka**. A reef and lagoon complex with soft bottom communities and coral reef fishes, but otherwise largely unknown. Buka Channel comprises a unique habitat in Papua New Guinea but is threatened by overfishing and poor land-use practices.
19. **South Coast Bougainville.** An area of reefs and associated habitats, with swamp forest, which differs from that on the mainland. Fauna are largely unknown, and this area contains reef systems in proximity to deep open ocean waters.
20. **Borone Bay.** A largely unknown area with unusual hydrology coupled with steeply sloped shore fall-off, facing threats from logging and mining in upland areas.
21 **Hermit Islands.** Extensive, discrete patch reefs with sea turtles and a highly productive area of rich fisheries. Reef areas are far from population centers, but threats exist from poaching and overfishing. Uncontrolled tourism in the western islands may represent a potential threat as well.
22 **Manus Complex.** Reefs and lagoon complexes, seagrass beds, and seabird rookery islands, with green tree snails, reef fishes, pelagics, and sea turtles. This is an area of high beta diversity with highly diverse reefs that are seriously threatened from dynamite fishing and by phosphate
23. **Cape Cretin.** An area of ancient reef faces.
24. **Vitiaz Straits.** Reefs, with steep land in proximity, threatened by land-use practices.
25. **Volcanic Chain: Manam to Long.** Volcanic islands, reef walls, and sea mounts, sea turtle nesting beaches, and upwelling areas. Pelagic fishes congregate at the sea walls and sea mounts. Threats arise from overfishing and overharvesting of sea turtle eggs.
26. **Madang Lagoon.** Coral reefs, lagoon islands, and mangrove patches, with coral and fish species. This is a well-studied area, species-rich, with high habitat diversity, which faces threats from commercial development in Madang town, as well as logging and dynamiting.
27. **Laing Island.** This is a reef system and marine research station, threatened by dynamiting and by copra plantation wastes.
28. **Sepik Delta.** Mangrove, brackish lake systems. This is a highly productive area with a unique hydrology and habitat for crocodiles. Threats arise from watershed mismanagement and introduction of exotic fishes.
29. **Vokeo and Islands.** Small island systems in association with deep water.
30. **Northwest Coast.** Sandy beaches with largely unsurveyed fauna. This area contains interesting current regimes and bottom topography and productive waters, and is threatened by overfishing and coastal

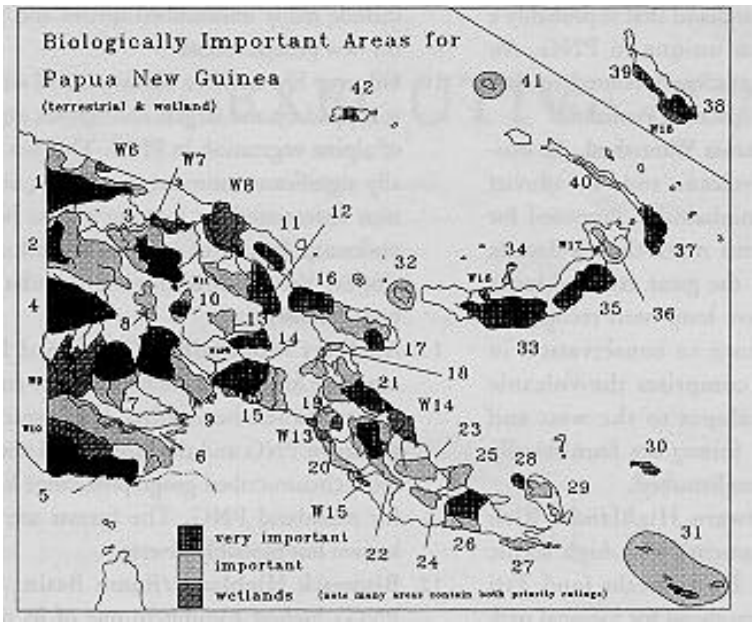
Critical Watersheds

W1. **Sepik/Fly Drainages.** These comprise the two largest drainages in Papua New Guinea. The Fly is of critical importance to the health of the Gulf of Papua.
W2. **Morobe/Waria Watershed.** Important upland drainages that affect coastal islands and reef of Morobe.
W3. **Vanapa/Brown.** A river system that drains into an important mangrove system.
W4. **Musa/Topographers.** Another small but important watershed that affects the marine systems around Tufi.
W5. **West New Britain.** This watershed is important to the marine systems of West New Britain.

SYNTHESIS MAP #3: TERRESTRIAL BIODIVERSITY

This map indicates 42 areas of important terrestrial biodiversity in Papua New Guinea and identifies 13 wetland sites. Note that four land classification categories are presented on this map: very important, important, important wetlands not subsumed in other categories, and unassigned. Many of the "unassigned" areas may support considerable levels of biodiversity and in many cases may merit conservation action at

CNA Synthesis Map #3



some level. They simply fall outside of the current criteria for placement in the two highest categories of importance.

1. **The North Coastal Hills.** Lower montane and lowland alluvial forests that are relatively poorly surveyed but known to be rich in Irianese specialties. The area includes the endemic fern genus Rheopteris and also interesting coastal limestone communities. The highlands of the North Coastal Ranges support two endemic species of large mammals (the giant glider and Scott's tree kangaroo) and a number of isolated and taxonomically distinct bird populations.
2. **The Star Highlands.** Pristine alpine and montane environments descending to mid-montane valleys, foothills, and fringing lowlands. They support a diverse montane and high altitude vegetation with many plant species in common with the mountains of Irian Jaya. The subalpine forests are home to a significant population of the globally threatened Macgregor's bird of paradise. The environmental transect from the summit heights northward to the Ai River lowlands has been documented as having the richest known mammal fauna in New Guinea.
3. **Central Range/Sepik Foothills.** A large wilderness area with low human population and remarkable habitat diversity, from lowland to subalpine forest. The area includes extensive stands of *Agathis labillardieri*, which support a highly diverse epiphytic flora. The health of the Sepik hill forests are important to the river and its human cultures.
4. **Upper Fly Lowlands.** This area of lowland and hill forest is delimited by the Palmer River on the east and Irian border on the west an the southern scarp of the central cordillera on the north. Except for the extensive settlements related to the Ok Tedi mine (in the west) this area comprises a large expanse of old growth wet rainforest that supports a small human population and is characteristic of the extraordinarily rich biota of the upper Fly platform.
5. **Tonda/Bulla Plain.** Savanna and riverine gallery forest unique in PNG. The large areas of savanna and seasonally flooded grasslands and marshes constitute a globally significant wintering ground for migratory waders and waterfowl both from Australia and the Palearctic.
6. **The Northern Trans-Fly.** Unsurveyed sea-

sonal forest and woodland that is probably a habitat formation unique in PNG. An undercollected flora closely related to that occurring in the Cape York Peninsula.

7. **Mount Bosavi/Aramia Watershed**. An outlying Pleistocene volcano and vast alluvial plain. Virtually uninhabited. Proposed for national park status more than a decade ago, the forests of the great extinct Mount Bosavi volcano have long been recognized to be of importance to conservation in PNG. The tract comprises the volcanic cone plus lower slopes to the west and southwest. These forests are faunistically rich and virtually undisturbed.
8. **Doma Peaks/Leiwaro Highlands.** Rich highlands environments with high scenic and biotic value. Doma Peaks (and Teri Gap) have been considered for national park status. These comprise a large mid-montane and upper montane tract of un-inhabited forest that is exceedingly rich in birds of paradise. Road access to 3000 meters on Tari Pass. Includes volcanic peaks.
9. **Kikori Karst/Lake Kutubu.** Unknown and unsurveyed, with a remarkable karst topography and PNG's largest highland lake. Lake Kutubu supports a diverse aquatic plant flora, and 11 of the 14 known fish species in the lake are endemic to it. The area also includes an enormous tract of tower limestone, which is botanically unknown. Limestone floras in southeast Asia are often very rich, and, if the Great Papuan Plateau reflects this diversity, it is most important that detailed studies be made of its flora. The limestone flora is poorly known from New Guinea, but it will likely include many undescribed species and possibly new generic records.
10. **Giluwe.** The massive Giluwe shield volcano is capped by the largest contiguous expanse of alpine vegetation in PNG. This is a globally significant montane and alpine wilderness threatened by logging of the beechpodocarp forests of its middle and upper slopes. Very rich biologically. Subalpine bogs extensive.
11. **Adelbert Mountains.** Threatened lower montane forests that are home to the endemic fire-maned bowerbird. the rarest bird species in PNG and the bird species with the most circumscribed geographic range known for mainland PNG. The forests are little known but probably diverse.
12. **Bismark Highlands/Ramu Basin.** From PNG's highest summit to one of its richest.

Photo by: Bruce Beehler

lowland alluvial forests. The Ramu supports extensive areas of lowland rainforest (including swamp forest), some of which is developed on ultrabasic parent rock. The only known locality of Lauterbachia (Monimiaceae).

13. **Kubor Highlands.** High peaks and uninhabited montane forests, much on limestone capped with volcanic ash. A fragile ecosystem that probably contains local endemic plant species.
14. **Crater Mountain.** Wet lower montane forest and Pleistocene volcanoes. The Crater Mountain ecosystem is a proposed Wildlife Management Area, chosen because of it large expanse of original forest and large populations of a diverse array of birds of paradise, including the rare black sicklebill *(Epimachus fastuosus)* and blue bird of paradise *(Paradisaea rudolphi).*
15. **Purari Basin.** Wet zone lowlands and hills. Virtually uninhabited and little studied. This includes a very diverse area of mangrove and swamp vegetation with lowland rainforest on small limestone hills out of the surrounding swamps. These evidently support many local plant endemics but are virtually uncollected. The area includes numerous species of Pandanus and also a rich palm flora, particularly of Calamus.
16. **Finisterre Range.** PNG's youngest mountain range, with alpine highlands that remain little surveyed. This large montane forest tract, with a broad elevational range from coastal hill forest to the treeline, supports species endemics of three birds of paradise,
17. **Saruwaged and Cromwell Ranges.** Alpine highlands and hill tracts threatened by development. This and the Finisterre area support numbers of locally endemic bird and mammal species and the only extensive Dacrydium forests in the Southern Hemisphere that remains unlogged.
18. **Watut Hills and Watershed.** Little-studied hill country east of the central highlands area. The endemic plant genus Piora is recorded only from Mt. Piora and Mt. Amungwiwa. The lower reaches of the Watut River drainage support populations of the endemic root parasite *Langsdorfia papuana,* a genus otherwise known only from Madagascar and Central and South America.
19. **Lakekamu Basin/Chapman Range.** Includes an entirely uninhabited tract of forest that ranges from pristine lowland alluvial forest to upper montane forest near treeline, all within a transect of no more than 20 kilometers. The lowland forest supports large populations of the southern crowned pigeon, southern cassowary, and Pesquet's parrot.
20. **Central Province Dry Zone.** Savanna and monsoon forest complex with wetlands, threatened by development. Also includes the second largest mangrove area in Central Province.
21. **Bowutu Mountains/Kuper Range.** The Bowutu Mountains comprise an area of ultrabasic montane flora plus coastal, mangrove, and seagrass communities. The Kuper Range is a high coastal mountain complex that is virtually uninhabited and the site of a number of detailed ecological studies on birds and plants.
22. **Owen Stanley Highlands.** Extensive alpine areas and vast tracts of pristine montane forests, ranging downward in the north to the forested Ioma lowlands. The Mount Albert Edward dome includes the largest alpine uplands in eastern PNG and thus is a critical montane resource. The lowland forests constitute a critically threatened resource in peninsular Papua, and those suggested for protection here may support populations of the globally threatened (and world's largest) butterfly, *Ornithoptera alexandrae.*
23. **Musa River.** Little known lowland forests and wetlands.
24. **Safia Dry Zone.** A low rainfall interior zone with unusual animal and plant communities.
25. **Topographers Range.** An isolated volcanic cone in association with the coastal fjord-

26. **Mt. Suckling.** A large montane wilderness isolated from the main Owen Stanley highlands. Virtually uninhabited and little disturbed at this point. The Suckling massif is the only significant alpine uplands in the eastern peninsula, and, in conjunction with the adjacent Bonua basin, stands as a remarkably pristine aggregate of montane and lowland forest in easternmost mainland PNG.
27. **Cloudy Mountains.** The most southerly mountain range in PNG. No collections are known from the area. Urgently needs study.
28. **Goodenough Highlands.** The massive central peaks of Goodenough Island are higher than any other mountains on New Guinea's fringing islands. The mountain forests that cloak these summits are home to an endemic species of forest wallaby and a bat endemic to these eastern islands. Many botanical novelties.
29. **Fergusson/Normanby.** Unusual montane habitats and (on Normanby) ultrabasic dwarf forest. Fergusson Island is one of PNG's great biological unknowns, with three distinct mountain ranges, *geothermal areas,* and *other* natural wonders. The triok possum Dactylopsila tatei, is a species endemic to Fergusson. Goldie's bird of paradise is confined to the forests of these two islands.
30. **Woodlark Island.** Floristically unusual; the forests of the interior of Woodlark are home to the endemic Woodlark cuscus.
31. **Louisiades**. The flora of this archipelago has been recognized as one of extreme botanical interest with high rates of local endemism, particularly at the *species level.* It includes important stands of Diospyros (including an undescribed ebony) and several locally endemic species of Hopea. The forests of Tagula Island are home to an endemic species of honeyeater and butcherbird.
32. **Umboi Island.** Umboi is the largest and richest of PNG's north coastal islands. It is home to populations of large numbers of species endemic to PNG, as well as a supports one of the richest waterbird populations in the Bismarck Archipelago.
33. **West New Britain.** Mountain and lowland forests distinct from mainland. Threatened by large scale timber operations. The Whiteman Range and its foothills support an important tract of limestone flora, surrounded by forests developed on sedimentary materials. Little is known of the area, but large tracts of Nothofagus forest occur on the higher plateaus.
34. **Willaumez Peninsula.** A remarkable physiographic feature with Lake Dakataua, it includes a very diverse area of lowland rainforest on rich volcanic soils. Threatened by logging and proposed development for oil palm plantations.
35. **Eastern New Britain.** Includes the uplifted and limestone-capped Nakanai Plateau. Little surveyed but apparently biotically rich. Lowland rainforest and montane forest, including areas of forest dominated by Lithocarpus and Nothofagus developed on the limestone substrate. The largest high altitude area in the Bismarck Archipelago.
36. **The Baining Mountains.** The high ranges of easternmost New Britain, threatened by logging activities. Not adequately surveyed. These mountains, isolated by rivers and lowlands from the Nakanai Mountains to the southwest, are certainly as fascinating as the latter. They have not been adequately surveyed and are 500 meters higher. These mountains are surrounded by lowlands with a growing populace and probably will be degraded unless action is taken soon.
37. **Southern New Ireland.** The Verron and Hans Meyer ranges are little known high ranges that merit study and conservation. Important montane and lowland vegetation. Brief initial surveys have shown this montane area to be very rich, with a number of bird species endemic to New Ireland.
38. **Southern Bougainville Island.** Highland wet forests threatened by logging and development. This area includes the central and

southern segments of the Crown Prince Range, from Panguna south to Lake Lorolu, and includes Mounts Takuan and Taraka. Where appropriate, this area extends downward toward the coast where good original forest prevails. Bougainville is home to many species whose affinities lie with the Solomon Islands to the south and southeast. Among the many interesting vertebrates is the little known Bougainville hon*eyeater (Stresemannia bougainvillei),* representing a genus endemic to this island.

39. **Eastern Bougainville.** Supports the largest stands of bamboos in Papuasia. A variety of vegetation types occur, including remnant stands of *Terminalia brassii* in swamp forests. Threatened by logging and possibly sulfur mining.
40. **The Lelet Plateau.** Comprises important hill and lowland rainforests, with some lower montane elements as well. These probably contain many plant endemics with interesting biogeographical relationships with Manus, the Philippines, and the Solomon Islands. Threatened by selective logging in the lowlands.
41. **Mussau Island**. The interior of Mussau Island, the largest in the St. Matthias group, comprises a large block of rainforest. It supports seven species of birds endemic to PNG, two of which are endemic to Mussau, the Mussau Rufous fantail *(Rhipidura matthiae)* and the Mussau pied monarch *(Monarcha menckei).*
42. **Manus Island.** The largest of the Admiralty group, isolated both from the great Bismarck islands to the southeast, and from mainland New Guinea far to the south. Not surprisingly, Manus's isolated fauna is rich in PNG endemics (eleven birds, two mammals). Of these, six are endemic to the Botanically, the area includes stands of an endemic *Calophyllum* and *Sararanga,* which are threatened by logging activity.

Wetland Sites

W6. **Sissano Lagoon and Wetlands.** Comprise the largest coastal lagoon on the north coast of mainland PNG, associated with a large wetland.

W7. **The Middle Sepik.** A huge complex of river meanders, oxbows, tributary lakes, marshes, and woodland swamps, both of ecological and economic importance.

W8. **Sepik Delta/Middle Ramu.** A coastal wetland/deltaic complex (Sepik) in association with a low alluvial meander belt of the Ramu River, the latter rich in swamp forests.

W9. **Middle Fly**. The Fly River, although only 1200 km long, is, on volume of water discharged, so large that it ranks with the

world's great rivers. The middle Fly floodplain, 15-20 km wide, is a mosaic of lakes, alluvial forest, swamp grassland, and swamp savanna. This, includes PNG's largest lake (Lake Murray).

W10. **Lower Fly.** A mosaic of swamps, open water, savanna, and gallery forest. The area has abundant wildlife and is an important tourist destination. It constitutes a very important wetland both for migrating birds and resident waterfowl. In Australian drought years it becomes an important refuge for Australian wetland birds.

W11.**Sirunki Wetlands.** The Sirunki Basin straddles the main montane watershed divide of PNG, with one segment of the wetlands draining northward into the Sepik, the other segment draining southward into the Fly system. An important highland headwaters.

W12.**Lake Tebera**. One of PNG's few lower montane lakes. Supports at least one endemic fish plus other rare fish species.

W13. **East Gulf Coastal Wetlands.** The greater Purari delta comprises a large complex of mangroves, deltaic swamps, and tidal environments.

W14. **Mambare Wetlands.** Woodland swamps and mangroves.

W15. **Central Province Wetlands.** A series of wetlands lie northwest of Port Moresby; because of proximity to the capital these wetlands are under varying levels of exploitation and disturbance. They support large and diverse populations of waterfowl and other wetland birds. The area is particularly important as a dry season refuge for migrant waterfowl from Australia and as a staging area for Palearctic shorebirds on their way to and from wintering areas in Australia.

W16. **Aria Wetlands**. Northern coast of western New Britain.

W17. **Toriu. Wetlands.** On the eastern coast of the Gazelle Peninsula, comprise a large area of estuarine marshes and flood plains along the lower courses of the Toriu, Nesai, and Pali rivers. Mangrove forests occur in the north, and there are extensive areas of herbaceous swamps.

W18. **Bougainville South Coastal Wetlands.** Important insular wetlands on the western coast of Bougainville island, dominated by *Campnosperma brevipetiolata, Terminalia brassii,* and *Metroxylon solomonensis.*

W19. **Lakes Onim. and Bune.** Small lakes surrounded by herbaceous wetland. (Not shown on map #3.)

W20. **Ramu River at Brahman Mission.** Lowland swamp forest dominated by *Campnosperma brevipetiolata.* (Not shown on map #3.)

W21. **Biges River.** A short coastal stream with a tidal estuary. The stream supports a diverse fish fauna (28 species recorded). (Not shown on map #3.)

THE CNA RECOMMENDATIONS

The Conservation Needs Assessment developed a consensus on a range of recommendations, which are grouped into seven categories for future action and are summarized below. Please see the full CNA Report for detailed recommendations.

National Environment and Conservation Plan

- The proposed National Environment and Conservation Plan should be fully developed and implemented by the government and nongovernmental organizations (NGOs). This plan should ensure that effective mechanisms are established for the future involvement of NGOs and landowners in environmental monitoring and project implementation, and for communication with landowners.
- Governmental capacity for environmental impact assessment, monitoring, and enforcement should be strengthened. Special measures need to be introduced to control the loss of biodiversity in Papua New Guinea and to control traffic in Wildlife.

Natural Resources Option Center (NROC)

- An autonomous Natural Resources Option Center should be established to increase public awareness of environmental and development issues, and to provide landowners' groups with balanced and detailed information about their legal rights, about natural resource development options and the consequences and impacts of these, and the experiences of other communities.
- The CNA Maps of High Biodiversity Areas should be distributed widely through the NRCIC to landowners' groups, NGOs, and other decision-makers.

Environmental Legislation and Regulations

- The existing legislative and regulatory framework relating to environmental protection needs to be reviewed, as some laws presently on the books have not been gazetted and others are not enforced.
- The National Conservation Council should be constituted, and the Conservation Areas Act of 1978 should be fully implemented.
- The Land Groups Incorporation Act of 1974 should be amended to make it more culturally appropriate and to make definitions of customary landowners' groups more accurate.

- The Land Disputes Settlement Act of 1975 should be amended to strengthen decisions of local and district land courts.
- The Land Tenure Conversion Act of 1964 should be amended to enable reconversion of individual freehold rights to customary tenure where appropriate.
- Laws and regulations covering marine conservation need to be developed.
- The current moratorium on new forestry projects should be continued, and existing projects should be reassessed.
- The provision for exemptions in the new Forest Act should be replaced and exemptions granted since 1989 should be reviewed.

Environmental and Conservation Management

- Greater emphasis should be placed on local participation and grassroots conservation initiatives. Local resource owner requests to participate in government-sponsored conservation initiatives should be accorded high priority.
- The introduction of conservation models from other countries to Papua New Guinea should be treated with caution, as local conditions, knowledge, and practices may make foreign approaches inappropriate. Instead, approaches more appropriate to conditions in Papua New Guinea should be emphasized.
- A social legend (see box, page 7) should be placed on the front of the CNA biodiversity map so all potential users recognize the need to consult landowning clans before taking action based on the map's information.

Conservation Research

- Papua New Guinea offers numerous opportunities for research by biologists and social scientists. A few of the priority areas identified in the course of the CAN workshop include surveys of unknown biotas, studies of threatened species, marine systems, lowland rainforests, and crop genetic resources, and collection of traditional knowledge about natural resource use.
- All researchers must be aware of the need to keep local landowners informed and involved, and in general should seek out the participation of Papua New Guinean scientists and students.
- Social scientists should be fully involved in analyzing, designing, monitoring, and evaluating conservation activities in Papua New Guinea.

Training

- Training is needed in several important areas, including participatory rural appraisal, rapid rural appraisal, social feasibility assessment for NGOs and government, and courses in parataxonomy.
- Training should take several forms, including in-service training and formal courses of study, including professional degrees in social and biological sciences.
- Particular stress should be placed upon providing local resource owners with training in environmental monitoring skills through the proposed NROC and/or by NGOs.

Institutions

- The relationship between NGOs and government needs to be strengthened, beginning with the appointment of an NGO representative to the National Environment and Conservation Working Group and to the National Conservation Council.
- The Department of Forests and the Department of Environment and Conservation should improve their working relationships with NGOs, particularly with regard to coordination of activities and sharing of information.
- The government may want to consider establishing an independent environmental trust fund, to support local and national conservation activity in Papua New Guinea. This could be financed by a levy on extractive industries such as logging and mining, as well as by support from international donor agencies.

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