TRADITIONAL ENVIRONMENTAL KNOWLEDGE AND ITS IMPLICATIONS FOR MODERN CONSERVATION AMONG THE HEWA OF PAPUA NEW GUINEA

by

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ABSTRACT

This dissertation examines the relationship between traditional human activities and the conservation of biological diversity, through a study of the Hewa people of Papua New Guinea. The research tests the proposition that traditional land owners in Papua New Guinea manage their resources to promote biodiversity. The evidence comes from Hewa traditional environmental knowledge of the effect of gardening on avian diversity. Since birds are the primary agents of seed dispersal in New Guinea's forests, their diversity is positively correlated with biodiversity. Using traditional knowledge, an inventory of local birds is developed and a comparison of avian diversity in disturbed habitats with primary forest is presented. These data are then compared to bird and plant transect counts as a means of verification. Traditional land tenure and religion are likewise examined for their potential application in conservation. The data indicate that traditional activities are not necessarily aimed at the conservation of biodiversity. The present diversity is more directly attributed to low population density and limited disturbance. This indicates that the characterization of the Hewa lifestyle as designed to promote biodiversity is a dangerous simplification and that the inclusion of the Hewa in the conservation of their lands is problematic.

DEDICATED

TO

MY WIFE, FAMILY AND FRIENDS

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CHAPTER 1

INTRODUCTION

If those who plan the future of tropical areas would follow some of the fundamentals of the Kayapo system, we would be well on a path to a socially and ecologically viable system for the humid tropics.
— Darrell Addisson Posey 1988

For the past twenty-five years, primitive man has been the subject of two conflicting characterizations. On one hand, archaeologists have increasingly documented the role prehistoric man has played in the decimation of wildlife. On the other hand, advocates for contemporary indigenous societies have promoted them as stewards of their lands, capable of conserving wildlife and sustainable management. Unlike many academic controversies, the resolution of this debate will have real consequences for future generations, since the fate of many of the planet's last great stretches of wilderness will depend on an accurate portrayal of the relationship between indigenous societies and their environment.

The aim of this dissertation is to address the relationship between the traditional lifestyle of one society, the Hewa of Papua New Guinea (PNG), and the conservation of biodiversity. It reflects the results of sixteen months of fieldwork that began in 1988-89 and continued in 1992, 1994 and 1996-97. I will focus on three aspects of traditional Hewa life — gardening, land tenure and religion.

Each has been proposed as a mechanism that enabled indigenous people to establish an equilibrium with their environments. I will demonstrate, however, that although the Hewa play a significant role in shaping this environment, their traditions are not always compatible with biodiversity conservation.

As we discover more about the complexities of conservation, it is becoming clear that the traditional park system will fail to conserve the biological diversity of most countries. In fact, conservation is no longer synonymous with preservation. Scientists now realize that they cannot create ecologically viable parks by focusing solely on the preservation of outstanding geological features or large mammals. All organisms and environments in an ecosystem are valuable. As a result, conservation is now defined as, "the wise use of resources so that future generations will be able to benefit from the same resource base," i.e. sustainable resource use (Clay 1991).

Traditional resource use strategies have been described as not only benign and sustainable, but as an appropriate foundation upon which to develop a modern conservation strategy (Rajasekaran & Warren 1994:13). However, this new approach to conservation is based largely on the untested assertion that indigenous people, because of their long association with the land, have developed lifestyles or adaptations that allow them to live in "balance" with their environment (Maybury-Lewis 1992; Bodley 1991,1976; Newman 1990; Nations 1990; Clad 1988). According to this line of reasoning, indigenous people must manage their lands more sustainably than modern societies in order to maintain environmental equilibrium (Harris 1974). Conservationists hope that once these management techniques are understood, such techniques will allow indigenous societies to continue to live sustainably on their land (Swartzendruber 1993; Baines 1990).

While this idea has popular appeal, it has recently come under fire from both anthropologists and conservationists (Diamond 1992; Beehler 1991; Hames 1991; Ehrlich 1981). Many observers accept the notion that the involvement of the indigenous people may lead to new and creative approaches to conservation (Hames 1991; Polunin 1991; West and Brechin 1991). However, they point out that we know very little about native conservation methods and should proceed cautiously (Hames 1991; Polunin 1991; West and Brechin 1991; Dwyer 1985). Likewise, references to "stability" and "balance" are not only vague, but also based on outdated concepts borrowed from ecology (Pimm 1991:4; Rambo 1989:4). Given the lack of data on the effectiveness of traditional conservation techniques, it would seem premature to advocate traditional practices as a blueprint for conservation. Yet, conservationists in PNG and throughout the world are hoping to use traditional knowledge to develop appropriate conservation strategies for tribal lands (Quiroz 1996:3; Swartzendruber 1993:6; Almquist 1993:3; Baines 1990:43).

The Yellowstone Model

As we come to the end of the twentieth century, the earth's remaining wilderness is quickly disappearing. Much of this wilderness is also home to the last of the relatively unacculturated societies on the planet. Until recently, conservation of important habitats consisted of removing the human inhabitants, incorporating the land into some sort of protected area, and prohibiting further use of the area's resources (Ryan 1992:15). This is known as the "Yellowstone model" of park planning.

Under the Yellowstone model, the basic mission of a national park is resource protection (West & Brechin 1991:17). By definition, areas designated as parks were not to be materially altered by human exploitation (West & Brechin 1991:xvi). The American park planners that originally employed this model were reacting to the slaughter of wildlife, destruction of forests, over-grazing and erosion that followed Americans in their westward migration (Dasmann 1988:304). Most American parks were established in the sparsely inhabited lands west of the Mississippi River, where Native Americans had already been removed. Therefore, the government of the United States was able to establish parks without the messiness of removing and providing for the land's traditional inhabitants (West & Brechin 1991:10).

The U.S. model for designing national parks continues to be the preferred model in countries with the available space and management resources (Cahn &

Cahn 1992:26). Many of the parks found today in the developing world were established following World War II when the U.S. parks were the only parks to emulate. Park planning in this era consisted of penciling in the area to be protected on the map and notifying the locals that park rules prohibited hunting, gathering or gardening in the newly created park (Neitschmann 1991:373). Relocation was encouraged because in many circles, traditional societies are seen as an obstacle to development (Krupnick 1992:219; Maybury-Lewis 1984:220). Indigenous societies were often described as backward and traditional ways an impediment to the economic well being of these people (Schmink & Redford 1992:7). As a result, development strategies tried to convince these "primitive remnants" to abandon their outdated ways and embrace development, usually in the form of an agricultural project aimed at involvement in the world commodity market (Schmink & Redford 1992:7).

The history of conservation projects involving the removal of indigenous people has been one of "good intentions gone bad" (Dove 1986:113). Typically, relocation is devastating to both the traditional local economy and the newly-created park. Indians and peasants are denied access to forests in Central America to make way for forestry projects and parks. These parks are not large enough to adequately conserve biodiversity and have been a failure in terms of rural development (see Areas 1992; Cardenal 1992; Godoy 1992; Mizal & Gallegos 1992;). The survival strategies of the San of Botswana are compromised when they are prevented from entering newly-established game reserves (Hitchcock 1985). Protected land designation has failed to stop land degradation in Chiapas (Cloud 1985). The Ik of Uganda faced starvation after their removal from Kidepo National Park (Calhoun 1991; Turnbull 1972). The Maasai and other East African tribes are removed from their ancestral grazing lands to make room for parks in Kenya and Tanzania (Boshe 1992; Bigrube 1992: Homewood & Rodgers 1988; Diehl 1985). The resulting parks are not large enough to serve the needs of species such as elephants and the interruption of traditional grazing patterns results in a loss of biological diversity both in and out of the park (Western 1997). Each of these cases has resulted in the loss of resources formerly controlled by the original residents and a reduced standard of living for those who are relocated. Consequently, there is little local support for parks.

The notion that only landscapes unaltered by man are suitable for inclusion in a park system has had a far-reaching effect on world conservation (De-Lacy 1992:5). Parks developed in this manner have succeeded in protecting only 4.9 percent of the earth's land mass (Ryan 1992:16). These areas were designed as scenic spectacles, not biological units. In fact many of today's parks, especially in the tropics, exist only on paper (Ryan 1992:16). In terms of biodiversity conservation, traditional parks have been called "200 year holding actions" - i.e. capable of sustaining their original diversity for 200 years before they are either destroyed or are reincorporated into conservation plans that are viable both socially and ecologically (Hales 1989:139). However, there has been a growing recognition that evicting a park's original tenants was short-sighted (West and Brechin 1991). A consensus has emerged that parks and protected areas must not only be viable ecosystems but also socially viable entities (Eaton 1992; Webb 1992; Metcafe 1992; Dower 1992; Dearden 1992; Kula 1992; Hough 1991; Haantens 1989; Hill 1989).

Achieving ecological viability for the world's parks will require the conservation of both entire ecosystems and the processes that create them. Since indigenous people have helped to shape the landscapes that park planners want to conserve, traditional activities are in reality just one of the many processes so important to the dynamics of biologically diverse landscapes. For instance, some seemingly destructive traditions, such as burning grasslands, actually promote biodiversity (Western 1989:158). Other research indicates that human alteration of the rainforest can increase the population of animals such as tapirs, woolly monkeys and deer (Posey 1982). If we can redefine conservation to include sustainable use of the environment, conservationists and advocates for indigenous rights can seize upon the connection between tradition and biodiversity to propose combining rural development with wilderness conservation. They can propose that both environmental and cultural preservation will be best served by allowing the indigenous inhabitants to remain in areas designated for conservation where they can participate in the management of their lands.

The future of conservation is now said to lie in expanding protected areas to include entire ecosystems and extending the benefits of conservation to the local populations (Western 1989; McNeeley 1989). Papua New Guinea's solution to this dilemma has been to designate land as either Wildlife Management Areas or Conservation Areas. Neither designation requires the removal of the traditional landowners. Under both of these designations the lands remain under traditional ownership and landowners are involved in management decisions (Swartzendruber 1993:6). Such designations limit logging, mining and other non-traditional activities. However, both of the above designations rely upon the traditional land management systems of the societies involved to conserve their lands. As of yet, we know very little of how these ecosystems function or how traditions operate as conservation tools.

Traditional Knowledge and Conservation

There is an urgent need for research that will unravel the complexities associated with the conservation of entire ecosystems (Myers 1995:347). However scientists lack even basic information on many areas, such as the remote largely unexplored Hewa territory, that may be rich in endemic species and important to conserve (Pimm 1995:347). However, before developing a plan to conserve an ecosystem, scientists must first determine what species are present and how a particular ecological community came to be (Leakey 1995:151). This means that even ecosystems that have been studied for years may be inadequately understood for their protection.

The complexity of ecosystem conservation has renewed appreciation for long term studies that chronicle the reaction of organisms to infrequent occurrences (Walker 1989:179). Both of these concerns have renewed interest in the traditional environmental knowledge (TEK) of indigenous people. Since there may not be sufficient time or money to study and conserve imperiled ecosystems, western science has begun to re-examine the potential of traditional knowledge to provide biological inventories and information on long-term ecosystem dynamics.

Today, it is common to read conservation proposals extolling the potential of TEK. For example, noting that alternative strategies for the sustainable use of resources must be developed, the authors of Papua New Guinea's 1993 Conservation Needs Assessment are hoping that the "traditional knowledge base within Melanesian societies may hold clues as to how this can be done" (Swartzendruber 1993:6). The World Wide Fund for Nature's South Pacific Conservation Program proposes to meet its objectives by, "supporting...field projects which build upon the conservationist component of traditional knowledge" (Baines 1990:36). Likewise the 1993 PNG Conservation Needs Assessment states, "Traditional Melanesian modes of subsistence have effectively conserved the natural environment for millennia without the need for specially designed conservation zones from which human use was excluded or limited" (Swartzendruber 1993:5).

However, gathering TEK can be a problem. Research methodologies for TEK must consider the ways in which knowledge is distributed among their informants. Not everyone in a society is equally proficient in identifying components of their ecosystem. Gender, occupation and age affect the distribution of knowledge (Almquist 1993:621). Traditional knowledge is often integrated into aspects of a culture, such as religion, that are not seen as scientific (Posey 1992:3). Likewise, TEK is not always compartmentalized into categories that fit neatly with western scientific categories, such as genus and species (Bulmer 1969:5). Finally, much of the research on TEK has been analyzed using the anthropological system of emic interpretation (i.e., reflecting the linguistic and cognitive categories of native people), rather than the scientific method (Posey 1992:2). Advocates of the emic approach do not feel the need to confirm their findings using the scientific method (Posey 1992:2). Since professionals typically involved in designing a conservation program use the scientific method, emic anthropology does not mesh easily with conservation biology.

Despite these difficulties, the possibilities for conservation and sustainable development have renewed interest in recording TEK. Some analysts are willing to subject TEK to the same critical evaluation as other research. They believe that in the short run, TEK may be able to serve as a basis for environmental monitoring and compiling biological inventories (Almquist 1993:63). Over the long run, researchers are looking to TEK for new insights that will build bridges between western science and the various indigenous knowledge systems (Kula 1992:4).

Implications for Research

This dissertation attempts to develop a methodology for using TEK not only to understand the relationship between traditional activities and the conservation of biodiversity, but to discover clues to conserving this landscape that are embedded within the Hewa culture. In order to accomplish this goal, I have relied primarily on the traditional environmental knowledge of the Hewa with respect to birds, in order to document the effect of this culture on biodiversity. This approach can be justified for several reasons.

First, TEK is emerging as a viable tool for unraveling the connections between organisms in an environment (Brookfield & Padoch 1994:41). Traditional knowledge has been proposed by international conservation agencies as a "shortcut" for developing biological inventories and a means of monitoring ecological processes (Almquist 1993:63; Baines 1990:41-3). Since the Hewa have lived in this territory for hundreds, if not thousands, of years, they have an encyclopedic knowledge of the flora and fauna of their land. Although the Hewa territory was described in the 1993 Conservation Needs Assessment as, "biologically unknown," I have combined the excellent field guides available for PNG birds with the Hewa TEK to establish a baseline for species that are considered key to forest dynamics and conservation.

Second, biodiversity conservation in New Guinea is primarily the conservation of forests and the birds that shape them (Schodde 1973:123). Since large terrestrial mammals are missing from the Papuan region, birds are the primary agents of seed dispersal in New Guinea (Beehler 1982:841). Therefore avian diversity is a good indicator of over-all biological diversity.

Although the word, "biodiversity," has entered the popular lexicon, its meaning has been expanded beyond the popular notion of "all of the organisms" found in a community (Wilson: 1992:393). Scientists have developed three measures of biodiversity, known respectively as alpha, beta and gamma, each with a specific meaning. Alpha diversity refers to the number of species within an ecological community (Wilson 1992:393). Beta diversity is a comparative measure of the biological diversity found in neighboring communities (Whitmore 1990:30). Gamma diversity measures the number of different ecological communities found in a given area (Leakey 1995:101). Since I am concerned with the effect of human activities on biodiversity, I will be comparing the avian diversity of altered landscapes with the primary forest. Therefore this dissertation is primarily concerned with the beta measure of biological diversity.

I will test the notion that the traditions of the Hewa might serve as a "blueprint" for the conservation of their lands, by examining the relationship of gardening, land tenure and religion to biodiversity. My research does not indicate that these activities will necessarily contribute to biodiversity conservation. Through gardening, the Hewa create a series of forest succession communities. A comparison of the avian diversity found in garden plots with the primary forest indicates that gardens and successional communities have a less diverse avifauna than primary forest. While the present level of gardening increases biodiversity, this diversity could decline if too much primary forest is converted to gardens. Likewise, the Hewa system of land tenure is designed not for conservation, but to provide flexible access to land for codescendants. When combined with a low population density and the ability of gardeners to move to more fertile land, the present system promotes biodiversity. However, if the population increases or families are unable to safely move to more fertile ground, this same system can allow more intensive gardening. Employing the traditional Hewa gardening techniques more intensively will result in larger areas of less diverse successional growth. Finally, traditional Hewa religious activities do not offer much hope as resource management tools. Neither taboos nor a willingness to appease the spirits are designed to promote conservation.

In the following chapters, I introduce the Hewa and the provide background to the issues involved in developing a new kind of park. Chapter 3 examines the archeological and historical evidence for labeling indigenous man as a natural conservationist. Chapter 4 introduces the concept of disturbance as the source of biological diversity in tropical forests. Chapter 5 will examine the effect of traditional Hewa gardening on avian diversity. The contributions that traditional land tenure and the Hewa religion might make to conservation of biodiversity in PNG and elsewhere are explored in Chapters 6 and 7.

CHAPTER 2

THE HEWA

A History - From Contact to the Present

The Hewa are a group of shifting horticulturalists that live in one of the most remote regions of Papua New Guinea's Central Range. The ruggedness of the western portion of the Central Range has discouraged exploration. This is the fretted limestone country that turned back the Hides, Karius and Champion expedition (Champion 1966). The earliest penetration of this territory was probably the Fox Brothers expedition of 1934 (Fowlkes 1995:131). This unauthorized gold prospecting team trekked west from Mt. Hagen, crossed the ranges separating the Enga from the Hewa country and continued to what was in all likelihood the Strickland River gorge, before returning to Hagen through the Tari basin (Schiefflin 1991:98). The Fox patrol found the Hewa, "full of beans and ready to fight...but not enough gold to fill a tooth" (Schiefflin 1991:98).

As expected, the Hewa account of this expedition differs from the Fox patrol's and fills in some of the details of this first contact. Unable to communicate with the patrol, fighting erupted as the expedition tried to obtain food. It was common practice for patrols to trade for food from the locals as they traversed the highlands. However, the Hewa gardens are small and there are no villages. Families were not anxious to trade their limited supply of garden produce with strangers. When a fight erupted, the Foxes shot some Hewa and their porters looted the gardens. As the word of the fighting spread through the hills the patrol encountered an increasingly hostile populace. Eventually the Fox brothers unleashed their carriers, killing several Hewa males and burning their houses. By the time the patrol reached the Strickland River, the Hewa were in full retreat, abandoning their houses at the sight of the approaching patrol. The patrol then helped themselves to the produce and pigs. No one else was killed.

The next exploratory patrol through the Hewa territory was in 1939. The Hagen-Sepik patrol, led by officer J.R. Black, was returning from Telifomin to Mt. Hagen. This expedition crossed the Hewa territory killing one Hewa male in the process (Steadman 1971:2). In 1958, J.P. Sinclair led an expedition to the headwaters of the Strickland River. The Sinclair patrol sighted several Hewa houses, but made no contact (Sinclair 1965:64-66). The first anthropological contact was made by Dr. Lyle Steadman in 1966 (Steadman 1971).

At the time of Steadman's fieldwork, the only obvious sign of outside influence was the presence of a few steel axes (Steadman 1971:3). Various missionary groups from the highlands had made forays into the area but had no permanent presence and no converts (Steadman 1971:3). In 1966, the Hewa language had not been systematically studied and no Hewa spoke the current lingua franca Tok Pisin/Pidgin English (Steadman 1971:25). All of Steadman's initial interviews had to be first translated from Steadman's Pidgin to Duna by a bilingual individual from Lake Kopiago and then from Duna to Hewa by another resident of Lake Kopiago (Steadman 1971:25).

Steadman completed his fieldwork in 1969. No additional field studies of any kind were conducted in this area until 1988, when he and I returned to begin my research with the Hewa. Since 1969 there have been noticeable changes in Hewa life. By the time of my arrival in 1988, steel axes were common, although I could still trade for stone ax heads. There were many pidgin speakers among the young males. Western style clothing, although rare, had begun to make its way into local dress. A handful of the Hewa had converted to the Lutheran, Catholic, Apostolic and Seventh-Day Adventist churches, even though there was no permanent mission in the area.

Since the construction of the airfield in 1992, this territory has experienced more outside influence than at any time in its history. Since 1994, a doctor from the Lutheran hospital at Wabag has made yearly visits to the Hewa and established a small aid post at Wanakipa. The presence of medical supplies has encouraged people with kinship ties to the clan territories bordering the airstrip to build a second house near the strip. Although these households continue to maintain gardens in the hills, they also garden and cut fire wood nearby and their effect on the forest is obvious. The Lutherans and Seventh-Day Adventists have now established Papua New Guineans as their permanent ministers near the airfield. While many males over the age of thirty continue to adhere to their traditional religious customs, it is rare to find a female of any age who has not become affiliated with one of the churches.

Today, no permanent government presence or trade stores have been established in the Hewa territory. However, money is now commonplace. Many Hewa travel to adjoining areas such as Porgera and Oksapmin to stay with relatives that have intermarried with these groups and find work. Occasionally, the government of the Southern Highlands will deliver a contract to maintain the footpaths that connect the Hewa to their neighbors to the south and east. The Lutherans provide the only steady source of income by paying a crew of men to cut the grass at the airstrip. Membership in this crew rotates quarterly, so that many of the Hewa men have an opportunity to earn approximately $100 per year for this work. However, the Hewa continue their traditional ways and schedule occasional wage work around the routines of gardening.

The Hewa Environment

In 1993, a Conservation Needs Assessment (CNA) was conducted by an international consortium of conservation agencies for the government of Papua New Guinea. Groups including the World Wildlife Fund, World Resources Institute, Conservation International, and USAID described this area as a "terrestrial unknown" listing it as the number two conservation priority for this nation (Swartzendruber 1993:11).

My fieldwork has centered on an area of the Southern Highlands province that corresponds to 142 30' East, 5 10' South. This study focuses on the 80 Hewa households found within the area bordered by the Laigaip River on the north, the Strickland River on the west and the Pori River on the east. A wall of limestone cliffs that rise abruptly in the south to over 2300 meters effectively separates the Hewa from the Duna, Paella and Ipili cultures. Recent Lutheran Mission estimates place the Hewa population at approximately 2000 individuals (personal communication), a slight increase from Steadman's 1969 estimate (Steadman 1971:1).

This rugged landscape defines Hewa life. The microclimate associated with altitude and terrain effectively confines Hewa horticulture to the area ranging from 500 meters above sea level, at the bank of the Laigaip, to the base of the mountain wall at 1500 meters. Within this belt, the Hewa raise their gardens, relying primarily on sweet potato (*Ipomoea batatas*), yams (*Dioscorea sp.*), banana (*Musa sp.*) and to a lesser degree cassava (*Manihot esculenta*) and pumpkin (*Cucurbita maxima*) as food crops. Scattered throughout the area are several species of Pandanus and *Pangium edule* trees that the Hewa claim individually. The seasonal ripening of these trees are used by the Hewa to distinguish seasons.

Although the Hewa hunt for cassowaries, pigs, birds and marsupials, this seems to be an activity primarily of young unmarried males (Thomas 1990). A more important factor in shaping this environment is the cycle of gardening to which the Hewa are committed. Wild foods are scarce in the mountains of New Guinea. Early explorers of these regions could not live off the land. They were confined to traveling in the highland valleys wherein there were major populations and plenty of garden produce to feed the expeditions (Diamond 1992:226).

Given the scarcity of wild foods in highland New Guinea, it is doubtful that the aboriginal settlers of the Hewa territory could have survived for long without agriculture (Clarke 1966). Gardens are the primary source of food and each Hewa household is committed to cutting, clearing, fencing and planting an average of four gardens, each roughly 100 x 100 meters, per year. This gardening cycle, combined with the hard work of pursuing game over the steep terrain and the lack of success associated with hunting, seems to relegate hunting to those young, single males who have the time for it.

Rather than villages, the Hewa live in scattered households, approximately 30 minutes walk from their closest neighbors. According to one patrol officer, "Many of the Hewa settlements are so remote and inaccessible as to be beyond the reach of the average patrol" (Permezel in Steadman 1971:6). There are no roads in this territory. Foot paths connect the Hewa with the outside world. No government offices, police or schools have been established. In a country where communities often are familiar with airplanes before they see an automobile and airstrips are carved from mountainsides, the Hewa were one of the last communities to be serviced by air. In 1992 the first airstrip was developed at Wanakipa, within my study area. In order to construct it, the Lutheran mission headquartered at Wabag, used a helicopter to deliver the components of a bulldozer. Once assembled, this machine scraped out the present airstrip at Wanakipa.

Population density remains low and in the absence of a medical aid post or police station, the Hewa will likely remain scattered. I have recorded genealogical and residential information on over 800 individuals in an area of approximately 500 square kilometers. Without birth records, it is difficult to produce data on infant mortality or life expectancy for the Hewa. However, it is possible to extrapolate from studies conducted by the Papua New Guinea Institute of Medical Research for the Southern Highlands as a whole (Gillett 1991). In an overview of the health of women in PNG, the author provides mortality tables for the provinces of PNG. Given the absence of medical care in the Hewa territory, I have chosen to use the 1971 mortality figures, rather than the 1980 statistics. Although medical care has increased in many parts of the highlands since independence, it has only recently come to the Hewa. Even with the construction of an aid-post, there is no staff doctor and the post is chronically short of supplies. Therefore, the 1971 mortality figures are closer to the reality of the Hewa situation. In 1971, the infant mortality rate for the Southern Highlands was 171 deaths per 1000 live births for males and 147 deaths per 1000 live births for females (Gillett 1991:18). Average life expectancy was 37 years (Gillett 1991:22).

During his research (1966-69), Steadman estimated the murder rate to be 7.78 per 1000, i.e. victimizing almost one percent of the population per year

(Steadman 1971:215). Steadman's research, entitled NEIGHBORS AND KILLERS, documented the cycle of murders and revenge killings that accompany witchcraft accusations among the Hewa. This cycle continues today. In fact, the son-in-law of my chief informant was killed in 1996 in revenge for his participation in a 1994 killing.

Two types of primary forest cover these mountains. From the river banks at 500 meters to approximately 1000 meters the forests are referred to as foothill vegetation (Johns 1982:321). Forests above 1000 meters but below 1700 meters are referred to as lower montane forest (Johns 1982:321). This category of vegetation is again defined by altitude. Above 750 meters, palms are rare (Beehler et.al. 1986a:18). Instead, stands of *Araucaria* (members of a family of trees resembling pines), *Castanopsis acuminatissima* and true oaks, *Lithocarpus*, are common (Johns 1982:321). The notable exception to these forests is the extensive and possibly anthropogenic grassland found along the Strickland River gorge (Beehler et.al. 1986a:19).

Although I have not compiled adequate records of the rainfall in this area to provide estimates of yearly precipitation, circumstantial evidence from other locales in PNG suggest this to be an area of high annual rainfall. According to Bruce Beehler, "In general, the highest rainfall occurs in association with mountain scarps ...such areas (as)...the southern scarp of the western half of the Central ranges. Some of these sites probably receive in excess of ten meters of rain a year" (Beehler et.al. 1986a:16-17). The most striking aspects of the Hewa landscape are the seemingly endless forest and the mountain wall that separates them from their highland neighbors. Since these features imply heavy rainfall in the rest of New Guinea, it is reasonable to assume that the Hewa are subjected to similar rain patterns. Unlike the forests of Malaysia and Borneo to the west, the forests of New Guinea do not experience the annual mass fruiting of *Dipterocarpaceae* associated with the onset of heavy rains (Whitmore 1991:55).

New Guinea is known for its spectacular array of birds. Approximately 740 species of birds can be found in PNG (Coates 1985:22). In addition to habitat and niche preferences within a habitat, avifauna are also distributed along an altitudinal gradient. Lowland and mountain communities below 1500 meters are the richest bird communities (Beehler et.al. 1986a:28). These lower elevation hill forests contain 150 species, on average (Beehler et.al. 1986a:27). In terms of worldwide studies in avian diversity, this is "comparable to sites in Kalimantan, Indonesia; richer than a forest site in Liberia, West Africa; but very much poorer than a variety of sites in Amazonia, where local lists commonly exceed 350 species" (Beehler et.al. 1986a:27).

In regards to the avifauna, New Guinea has an unusually large number of frugivores, nectar-eaters and ground dwelling forest birds. According to Beehler, "In comparison with a comparable lowland forest community in Peru, the New Guinea fauna has twice as many fruit-eaters and nearly twice as many nectar-eaters, as measured by proportion of the fauna" (Beehler et.al.

1986a:28). This disparity is due, at least in part, to New Guinea's geography. Located to the east of the Wallace's line, the island of New Guinea was not colonized by placental mammals. All the placental mammals on the island, with the exception of bats, were introduced by man (Flannery 1995). Like Australia, marsupials dominate the island's mammalian fauna and the monkeys, cats and deer of Asia are absent. Since there are fewer mammals, there are fewer mammalian frugivores and pollen eaters. New Guinea's birds fill the roles taken by mammals on the western side of Wallace's line. Consequently, there has been an extraordinary radiation of species of birds to fill these niches. Fruit and pollen eaters are essential players in the dispersal of seeds and pollen in the forest. The interaction of the Hewa with these birds is therefore an essential part of forest dynamics and an important consideration in developing a conservation strategy for this area.

CHAPTER 3

THE DEMISE OF THE NOBLE SAVAGE

Today, the influence of the modern world extends even to societies whose homelands are described as "wilderness". While anthropologists continue to study the remaining preindustrial societies, the circumstances of these societies opens any study to charges that either the people in question have not had the time to adjust to their new circumstances or that the findings are applicable only to the subjects of the study (Hames 1991). There may not be enough time left to settle this debate before the cultures and environments we are trying to conserve are destroyed.

Although isolated and relatively unspoiled by world standards, Papua New Guinea's societies are not immune to the forces shaping the rest of the world. Foreign logging firms have discovered PNG's forests. These firms entice local people with large sums of money, then enter into illegal contracts with villagers and harvest timber at unsustainable rates (Tickell 1993). Modern weapons are adopted by indigenous hunters who then deplete local game populations. For example, Chris Healey reports that in less than eight years, Jimi valley plume hunters had put enough pressure on local birds to force him to change his assessment of the ability of social restraints to promote a sustainable harvest of plumes (Healey 1986).

However, the idea that indigenous societies have developed a harmonious relationship with their natural surroundings is rooted deeply in the history of Western civilization. Like many western traditions, the idea may have originated with the Greeks (Maybury-Lewis 1992:24). First Greek, and then the Roman philosophers, began to portray their societies as civilizations that had degenerated from the "Golden Age" of their distant ancestors (Diamond 1992:318). Both Homer and Ovid contrasted the honest nature of primitives with the treachery and conflict of their own times (Maybury-Lewis 1992; Diamond 1992). The idea that primitives are innately good descendants from a better past has been labeled the myth of the "Noble Savage." The seventeenth and eighteenth century European explorers inherited this tradition. While the idea of the noble savage was most fully developed by Rousseau, many authors and explorers spoke of the American Indians and the Polynesians that they encountered as remnants of the "Golden Age" (Diamond 1992: Redford 1991). These societies seemed to be free of many of the ills that plagued contemporary Europe. While Europeans were greedy and destructive, the aboriginals were collective, communal, humane and respectful of nature (Redford 1991). They seemed to live in veritable gardens of Eden, easily satisfying their material needs from their pristine (by European standards) lands.

The preindustrial societies contacted by Europeans were subsequently transformed or eliminated, but their reputation as societies able to live in conformity with nature has survived. There has been a tendency in human ecology research to assume that traditional societies have not appreciably altered their environment (Clarke 1971:190). In fact, the myth of the noble savage seems to be one of the few traditions that modern western civilizations have inherited intact (Redford 1991). As our environment seems increasingly threatened, we often look back to the American Indian either with nostalgia for a time when man lived in harmony with nature (Strickland 1970; Jacobs 1972) or for help in developing a modern conservation ethic (White 1984; Callicut 1989). We have inherited the tradition of the Golden Age populated by noble savages, ascribing it to virtually all preindustrial societies.

The idea that primitive people live in relative harmony with both nature and with each other has great appeal. Regardless of the environment to be conserved, there seems to be someone willing to champion the traditional inhabitants as the people most capable of conserving it (see Kottak 1993; Padoch 1993; Maybury-Lewis 1992; Russell 1992; Posey 1992, 1985, 1984; Clay 1990 & 1988; Nations 1990; Newman 1990; Taylor 1990; Bodley 1988 & 1976; Dasmann 1988; Gardner & Nelson 1988; Wright 1988; Klee 1980; Martin 1978). Consequently, contemporary literature is riddled with references to the ability of preindustrial societies to manage their environment. A closer look at such claims, however, is needed.

The Archaeological Record

The archaeological record is packed with evidence that implicates humans in prehistoric extinctions (Simms 1992; Martin and Klein 1984; Ehrlich 1981). Catastrophic extinctions have occurred world-wide in the wake of human colonization. The pattern of extinctions begins in Australia and New Guinea between 30,000 and 15,000 years ago (Burney 1993: Murray 1984; Bulmer 1982). North and South America next experienced a series of extinctions, coinciding with the appearance of humans between 10,000 and 12,000 years ago, that have been described as a "blitzkrieg" (Martin and Mossiman 1975).

Finally, another wave of extinctions occurred as humans colonized the oceanic islands. The Greater Antilles, New Zealand, Madagascar and the Mediterranean islands all experienced extinctions between 1,000 and 6,000 years ago (Burney 1993; Anderson 1984; Cassells 1984; Olsen and James 1984; Trotter and McCullough 1984). The exact nature of prehistoric man's role in these extinctions continues to stir scientific debate. In Australia, for example, the reasons for major extinctions remain obscure (Burney 1993; Horton 1984; Merriless 1984). Critics of the blitzkrieg model point to the circumstantial nature of the evidence. Marshall can find only 14 cases with convincing paleontological evidence of man's role in a big game kill in North America (Marshall 1984:790). Angebroad, surveying North American sites occurring after 15,000 yr. B.P., finds evidence of human participation in only 29 percent of the discovered large mammal skeletons (Angebroad 1984:103).

The data that do exist suggest that paleolithic humans killed relatively few species - mainly mammoths - with no indication of a role for humans in the demise of species such as the giant beaver (Grayson 1984 & 1987). Skeptics also point out that while Eurasia had a longer history of man/animal interaction, it also experienced a wave of extinctions (Vereschagen and Baryshnikov 1984; Ehrlich 1981).

Part of the problem with determining man's role in the megafaunal extinctions is the age of the sites. However, as we get closer to the present and examine the archaeological evidence of island extinctions, man's role becomes much clearer. There is evidence for human-induced extinction prior to European contact for practically all of the Pacific islands between New Guinea, Easter Island and Madagascar (Case 1992; Cassells 1984; Olsen and James 1984; Dewar 1984). Although the details would have varied for each island, the evidence of man's role in one particular extinction, that of the moa, may be instructive.

Moas (large birds resembling an ostrich) were found throughout the islands of New Zealand (Anderson 1984). Evidence suggests that the ancestors of the Maoris landed in New Zealand approximately 1,000 years ago (Cassels 1984; Anderson 1984). However, by the time that Europeans had arrived (approximately 700 years later), all moas were extinct (Cassels 1989; Anderson 1984; Trotter and McCullough 1984). Archaeologists have found over 100 Maori hunting sites, containing between 100,000 and 500,000 moa skeletons, suggesting that the Maoris hunted moas intensively for years (Anderson 1989). In addition, pollen analysis indicates that the Maoris were also clearing New Zealand's forests (Trotter & McCullough 1984). Within 700 years, the Maoris had cut and burned all of the areas to be cleared prior to European settlement (Trotter and McCullough 1984). Since moas were forest dwellers, habitat destruction probably contributed to their extinction (Trotter and McCullough 1984).

Archaeological evidence not only demonstrates man's ability to kill large game species, but also provide clues on the type of prey (by age and sex) primitive hunters may have preferred (Simms 1992:190). Several North American sites indicate that whether their prey was bison, mule deer or bighorn sheep, hunters favored animals of prime reproductive age and showed a slight bias toward pregnant females (Frison 1978; Simms 1992). When hunters hunt for meat and roam large territories, the urgency of providing food may override any conservation concerns (Simms 1992). Hunting females in their prime probably makes good sense nutritionally (Speth and Spielman 1983). However, killing pregnant females of game species is not what we expect of a people concerned with conservation (Simms 1992).

Since healthy animals that are in their prime are more difficult to prey upon than the old, sick or young, one might expect prehistoric hunters to have experienced some difficulty in killing their prey. Yet, Jared Diamond's research in the Gauttier Mountains of New Guinea gives us a glimpse of the reaction that prey might have to humans in areas relatively recently invaded by man (Diamond 1984). The Gauttier Mountains are isolated, surrounded by swamps and so difficult to reach that animals living here have rarely, if ever, seen humans (Diamond 1984). Diamond was therefore able to approach animals that are elsewhere shy and have been drastically reduced by hunters using primitive weaponry (Diamond 1984). He suggests that primitive man, armed with weapons that archaeologists consider superior to those found in New Guinea, may have had a devastating effect on game if their unwariness resembled the species found in the Gauttier (Diamond 1984).

The spectacular size of some moa species and the rapidity of their extinction focused the attention of archaeologists on hunting by Maoris. However, as we know, the Maori were also horticulturists and whose gardens shaped their environment (Trotter and McCullough 1984). The side effects of these agricultural activities may have been the greatest threat to the conservation of biodiversity by human cultures. Again archaeological evidence from three societies – the Anasazi, the Maya, and Easter Island - demonstrates this point.

The Anasazi farmed the Mogollon Rim area of the southwestern U.S. for one thousand years (Simms 1992). They cut the juniper and pine forests for fuel and to build the buildings that survive as reminders of their former occupation of the area (Kohler 1992; Orcutt 1991; Kohler and Matthews 1988; Bentacourt 1986; Cordell 1984; Bentacourt and Vandevander 1981). However, by approximately 1100 A.D. the Anasazi had deforested the lands surrounding their pueblos and were importing timber from 75 kilometers away (Kohler and Matthews 1988; Bentacourt et.al 1985).

The Anasazi could conceivably have developed a more sustainable harvest rate by cutting fewer trees or by spreading their population more evenly over their territory, but they did not. Eventually, the forests could no longer sustain this rate of cutting (Bentacourt and Van Devender 1981). By the time the Spanish entered the southwest, the Anasazi had converted what was once a pinyon and juniper forest into a desert and abandoned their pueblos.

The Polynesian settlers of Easter Island played out a similar scenario in the eastern Pacific from 400 to 1500 A.D. (Kirch 1984). Pollen analysis reveals that they drastically altered the environment of Easter Island by clearing the forests (Kirch 1984; Fleney 1984; Fleney and Ring 1979; McCoy 1979). By 1500 A.D., the human population had risen to 7000 persons (Kirch 1984). However, the island's forests had been so depleted that there was a shortage of both raw materials for canoes and fertile land for gardens (Kirch 1984). Human-induced environmental degradation led to poor crop yields and conflict over the dwindling resources (Kirch 1989; Fleney and King 1979). When the Dutch explorer Jacob Roggeven arrived in 1772, Easter island's population had dropped to 4,000 persons, the islanders had stopped carving the stone statues they are now famous for, and the landscape had become a barren grassland (Kirch 1984; Fleney 1984; Fleney and King 1979).

Mayan civilization dominated Guatemala and southeastern Mexico for one thousand years (Schele and Freidel 1990; Coe 1989; Gallencamp 1985). The Maya were skilled agriculturists. They built terraces to prevent erosion, constructed canals, and toward the end of the Classic Maya period, practiced intensive agriculture (Culbert 1988:98). The Maya had developed an encyclopedic knowledge of their environment's biodiversity and a sustainable agroforestry system of multi-cropping and tree tending (Attran 1993; Gomez-Pompa 1990, 1989,1987).

Yet this system and the knowledge that accompanied it were unable to stem the tide of environmental degradation that followed the growth of Mayan civilization. Between 800 and 1,000 A.D., Mayan populations experienced a drastic decline (Culbert 1988). The reasons for the collapse of Mayan civilization continue to be hotly debated (see Low 1985; Harrison and Turner 1978). However, there seems to be a consensus that the environmental degradation played a role (Culbert 1988; Rice 1978). While the traditional Mayan system of crop management had been successful for 900 years, it was developed under a less intensive agricultural regime (Culbert 1988:99). Some archaeologists have speculated that by adopting more intensive methods of agriculture, the Maya traded a short-term gain in crop yield for the long-term instability brought on by a decline in soil fertility (Attran 1993: Culbert 1988).

Thus, archaeological evidence casts considerable doubt on the existence of a "Golden Age". Prehistoric man altered his environment in a variety of ways.

He hunted for meat and decoration, cleared forests for raw materials and gardens, and used fire to shape ecosystems. Therefore the "virgin" lands encountered by European explorers were in reality lands that had been extensively changed by their aboriginal inhabitants (Simms 1992).

Most importantly, prehistoric man, while he probably possessed the vast environmental knowledge that survives in some traditional societies, undoubtedly had difficulty responding to short-term fluctuations in resources caused, for example, by temporary rainfall shortage or long-term declines prompted by a shift in global rainfall patterns (Diamond 1992:337; Brown and Brown 1992). As evidenced by the current debate over the possible effects of depletion of the ozone layer and global warming, this is a difficulty we continue to experience in modern societies.

Likewise, as humans encounter novel circumstances, a reliance on traditional methods may only worsen the situation. In the case of prehistoric man, traditional methods of hunting and gardening had carried him through countless short-term fluctuations in game populations or harvests. Intensively applying these methods when hunting game not accustomed to human predation, or planting crops in soil whose fertility progressively declined with each crop, might have led to environmental degradation and extinction of useful resources.

Contemporary Traditional Societies

Did the modern descendants of past exploitative cultures learn the error of their ancestors' ways and eventually develop lifestyles that allow them to live in harmony with their environment? Many researchers have come to the conclusion that native lifestyles are designed to conserve their environment because they appear to live below the carrying capacity of their lands and almost universally profess a reverence for the land and its creatures (Maybury-Lewis 1992:58; Hames 1991:173). The 1854 speech attributed to Chief Seattle – "For whatever happens to the beasts, soon happens to man. All things are connected" (Maybury-Lewis 1992:59) – is often cited as evidence of the kind of ethos that preindustrial societies have developed, an ethos that will enable preindustrial man to do a better job of conservation than western societies.

However, such societies have contributed to extinction of (1) the wolf, bear and beaver in Britain; (2) aurochs in Europe; (3) the ostrich, lion, tiger and leopard in the Near and Middle East; and (4) the wolf and sea lions in Japan (Diamond 1984). Brightman, citing their "proclivity to kill indiscriminately in numbers beyond what is needed," has questioned the conservationist nature of indigenous Canadian hunters (Brightman 1987). More recently, Ehrlich reports that the introduction of the rifle and power boats among the Aivilingmiut Eskimo totally changed their hunting patterns (Ehrlich 1981). Rather than paddling their boats close enough to spear seals, hunters took pot-shots (Erlich 1981). Nineteen of twenty resulting kills were lost as the wounded seals slipped off the ice flows and sank before the hunters could get to them (Ehrlich 1981:136).

Some see the above as evidence that the conservation ethic is absent in primitive man (Hester 1984; Dimbleby 1974). However, in a perverse way, these examples have served to strengthen the reputation of natives as conservationists (Hames 1991:173). Proponents of the "primitive conservationist" see technological introductions such as the rifle as non-native. Such implements were too new to allow a society to evolve and adjust to them. Here, according to Hames, "the exception proves the rule: instances of non-conservation are the result of a loss or disruption of aboriginal culture or western acculturation" (Hames 1991:173).

In spite of the evidence to the contrary, the notion that contemporary traditional societies have learned to live in balance with their environment continues to be attractive. Some anthropologists may see this claim as a way to champion their people (Kottak 1993; Maybury-Lewis 1992). Others hope that by supporting indigenous land claims, they may be able to stem the tide of environmental degradation and preserve what is left of our natural heritage (Clay 1990; Shiva and Bandyopadhay 1990; Nations 1990; Taylor 1990). Both conservationists and indigenous rights activists have been quick to seize upon their "convergent interests" (Clay 1990). The journal *Cultural Survival* has dedicated an entire volume to the possibilities of conservation through the exercise of the traditional lifestyles of indigenous peoples (Cultural Survival 1985). With the exception of Redford and Robinson, none of the authors in this volume indicate that there may be a conflict between the goals of tribal hunters and conservationists (Redford and Robinson 1985).

Since the fate of much of the earth's remaining cultural and natural heritage is at stake, the focus of the "primitive conservationist" debate has begun to move beyond assertion to recording the actual behavior of tribal societies and their specific mechanisms for regulating interactions with their environment (see Redford and Padoch 1992; West and Brechin 1991; Hames and Vickers 1987; Nunn and Williams 1982; Morautta 1982; Klee 1980). This research has underlined the fact that western science still knows very little either about the environment that it is being asked to conserve or about how traditional societies interact with their environment.

While cross-cultural comparison can be difficult, by concentrating on behavior, analysts have developed several cross-cultural themes. First, traditional societies are storehouses of information concerning their environment. The depth of their knowledge often surpasses that currently held by western science (Schulties 1992; Posey 1992, 1985, 1984). This knowledge can provide insights important to the success of any conservation program (Altierri 1992; Drijver 1992; Eaton 1992; Johnson 1992; Kula 1992; LeBlanc 1992; Lees 1992; Posey 1992,1985; Brokensha 1980). Second, traditional societies do not passively blend with their environment. They shape it through their lifestyles (Hudson 1989; Dove 1984; Ellen 1982; Hamilton 1982; Lewis 1982; Nunn 1982; Harris

1980). Such interaction can have significant (although not necessarily catastrophic) effects and produce a "spatiotemporal mosaic of negative impacts, harmony, temporary balance and imbalance" (Simms 1992:186).

Shaping the environment can go beyond clearing forests, burning grasslands or selective hunting. Some societies have developed sophisticated agroforestry techniques which they use to shape the forest to their needs (Altierri 1993; Posey 1992, 1990, 1984; Gomez-Pompa 1990, 1989, 1987; Jenkins 1988; Clarke 1971). It should be noted, however, that Parker has recently challenged Posey's contention that the Kayapo intentionally manage their forest (Parker 1992). In spite of this disagreement, indigenous people clearly change their lands through their actions and the results of these actions will have implications for their inclusion in a conservation program.

New Guinea

The island of New Guinea represents one of the earth's last great stands of rainforest (Swartzendruber 1993). However in New Guinea, as throughout the world, preindustrial man has been shaping the environment for thousands of years (Burney 1993; Hope 1977; Loffler 1977; J.Smith 1977). The wave of extinction that followed man's appearance here included the local extermination of the giant echidna, tree kangaroos, dugongs, megapodes and several species of bird of paradise prior to the colonial period (Bulmer 1985:61). Today the patchy distribution of animals in their traditional ranges may be evidence of local extinctions (Bulmer 1985:61; J.Smith 1977:202-3). For example, rock wallabies that are rare on the hunted slopes of Mt. Wilhelm are plentiful on the more remote ranges (J.Smith 1977:203). Because of hunting and clearing, wallabies do not occur at all in the man-made grasslands (Hope 1977:25).

Yet in New Guinea, as elsewhere, the evidence of man's effect on wildlife is largely circumstantial and difficult to evaluate. Therefore we can make only generalizations concerning the relationship of man to the New Guinea environment (Hope 1977:25). Besides hunting, traditional subsistence patterns in New Guinea involve the felling of trees (for gardens and building materials), burning grasslands, and the harvest of a variety of wild plants. Man's impact on the forests of Mt. Hagen and the upper Waghi Valley have been dated to 6,500 years B.P. Research indicates that as populations increased, the highlanders moved from hunting to progressively more intensive forms of agriculture to feed themselves (Watson 1977,1965; Morren 1977; Clarke 1976).

With European contact in the Pacific, the sweet potato was introduced to New Guinea approximately 350 years ago (Clarke 1976:299). This introduction has been so successful that in the last 300 years, the sweet potato has become the staple of the highlands economy (Watson 1977,1965). The grasslands that dominate the highland valleys are probably the result of continuous planting and burning over the last 300 years (J. Smith 1977:190).

The environment in New Guinea was not friendly to Europeans. Unlike other areas of the world, New Guinea was not subjected to waves of colonization and very little of the country was disturbed by the introduction of European methods of farming and forestry. Since the exploration of the highlands began in the 1930's, analysts have had the opportunity to observe the workings of traditional societies. Traditions, both technological and ideological, have not been eroded by the years of outside influence that characterized the rest of the colonial world.

Predictably, ecologists and anthropologists have reached opposite conclusions concerning the ability of the natives to steward their environment. Anthropologists point to the apparent stability of traditional lifestyles and the importance the people put on their relationship with the land as evidence of the ability of indigenous New Guineans to conserve their natural resources (Carrier 1982; Peni 1982; Waiko and Jiregari 1982; Klee 1980; Wagner 1977). For instance, the Miyanmin have supposedly developed a complex strategy for the management and exploitation of game (Morren 1985:19). George Morren has also described a system by which the Miyanmin move their settlements in response to soil fertility (Morren 1986). In addition, these movements promote the management game populations. By moving hunters from areas with declining soil fertility, the Miyanmin rotate their hunting to new areas and avoid the danger of overexploiting their game resources. Ultimately this enables the game populations to recover and the Miyanmin to maintain a state of equilibrium with their environment (Morren 1986:20). According to some analysts, the traditional peoples of New Guinea have developed the ability to conserve vegetation (De'Ath

1982; Paglau 1982; Wood and Humphries 1982), wildlife (Kende 1982; Kwapenda 1982), and marine resources (Hudson 1982; Gaigo 1982; Olewale and Sedu 1982).

However, in New Guinea as elsewhere, there are researchers who question the usefulness of characterizing traditional societies as conservationist (Diamond 1992; Beehler 1991; Bulmer 1982; Dwyer 1982b; Johannes 1982; Powell 1982; Lipset 1985; Schodde 1977). Dwyer has pointed out that human population density in New Guinea can have the same effect as an increase in human populations in the rest of the world -- i.e., the depletion of faunal resources (Dwyer 1982a:167). Some groups respond to such depletion by moving or changing their hunting tactics to those that are effective on other species, such as switching from hunting to trapping. This, in effect, gives their former prey a chance to recover (Morren 1986; Dwyer 1982 a:540). However, it is difficult to determine the goal of such practices. Are they aimed at conservation, or merely accessing a new and temporarily more abundant resource (Bulmer 1982; Dwyer 1982a; Dwyer 1983)?

In New Guinea, traditional fishing practices have severely depleted stocks of shellfish (Swadley 1977;1982), turtles (Spring 1982), dugong (Hudson 1982; Olivale 1982, Sidu 1982) and the coastal fishery in general (Johannes 1982). The Jimi valley plume hunters studied by Healey did not switch prey (as many would have predicted) in response to a decline in birds of paradise (Healey 1986:125). Their hunting has now endangered some species (Healey

1986:123). It is interesting to note that Healey's 1986 findings contradict his 1978 prediction that beliefs and societal rules would act to regulate hunting (Healey 1986:197). Again, it is difficult for these plume hunters, despite their knowledge of their prey and its environment, to distinguish between short-term fluctuations and a genuine decline in their prey.

The present environment in New Guinea is one of rapid change. The human population is growing rapidly and with the introduction of roads and a cash economy, the demand for food as well as traditional ceremonial items has skyrocketed. However, hunters using traditional methods and knowledge to harvest birds are using a model based on the past. A reliance on these methods can have disastrous consequences because these traditions evolved under circumstances that differ from today.

In addition to market forces and population pressures, Christianity is now a part of the lives of many of the people. The impact of Christianity has been mixed. On one hand, game animals are no longer needed for sacrifices (Dwyer 1982b:183). On the other hand, the synergism that characterized secular and religious life has been broken (Dwyer 1982b). Peter Dwyer has observed that the impact of Christianity on highland Papua New Guinea has been largely negative. According to Dwyer, "God's impact ...will have been to replace old models that may have been conservationist in their result and which were certainly more leisurely despoilers of wildlife resources, with a model which tends not to be conservative and which is certainly more aggressive in its relations with nature" (Dwyer 1982b:183).

In summary, although New Guinea's environment and cultures are remote, they have not escaped the problems that have plagued indigenous societies in other parts of the world. Archaeological evidence implicates man in the extinction and alteration of New Guinea's flora and fauna. Current research indicates that contemporary New Guineans will fare no better than other people at sustainably using their environment in the face of growing human populations and world market forces. Change in New Guinea is imminent and the indigenous populations here seem to be no better prepared for dealing with this change than were their counterparts on other continents.

CHAPTER 4

DISTURBANCE AND BIODIVERSITY CONSERVATION

The ability of indigenous societies to live in harmony with their environment is far from resolved. Researchers have unearthed enough evidence of man's involvement in extinctions to keep alive the "man against nature versus the man in partnership with nature" debate (Grumbine 1996:79). Further complicating matters are recent discoveries in ecology, which have begun to undermine many of the traditional explanations for natural phenomena. This research has profound implications for conservation and requires a reevaluation of the premises underlying this entire debate. Before engaging indigenous people in modern conservation, it is productive to examine the theoretical underpinnings of the "primitive conservationist" model.

Traditionally, western science has taken a mechanistic view of the universe. The world is described as being like a clock in that, "the separate elements are connected by lawful relationships into a working system that produces well-defined controllable outcomes" (Goerner 1994:5). This view fathered the scientific revolution and is the philosophical basis of much of our ecological research (Goerner 1994:11). The mechanist assumes that it is only a matter of time until we can inventory nature and understand the connections between each of its components. Once this is accomplished, mankind will be able to manipulate nature to suit our needs (Goerner 1994:11). Since TEK contains a wealth of knowledge concerning landscapes that have not been surveyed, many researchers hope to use it to develop biotic inventories.

From a mechanistic perspective, the conservation of tropical forests requires the development of a plan to maintain their equilibrium. An ecosystem is said to be in equilibrium when as a result of the biotic interactions between the member species, the relative abundance and composition of species become stable throughout time (Reice 1994:424). Tropical rainforests are known for their stablility. These forests contain tremendous species diversity and the majority of these species have narrow ecological niches. Therefore tropical rainforests are often described as having achieved equilibrium. Advocates of traditional societies maintain that cultural practices function to help maintain an ecosystem once it has reached the "goal" of equilibrium between species and available niches (E.A. Smith 1983).

Yet, is the "natural" state of an ecosystem in fact a state of equilibrium? The assumption that ecosystems tend toward equilibrium is so pervasive that this question borders on heresy. However, the difficulty in defining extremely complex systems has led ecologists to concentrate on the dynamic components of an ecosystem rather than stability (Pickett 1992; Dove 1988; Jochim 1982; Ellen 1982). Many ecologists now recognize the difficulty of adequately defining natural systems, as well as the explanatory poverty that results from simplifying them (Ellen 1982). Today the flux or transient nature of an ecosystem is emphasized (Pickett 1992:84).

In the latest ecological paradigm, the balance of nature concept is described as non-scientific (Pickett 1992:54). Unfortunately, this shift has gone unrecognized by many anthropologists (E.A.Smith 1983:3). Authors continue to portray traditional societies as "in balance" or describe a practice as "adaptive." Yet, this use of terms drawn from ecology and evolutionary biology is often outmoded (Hames 1991; Palmer 1990; Smith 1983).

Over the past twenty years, scientists from a variety of fields have increased our understanding of ecological processes. Their research has implications for our understanding of the role of humans in shaping tropical forests. A rigorous application of the concepts of these disciplines may not only expose the flaws in the "primitive conservationist" model, but also present possibilities for designing conservation programs that might help conservationists and indigenous advocates to realize their convergent interests.

Disturbance and Biodiversity

Current research has focused on the role of nonequilibrium factors, commonly referred to as disturbance, in the enhancement of biodiversity (Reice 1994:924). Ecologists define a disturbance as any "relatively discrete event that disrupts a population, community or ecosystem and changes resources available" (Pickett & White 1985). Disturbance should not to be confused with predation. Predation is "intrinsic to the life of the prey species, which can and does adapt to it" (Reice 1994:428). On the other hand, disturbance is unpredictable and nonselective. It can come in any size, at any time and produce effects that will vary from minutes to centuries in duration.

While we typically think of disturbance as phenomena like storms that originate outside of an ecosystem, disturbance can also be generated from the internal dynamics of an ecosystem. Ecologists have discovered rich, dynamic and unpredictable behavior arising from the internal dynamics of laboratory populations without an external source of disturbance (May 1989:37). These eruptions are an underlying feature of the population dynamics of these species and can occur without any change in physical or biological conditions (Hastings and Higgins 1994:1136).

For example, computer-simulated histories of Dungeness crab populations demonstrate that the crab population can fluctuate widely without any external disturbance to the system (Hastings and Higgins 1994:1136). A 1989 *New Scientist* article by Robert May describes another example of the dynamic nature of life. According to May, the fate of laboratory populations of creatures such as blowflies have been found to diverge rapidly with as little as 0.3 percent difference in their initial size (May 1989:38). This divergence becomes even more dramatic as differences in the fecundity between individuals come into play. When the average number of offspring produced per individual in a generation was less than one, the population crashed. If the number of offspring is greater than one but less than three, the population reached a steady state. However, as the rate of reproduction grew beyond a value of three, the population began to go through a series of boom and bust cycles that become more complex the greater the rate of increase (May 1989:36-37). In each case, what had at first glance seemed to be random behavior, was not. It was the result of simple mathematical relationships that had been understood for some time (May 1989:38).

Population fluctuations are now understood to be the product of internal dynamics as well as external perturbations (Schaffer & Kott 1986:63). Some populations may, under the right circumstances, achieve a steady-state which researchers have labeled dynamic equilibrium. Others may become extinct or suffer a major reduction only to recover and rebuild their numbers (May 1989).

Although disturbance may kill or displace individual organisms, it generally creates the patchiness that characterizes many environments. This patchiness creates the niches that present opportunities for colonization by new species (Reice 1994:431). For example, a windstorm that downs trees in the forest creates gaps. Although the physical environment of the patch will determine the scale of the disturbance, disturbance clears the way for new species capable of colonizing these gaps, thus increasing the biological diversity of the area (Reice 1994:427).

However minor disturbances, such as the internal boom and bust dynamics mentioned above, can also create patchiness and are perhaps as crucial as more dramatic disturbances in promoting biological diversity. For example, a decline in the population of a predator in an ecosystem might open the door for a boom in the population of one prey species, while leading to the decline of another prey species unable to compete in the absence of this predator (Pimm 1991:673). Such a scenario might be responsible for booms in elephant populations that temporarily ravage African landscapes (Leakey 1995).

However, at either extreme of the disturbance continuum, environments that are either undisturbed or wracked by severe disturbances will eventually be dominated by a few species (Terborgh 1992:99). Therefore, in terms of its ability to generate biodiversity, disturbance is a scale related phenomena. Too much or too little disturbance produces environments that are not as diverse as those that are continually subjected to minor disturbances. This "intermediate disturbance hypothesis" argues that intermediate disturbance promotes the high degree of species richness by creating a mosaic of environments that, in turn, prevents the extinction of competing species (Connell 1978).

The Hewa actually increase the biodiversity of their lands when they cut gardens. By felling the forest, they create a mosaic of primary forest, secondary forest, grasslands, gardens and the various phases of succession growth (gamma diversity). They also create habitats for organisms that cannot survive in the primary forest (alpha diversity). For example the birds in Table 1 inhabit the grasslands and successional communities created by the Hewa. Therefore, by cutting a garden in the forest, it is possible for the Hewa to increase two measures of biodiversity (alpha and gamma), while creating areas that are lower in biodiversity (beta) than the surrounding forest (Tables 2&3).

Yet if ecosystems are constantly recovering from disturbances, how does one explain the apparent stability of nature? One factor is that the intervals between disturbances can be very long, giving the impression that equilibrium develops (Reice 1994:434). Another is that stability is the product of the interaction of the species in a community (Pimm 1991:673).

Species interactions form what is known as a food web (Pimm 1991:669). Although complex and difficult to delineate, food webs are a common feature of all ecosystems with common properties (Pimm 1991:669-72). Webs seem to create community level properties resulting from the interaction of species that can act as a deterrent to invaders. Ecological communities composed of many strongly interacting species, like tropical forests, exhibit community level properties that seem to limit the possibilities for potential invaders (Case 1990:9610). As a result, mature relatively intact ecosystems are tough to penetrate.

The key to this dynamic is whether the ecosystem is mature and intact when a new species arrives. Not only can mature communities repel low levels of invaders, but they seem to provide safe havens for species that ecologists describe as inferior competitors. Research indicates that inferior competitors are capable of resisting invaders when the inferior species is securely lodged in an intact community (Leakey 1995:162).

To scientists of the non-equilibrium school, recovery from disturbance - not equilibrium - is the normal state of affairs in any ecosystem (Reice 1994:427). Every place is in varying degrees of recovery from a disturbance.

The eventual structure of any ecological community is determined by its response to continual disturbance. As long as disturbances occur frequently enough to prevent the competitive exclusion of poorer competitors, these species can continue to survive along with more efficient species (Reice 1994:428).

The "noise" often seen in graphic representations of populations is not an inconsequential deviation from equilibrium, but a reaction to constant internal and external disturbance. Dynamic growth and shrinkage is the nature of existence for populations reacting to disturbance. The net result for ecosystems experiencing intermediate scale disturbance is relative species richness because competition is buffered by the removal of both efficient and inefficient competitors by disturbance (Reice 1994:428).

Tropical Rainforests

Why then are the tropical forests home to such tremendous diversity? These regions are characterized by their stability. Temperature and rainfall are much more predictable in the tropics than in the temperate regions. If biodiversity is the product of disturbance, how did such outwardly stable environments become a "major source of evolutionary novelty" (Jablonski 1993:142)?

The answer to this question seems to be that in the case of tropical rain forests, appearances are deceiving. Researchers in the Amazon basin are finding these forests more heterogeneous and prone to disturbance than had previously been reported (Whitmore 1990). These forests are also subject to global disturbances that have produced planetary warming and cooling of the earlier glacial cycles.

During earlier ice ages, both Amazonia and African rainforests contracted into isolated remnants (Whitmore 1990:94). In fact, evidence emerging from Amazonia indicates that this ecosystem underwent Milankovitch cycle induced climate change throughout the last sixty-five million years (Kricher 1997:119). These climate changes have alternately expanded and contracted the rainforest we now associate with Amazonia. Likewise, Amazonian bird distributions indicate that at least nine major islands of tropical forest refuges survived the driest, coolest periods of the Pleistocene (Kricher 1997). As the glaciers retreated and rainfall increased, these island refuges expanded until these "islands" were reunited. This process of growth, retreat and fragmentation that has been recorded for the Amazonian rainforest has been equated with the biodiversity-enhancing effect of bringing the islands of the Galapagos together and again separating them over a millennia (Western 1997:202). Each time the islands collide after a prolonged isolation, some species would become extinct. However, the isolation, competition and recolonization have the net effect of species enrichment (Western 1997:203).

Although seemingly uniform when seen from the air, tropical forest habitats are also heterogeneous with respect to their potential to harbor species because of differences in the physical environments found within them (Reice 1994:427). Differences in altitude and soil composition can produce different environments beneath a green canopy. Canopy heights are not uniform. The epiphytes, lianas and flowering and fruiting plants present different feeding opportunities for arthropods, reptiles and birds. In short, the structural complexity of the vegetation within these forests creates a greater number of niches than found in temperate counterparts (Terborgh 1992:59).

Yet, these same highly connected ecosystems, such as tropical rainforests, are also the most sensitive to species loss. If the disturbance is of sufficient magnitude, the connections between organisms can fray and secondary extinctions will occur (Pimm 1991:673). Likewise, if a "keystone species," i.e. a species whose removal has a disproportionate effect on a food web is removed, the existing web can collapse (Pimm 1991:674). On the other hand, in simple communities where members are dependent on a few organisms for food, the loss of a single plant species can be catastrophic (Pimm 1991:674).

In New Guinea, the composition of avian communities provides a good illustration of the ability of vegetative structural complexity to accommodate biological diversity. Five factors have been identified that allow ecologically similar species of birds in New Guinea to partition the same habitat. They are body size, foraging level in the vegetation, foraging technique, diet and season of peak activity (Diamond 1973). Size differences between birds are often a factor when they are competing for the same resource. For example, fruit bearing trees can have several species of birds foraging simultaneously. The large birds will eat the larger fruit, while the smaller birds will then forage the smaller limbs that cannot support the larger competitors (Diamond 1973). Similar examples of partitioning a habitat by size have been found among kingfishers and lories (Beehler 1982:857). Insectivorous birds often divide the forest vertically, foraging at different levels of the forest. Beehler cites reports of four species of fantails and three species of whistlers segregating themselves to forage in the upper canopy, open under story, and lower thickets -- all within the same patch of forest (Beehler 1982:857). In a similar fashion, phylogenetically similar birds have been observed partitioning habitats by varying their diet, occupying the same area at different times and employing different foraging strategies within the same habitat (Beehler 1982:858).

Implications for Research

The underlying assumption of much of the research into the relationship between traditional societies and their environment has been that non-western societies have learned to minimize their impact and not disturb the balance of nature. However, research indicates that ecosystems are rarely, if ever, in a state of equilibrium. Greater species diversity is found not in stable ecosystems, but in systems that experience disturbance. Therefore there is no sense in searching for clues to man's ability to balance a system that has no inherent tendency toward balance. Instead traditional activities should be examined as possible sources of disturbance.

The diversity enhancing effects of disturbance are related both to the scale of the disturbance and the species in question. A minor change in conditions, such as a drop in soil fertility, a change in forest composition or rainfall patterns, can be so slight as to not initiate a response from humans. Yet such changes can represent a disturbance of sufficient magnitude to theoretically send the ecosystem spiraling off in a new and unpredictable direction.

Traditional activities that at one time were sustainable and produced an increase in the number of species could, under slightly different conditions, diminish biodiversity. It is therefore understandable that traditional societies could both promote biodiversity and cause extinctions using the same traditional activities under varying conditions. We now have plenty of evidence that preindustrial societies are capable of pushing their environments past the point of no return using traditional techniques.

In the next chapter, I will treat Hewa gardening as a type of disturbance and compare the diversity of primary forest with the man-made landscapes created by the Hewa. In order to gauge the diversity of each environment, I relied on birds as indicators of biological diversity. The use of birds as indicators of biological diversity is widespread (Beehler et.al 1987). I have taken advantage of my informants' encyclopedic knowledge of their environment to develop an inventory of birds and map the interactions between birds, plants and other organisms found in the Hewa territory. I then investigate the role of man-made disturbance in producing biodiversity, by identifying the birds associated with each of the succession environments that result from gardening.

Table 1

Birds of Grasslands and the Forest Edge

Genus	Species	Common name	Hewa name	Diet
Rallina	tricolor	Red-necked Rail	Kokoma	I/G
Oriolus	szalayi	Brown Oriole	Kritau	F/I
Gerygone	palpebrosa	Fairy Gerygone	Philopatu	I
Caprimulgus	macrurus	Long-tailed Nightjar	Luakanalu	I
Oedistoma	pygmaeum	Pygmy Honeyeater	Peteta	N/I
Centropus	menbeki	Greater Black Coucal	Tei	A/V
Coracina	melaena	Black Cuchoo-shrike	Teta	A/F
Cracticus	cassicus	Butcher Bird	Tui	A/F
Rhipidura	leucophrys	Willie Wagtail	Mopagalalo	I
Porzana	tabuensis	Spotless Crake	Tai Tai Nok	I/G
Xanthotis	flaviventer	Tawny Breasted Honeyeater	Toblaibak	G
Gerygone	chloronotus	Green-backed Gerygone	Philopatu	I
Oedistoma	iliolophus	Dwarf Honeyeater	Peteta	N/I
18/12Lalage	atrovirens	Black-browed Triller	Keketia	F/A
Rallina	forbesi	Forbes' Forest Rail	Kokoma	I/G
Pitohui	ferrugineus	Rusty Pitohui	Labinam	F/I
Megacrex	inepta	New Guinea Flightless Rail	Meanalu Hot	I/G
Meliphaga	albonotata	Scrub White-eared Meliphaga	Niatili	F/I
Melilestes	megarhynchus	Long-billed Honeyeater	Sisinek	I/F

CHAPTER 5

GARDENING AND CONSERVATION

In spite of the assertions concerning the compatibility of indigenous people with conservation programs, there has not been much research conducted on how indigenous societies affect their resource base (Stearman & Redford 1992:235). There is presently no agreement on exactly how much primary forest can be converted to a forest-fallow regime before the overall diversity of this landscape decreases. In order to determine the potential of shifting cultivation to conserve biodiversity, it may be profitable to examine gardening as a source of disturbance. By comparing the biological diversity of man-made successional communities to that of the climax forest, we can develop a picture of the diversity of this landscape and the changes that might follow more extensive gardening.

This chapter examines the effect the Hewa have on their resource base by concentrating on the effect gardening has on avian diversity. By recording the Hewa traditional knowledge of birds, the plants that birds prey upon and habitats they frequent, I will examine the effect of gardening on biodiversity. In the process, I will evaluate the role traditional knowledge can play in producing biological inventories and understanding ecosystem dynamics.

Gardens and Forest Gaps

The Hewa make their living from the local environment. They hunt, gather wild fruits and nuts, and encourage wild pandanus and nut trees to grow within their clan territories. However, their biggest impact on their environment comes from gardening. By cutting gardens, the Hewa are responsible for the mosaic of environments – garden, grassland, secondary and primary forest – that defines their territory.

Each family cuts approximately four gardens per year. Typical crops include pumpkin, sweet potato, taro, sugar cane, and bananas. Gardens usually begin to produce sweet potato in the fifth month after planting. The garden will produce steadily for approximately three months; yields then gradually taper off for the next two.

The Hewa prefer to cut secondary forest that is approximately twenty to twenty-five years old for gardens. Cutting secondary forest to produce gardens seems to be a common practice among horticulturists in New Guinea (Clarke 1976:253). Secondary trees are usually not as large as their primary forest counterparts and are easier to cut with an ax. In addition, secondary growth trees provide firewood, building materials and decoration for the Hewa. Consequently, secondary forest growth is more useful to the Hewa. Once the primary forest has been cut, the Hewa will not allow the garden to return to primary forest if they continue to live in the area. Instead, they are gradually thin the secondary forest as it grows.

As the Hewa move about their lands, they are not creating isolated 100 x 100 meter gaps in the forest. Instead, they continually link these gardens, reusing as much of the adjoining garden's fence as possible for each new garden, until they exhaust suitable land. As a result, bands of secondary forest are created and recreated along the mountain sides between 700 and 1000 meters above sea level.

Although western scientists have known the process of succession for some time, we are only beginning to understand the relationship between forest gaps and high biological diversity (Kricher 1997:58). The opinion of researchers has been divided over the role shifting cultivators should play in the land-use strategy of a modern state. In some circles, shifting cultivation has been hailed for its sustainability (Clarke 1976). Traditional gardening and forest succession regimes have also been described as a promising prototype for forest management (Padoch & Peters 1993). More recently, shifting cultivation has been praised for its ability to conserve agrodiversity, i.e., crop biodiversity (Brookfield & Padoch 1994). On the other hand, traditional land use patterns have also produced sufficient environmental degradation to spur an international movement aimed at stabilizing the shifting cultivator. The linkage between agrodiversity, resource management and biodiversity is of such importance that the United Nations has launched a project entitled "Population, Land Management and Environmental Change (PLEC)" to examine the role traditional agricultural practices might play in conservation (Brookfield & Padoch 1994:423).

The objective of this section is to determine the role traditional Hewa cultivation can play biodiversity conservation. In order to do so, I will first present the traditional environmental knowledge of the Hewa concerning the birds that are found in this area and their habitat preferences. Although there are several guides to New Guinea's birds, no systematic study of birds has been done in the Hewa territory. I will then use bird and plant censuses to verify the predictions of TEK on the effect of human habitat alteration on avian diversity. If the predictions generated by TEK are accurate, they will help the Hewa to play a larger role in conservation planning.

Methodology

Given the difficulties of conducting bird surveys in the tropical forest (Karr 1981), as well as the pitfalls of relying on traditional knowledge (see Chapter 1), I used a combination of methods to obtain and verify information. During my work, three local men have emerged as the most knowledgeable informants concerning the birds, trees and habitat preference. These men were my companions on all my interviews, transacts and surveys.

In order to check the information obtained interviews, I compared the TEK with both bird and plant censuses. I surveyed the vegetation in six plots of 20+ years of secondary growth. I chose to survey six plots because that gave me two samples within each of the three altitudinal zones, as described by the Hewa. Plant censuses were conducted along paths by counting species of trees at least ten centimeters dbh (diameter at breast height), four meters on either side of the path. This procedure follows protocols described in Beehler 1987, Blankespoor 1991 and Bernstein 1995. The plant specialists at the University of Papua New Guinea and the Lae Herbarium analyzed samples.

The age of each plot was determined relative to 1975, the date of PNG's independence. The Hewa do have a calendar based upon the fruiting of pandanus and *Pangium edule*. However, since this calendar describes the fruiting sequence and not actual dates, it is somewhat ambiguous. Some of the pandanus species can be found at all of the altitudinal bands accepted by the Hewa. There can also be several months difference between the ripening of a fruit at the lower altitudes and that same fruit's ripening at the highest altitude. Therefore, the Hewa calendar is used as a guide for action by the Hewa, and not an absolute marker of the days in a year. Papua New Guinea's independence day is a benchmark date that all informants could remember. Hence, each of my informants agreed upon the age of the forest succession in each sample site relative to the date of PNG's independence.

I also conducted transect bird counts along two fixed routes on forest paths from 700 to 1250 meters above sea level by establishing ten stations along 50 meter altitudinal intervals and recording the birds either seen or heard at each station during three minute stops. Transects were conducted from 0700 to 1100 hours, six days per week from September 1996 through January 1997. Each route followed a ridge that threaded in and out of primary and long-fallow secondary forest. This protocol was adopted from Beehler 1987 and following personal communication with Thane Pratt at the University of Chicago and Mary Lecroy of The American Museum of Natural History.

Results

So far, my research has recorded 128 Hewa categories for birds that correspond to 171 species. Feld reports that the Kaluli people of the Great Papuan Plateau also merge species with 125 Kaluli categories corresponding to approximately 155 species (Feld 1990). While Mayr reports a greater coincidence between native categories and species, Manjep and Bulmer report a similar merging of species in the Kaironk valley of PNG (see Mayr 1963 and Manjep & Bulmer 1977). In my case, I may have inflated the number of species recorded by reporting the co-occurance of *Sericonis virgatus* with *Sericonis beccarii* as well as the co-occurance of three species of *Zosterops* (Diamond personal communication). A full accounting of my data can be found in Appendix 1.

The Hewa associate species with altitude and habitat, as do western ornithologists (Diamond 1973; Beehler et.al.1986). They also associate some birds exclusively with primary forest and others with only the oldest (20+ year) of secondary forest growth. My informants predict that the birds in Table 2 will be removed when the primary/climax forest is removed. Table 3 lists those birds that, according to the Hewa, are only capable of making use of primary forest and secondary forest after at least 20 years of regrowth.

It is important to note that traditional knowledge predicts the loss of 55 birds or roughly 30 percent of the species recorded in the Hewa territory with the cutting of the primary forest. Another 42 species can be expected to be removed with a shortened fallow period for old gardens. Of particular interest to conservationists is the predicted loss of the species of *Ducula* and *Ptilinopus* with the cutting of the primary forest. These fruit pigeons are found more frequently in New Guinea than in any other region and are believed to disperse seeds of the unique forest trees of New Guinea (Beehler et.al. 1986:28).

The Hewa also predict the loss of the cassowary, cuckoo-doves, ground-doves, hornbill, goshawks, eagle, lorikeets and brush-turkey with the adoption of a shortened forest fallow regime. With the exception of the eagle and goshawk, all of these birds are thought to be vital to pollination and seed dispersal of the forests of the Central Range.

I used these data to develop predictions that could be tested through the conventional technique of transect counts. First, the predicted loss of bird species between primary and oldest secondary growth will reflect a loss of plant foods in secondary growth. Second, the number of species of birds, as measured through transect counts and predicted by traditional knowledge, should reflect the increased human activity between 700-1000m.

As a means of verification of the data in Tables 2 and 3, I conducted surveys of secondary growth in six garden plots that had been in fallow for approximately twenty years and were identified by my informants as ready to be recut for gardens. Using Beehler 1987 as a template, dominant species are listed in order of abundance. The data shown in Table 4 represents the dominant vegetation in each plot. The Hewa term for the tree is in parentheses.

Many studies have shown that secondary forest growth is not as diverse as primary forest. For instance, in a comparison of farms, secondary habitat and primary forest in Liberia, Gilbert Blankenspoor finds that not only does the primary forest support more species of birds than does the re-growth, but it also supports more specialist bird species than does re-growth (Blankenspoor 1991:60). Studies of secondary habitats in Peru and Gabon recorded fewer species in secondary habitats (Terborgh and Weske 1969; Brosset 1986). A study conducted in India revealed that disturbed areas become dominated by a few common species (Beehler et.al. 1987:207).

However, the purpose of this survey was to determine the presence of plants that would mature to produce foods for the birds associated with these forests. My reasoning is as follows: Though the birds responsible for seed dispersal in the primary forest may not currently visit these sites, the presence of trees that will mature into food sources would allow them to feed there eventually. If food plants could be found, any conservation plan might be modified to lengthen the fallow period and attract birds that have not traditionally visited secondary sights.

As predicted, most of the vegetation found in these sample plots was not described by the Hewa as being a food source for most of the seed and pollen dispersing birds of their forests. In terms of the birds using the forests, TEK holds that the white-bibbed ground-dove *Gallicolumba jobiensis,* wattled brush-turkey *Aepypodius arfakianus* and brown-collared brush-turkey *Talegalla jobiensis* are the primary avian consumers of the fruits of of *Adesia* and *Castanopsis*. None of these birds are said by the Hewa to frequent secondary growth. As in each of the above-mentioned studies, there was an increase in the number of species birds that employ a generalist feeding strategy in disturbed areas.

However, old secondary growth is not a monolithic entity and I expected that some of the plant species found in old re-growth would also be found in primary forest. In spite of the presence of some foods for the above-mentioned species, there were not enough potential food sources to conclude that the Hewa could substantially increase bird habitat by lengthening fallow cycles by a few years.

Finally, in an attempt to verify my informants' information, I conducted transect surveys using two different pathways leading into the mountains. If traditional activities do in fact change the species composition of the bird communities, then a bird census should reflect this change. My informants and I worked six days per week conducting this census by establishing stations at 50 meter elevation intervals (the protocol is described fully above). Table 5 presents the results of my transect surveys for these species. Since counts were performed every 50 meters in altitude, the numbers under each heading are the sum of the two station counts conducted within that altitude range. For example, the first heading under the Papuan ring parrot reads, "2,3". This indicates that the sum of my observations at 700 and 750 meters for my first route was "2" and the sum for the same stations within the 700 range on my second route was "3."

In the interest of intellectual honesty, it is appropriate at this juncture to revisit the limitations of TEK. Birding in the rainforest is primarily a matter of identifying the birds by their vocalizations. It is difficult, if not impossible, to identify the birds encountered on a census by sight alone. Although I accompanied my informants on each census, I relied on the Hewa to make the majority of identifications. Therefore, I used the Hewa classifications for my counts.

In addition the limitations of conducting research in a tropical rain forest must be taken into account before any firm conclusions can be drawn. For example, some of the birds are most active at the dawn. Since my observation route started at my house at 700 meters, I probably missed some birds in my survey because they had become less active by the time I reached the higher elevations that they inhabit. Species that were not heard or seen on my counts may be elsewhere, taking advantage of a tree fruiting far from my route. Species such as Gurney's eagle are rare and difficult to observe. While I have observed or heard all of the birds presented in the Appendix over my several seasons of fieldwork, I did not observe or hear all of the species during the station counts.

These factors, and the steep and sharply folded landscape, combine to present a more complex picture of the on-the-ground reality than traditional knowledge would imply. The Hewa find some slopes too difficult to cultivate. Therefore, secondary growth is often interspersed with primary forest. Vegetation zones recognized by the Hewa are within the biomes we describe as lower montane and hill forest. These biomes begin to intergrade at 800 meters above sea level. Many of the species to be found in the Hewa territory are said to include this middle zone, from 800-1000 meters above sea level, in their range. In addition, trees considered too large to fell are left standing in the gardens. Such trees attract avian visitors that might not otherwise be found in a completely altered landscape. With a scattered human population and rugged landscape, the Hewa have not yet produced landscapes that are obvious barriers to bird movement.

Added to these physical obstacles was the Hewa practice of including more than one species under the same category. This is the case for the Hewa birds categorized as "Isisapi," "Klaikal," "Kun," "Teti," "Orlau," and "We." In the case of Isisapi, Klaikal, Kun and Teti, each category contains two species. For these categories, I have given identical census counts. I was not able to differentiate between the categories while conducting the census. The Hewa include four species under the category of "Orlau" and three species are classified as

"We." These species commonly move through the forest in flocks. They often mix with other species and are invariably loud as they pass over and through the canopy. Although I have been fortunate enough to observe each of the species the Hewa lumped into each category, I am confident in my identification of only one species in each category while on census. Therefore, I have only included the little red lorikeet (Orlau) and the rainbow lorikeet (We) in my census count. The numbers under these headings in the census represent *flocks, not individual birds*.

The blue-collared and red-cheeked parrots called "Klaikal" also presented some difficulties for data collection. While the Hewa maintain that the preferred elevation for both species is between 1000-1500 meters above sea level, red-cheeked parrots have been observed from sea level to 800 meters, while blue-collared parrots are thought to range from 800-1800 meters above sea level (Beehler et.al.1986:121). My informants differentiate between the calls of the two species and I did record blue-collared parrots within their range.

I also recorded three birds on my census that my informants and I have not been able to identify using the field guides. While it would be personally rewarding to have discovered a new species, it is more likely that these Hewa categories of birds represent either the male or female of an already known species. For the majority of the birds found within the Hewa territory, the altitude preferred by each species, as understood by western ornithologists, approximates the information provided by my informants.

However, there were several prominent exceptions to the agreement between field guides and traditional knowledge. Table 6 presents those species that are said by the Hewa to have ranges that differ from those presented in the literature (see Beehler et.al.1986 and Coates 1985). One interpretation of the data in Table 6 is that human activity has forced the birds that are adversely effected to the upper limits of their range. According to the Hewa, many of these birds have specialized diets. As gardening and forest succession change the landscape, perhaps these species are forced to forage in the uncut forest at higher elevations that continues to produce their food requirements. In any event, Table 6 indicates the sensitivity of some species to human activity and which species may be most vulnerable to extinction with increased disturbance.

Discussion

In spite of lack of laboratory precision, it seems foolish to disregard the warnings that traditional knowledge can provide to conservationists. With little funding available for research in remote areas, it is precisely this type of information – species inventories, predator/prey interactions and forest dynamics – that are unavailable when conservationists attempt to conserve these areas. The traditional knowledge of the Hewa concurs with research conducted elsewhere by western scientists. That research documents the simplification of the ecological communities found in secondary growth. The information provided by my Hewa informants also mirrors conventional research in that it identifies landscapes managed by humans as a source of vegetative diversity but poorer in animal and bird life (see Blankenspoor 1991; Beehler et.al. 1987; Nabhan 1982; Schodde 1973).

The information provided by the Hewa, when combined with a greater understanding of biodiversity, illustrates that the description of the Hewa as managers or promoters of biodiversity is a dangerous over-simplification of their impact on this environment. The Hewa actively promote and perpetuate environments that, while essential to their survival, have a catastrophic effect on the exotic bird life associated with PNG. The doves and pigeons named in Tables 2 and 3 are the focus of conservation efforts in PNG. Although the Hewa have not determined the exact area of land that can be converted to garden before the diversity of this area begins to decline, limiting the scale of gardening will obviously be important to the future of avian diversity in this area.

Table 2
Hewa TEK of Birds Found Only In Primary Forest

Common name	Genus	Species	Diet	Altitude
Dwarf Whistler	Pachycare	flavogrisea	I	N,C
Long-tailed Buzzard	Henicopernis	longicauda	V	A
Belford's Melectides	Melidectes	belfordi	N/A	C
Palm Cockatoo	Probosciger	aterrimus	S	A
Papuan King-Parrot	Alisterus	chloropterus	S	N,C
Pheasant Pidgeon	Otidiphaps	nobis	S/F	N,C
Grass Owls	Tyto	capensis	V	A
White-eared Bronze Cuckoo	Chrysococcyx	meyerii	I	N,C
Macgregor's Bower Bird	Amblyornis	macgregoriae	F/I	C
Black-winged Monarch	Monarcha	frater	A/I	A
Sooty Owls	Tyto	tenebricosa	V	A
White-faced Robin	Tregellasia	leucops	I	A
Purple Tailed Imperial Pigeon	Ducula	rufigaster	F	N,C
White-bibbed Ground-Dove	Gallicolumba	jobiensis	F	N,C
Spotted Babbler	Ptilorrhoa	leucosticta	A	A

Diet codes: S=seeds, F=fruit, A=arthropods, I=insects, N=nectar,V=vertebrate,
L=lichens, G=generalist. Altitude: A=all, H,N=500-1000m ; N,C=1000-1500m

Table 2
Hewa TEK of Birds Found Only in Primary Forest

Common name	Genus	Species	Diet	Altitude
Brown Collared Brush Turkey	Talegalla	jobiensis	G	A
Wattled Brush-turkey	Aepypodius	arfakianus	G	N,C
Pink-spotted Fruit-Dove	Ptilinopus	perlatus	F	A
Red-cheeked Parrot	Geoffroyus	geoffroyi	F/S	N,C
Blue Jewel-Babbler	Ptilorrhoa	caerulescens	A	A
Josephine's Lorikeet	Charmosyna	josefinae	N	N,C
Little Red Lorikeet	Charmosyna	pulchella	N	A
Red-flanked Lorikeet	Charmosyna	placentis	N	A
Pygmy Lorikeet	Charmosyna	wilhelminae	N	C
White-breasted Fruit-Dove	Ptilinopis	rivoli	F	N,C
Feline Owlet-nightjar	Aegotheles	insignis	I	A
Dwarf Fruit-Dove	Ptilinopus	nanus	F	A
Shovel-billed Kingfisher	Clytoceyx	rex	A/V	A
Flame Bowerbird	Sericulus	aureus	F/A	C
Hornbill	Rhyticeros	plicatus	F/G	A

Diet codes: S=seeds, F=fruit, A=arthropods, I=insects, N=nectar,V=vertebrate,
L=lichens, G=generalist. Altitude: A=all, H,N=500-1000m ; N,C=1000-1500m

Table 2
Hewa TEK of Birds Found Only in Primary Forest

Common name	Genus	Species	Diet	Altitude
Gurney's eagle	Aquila	gurneyi	V	N,C
Little Paradise Kingfisher	Tanysiptera	hydrocharis	A/V	N,C
Common Paradise Kingfisher	Tanysiptera	galatea	A/V	N, C
Great Cuckoo-Dove	Reinwardtoena	reinwardtii	F	A
Common Scrub fowl	Megapodius	freycinet	G	N,C
Wattled ploughbill	Eulacestoma	nigropectus	I	N,C
Blue-collared Parrot	Geoffroyus	simplex	S	N,C
Rufous Owls	Ninox	rufa	V	A
Northern Scrub Robin	Drymodes	superciliaris	I	A
Ornate Fruit-Dove	Ptilinopus	ornatus	F	A
Red Myzomela	Myzomela	cruentata	N/I	C
Vulturine Parrot	Psittrichas	fulgidus	F	N,C
Common Smoky Honeyeater	Melipotes	fumigatus	F	N,C
Ornate Melectides	Melectides	torquatus	N/A	N,C
Red-throated Myzomela	Myzomela	eques	N/I	C

Diet codes: S=seeds, F=fruit, A=arthropods, I=insects, N=nectar, V=vertebrate, L=lichens, G=generalist. Altitude: A=all, H,N=500-1000m ; N,C=1000-1500m

Table 2
Hewa TEK of Birds Found Only in Primary Forest

Common name	Genus	Species	Diet	Altitude
Mountain Red-headed Myzomela	Myzomela	adolphinae	N/I	C
Papuan Black Myzomela	Myzomela	nigrita	N/I	C
Yellow-browed Melidectes	Melidectes	rufocrissalis	N/A	C
Short-tailed Paradigalla	Paradigalla	brevicauda	F/A	C
Grey Goshawk	Accipter	novaehollandiae	V	N,C
Black-mantled Goshawk	Accipter	melanochlamys	V	N,C
King of Saxony BOP	Pteridophora	alberti	F/I	C
Black-Billed Cuckoo-Dove	Macropygia	nigrirostris	F	N,C
Papuan Mt Pigeon	Gymnophaps	albertisii	F	N,C
Crested Pithoui	Pithoui	cristatus	A	A
Mountain Owlet-nightjar	Aegotheles	albertisi	I	A

Diet codes: S=seeds, F=fruit, A=arthropods, I=insects, N=nectar,V=vertebrate, L=lichens, G=generalist. Altitude: A=all, H,N=500-1000m ; N,C=1000-1500m

Table 3.
Hewa TEK for Birds Found in Old Secondary Forest

Common name	Genus	Species	Diet	Altitude
Dwarf Cassowary	Casuarius	bennetti	F	A
Bush-hen	Amaurornis	olovaceus	I/G	N,C
Spotted Catbird	Alluroedus	melanotis	F/A	N,C
Buff-faced Pygmy-Parrot	Micropsitta	pusio	L	N,C
King BOP	Cicinnurus	regius	F/A	A
Cinnamon Ground Dove	Gallicolumba	rufigula	S	A
Zoe Imperial Pigeon	Ducula	zoeae	F	A
Sulphur-crested Cockatoo	Cacatua	galerita	S	A
Stout-billed Cuckoo-shrike	Coracina	caeruleogrisea	A/F	A
Black-bellied Cuckoo-shrike	Coracina	montana	A	A
Satin Flycatcher	Myiagra	cyanoleuca	I	A
New Guinea Bronzewing	Henicophaps	albifrons	S/F	A
Papuan Hanging Parrot	Loriculus	aurantiifrons	N/I	A
Black Fantail	Rhipidura	threnothorax	I	H,N
Rufous-Bell Kookabura	Dacelo	tyro	A/V	H,N
Black-shouldered Cuckoo-shrike	Coracina	monio	A	A
Grey-headed Cuckoo-shrike	Coracina	schisticeps	F	A

DIET CODES S=seeds,F=fruit,A=arthropods,I=insects,N=nectar,V=vertebrates, L=lichens,G=generalist. Altitude: A=all; H,N=500-1000 N,C=1000-1500

Table 3.
Hewa TEK for Birds Found in Old Secondary Forest

Common name	Genus	Species	Diet	Altitude
Blue-breasted Pitta	Pitta	erythrogaster macklotii	I/A	A
Noisy Pitta	Pitta	versicolor	I/A	A
Common Koel	Eudynamys	scolopacea	I/G	A
Pheasant Koel	Centropus	phasianinus	G	A
Scrub Wren	Sericornis	virgatus	I	A
New Guinea Harpy's Eagle	Harpyopsis	novaeguineae	V	A
Sclater's Whistlers	Pachycephala	soror	I	A
Yellow-bellied Sunbird	Nectarina	jugularis	N/A	A
New Guinea White Eye	Zosterops	Novaeguinneae	G	A
Black-fronted White-eye	Zosterops	artifrons	G	A
Western Mountain White-eye	Zosterops	fuscicapillus	G	A
Yellow-legged Flycatcher	Microeca	griseoceps	I	A
Olive Flycatcher	Microeca	flavovirescens	I	A
Wompoo Fruit Dove	Ptilinopus	magnificus	F	A
Magnificent BOP	Cicinnurus	magnificus	F/A	A
Black Berrypecker	Melanocharis	nigra	F	A

DIET CODES S=seeds,F=fruit,A=arthropods,I=insects,N=nectar,V=vertebrates,
L=lichens,G=generalist. Altitude: A=all; H,N=500-1000 N,C=1000-1500

Table 3.
Hewa TEK for Birds Found in Old Secondary Forest

Common name	Genus	Species	Diet	Altitude
Spotted Berrypecker	Rhamphocharis	crassirostris	F	A
Superb Fruit-dove	Ptilinopus	superbus	F	A
Rusty Mouse Warbler	Crateroscelis	murina	I	A
Brown Cuckoo-Dove	Macropygia	amboinensis	F	A
Boyer's Cuckoo-shrike	Coracina	boyeri	A/F	A
Little Shrike Thrush	Colluricincla	megarhyncha	A	A
Slaty-chinned Longbill	Toxorhamphus	poliopterus	N/A	A
Beccari's Scrub-wren	Sericornis	becarii	I	A
Grey-green Scrub-wren	Sericornis	arfakianus	I	A

DIET CODES S=seeds,F=fruit,A=arthropods,I=Insects,N=nectar,V=vertebrates,
L=lichens,G=generalist. Altitude: A=all; H,N=500-1000 N,C=1000-1500

TABLE 4

Plant Census

Plot 1 (51 species recorded)
Approximate fallow age = 18 yr/1978
Altitude = 700-750 meters
Dominant tree species
= Macaranga aleuritiodes (Po)
= Trema orientalis (Limi)
= Ficus nodosa (Wapol)
= Adesia sp.** (Wapeli)

Plot 2 (48 species recorded)
Approximate fallow age = 23 yr/1973
Altitude = 690-735 meters
Dominant tree species
= Geusiapetranda (Telime Labu)
= Trema orientalis (Limi)
= Ficus nodosa (Wapol)
= Adesia sp.** (Wapeli)

Plot 3 (46 species recorded)
Approximate fallow age = 22 yr/1974
Altitude = 1185-1215 meters
Dominant tree species
= Commersonia bartrama (Yaitu)
= Piper sp. (Waisa)
= Castanopsis acuminatissima (Saki)
= Adesia sp.** (Wapeli)

** TEK holds that Gallicolumba jobiensis, Aepypodius arfkianus and Talegalla jobiensis are the primary avian predators of the designated species. None are predicted to frequent secondary growth.

TABLE 4

Plant Census

Plot 4 (44 species recorded)
Approximate fallow age = 20 yr/1976
Altitude = 1110-1210 meters
Dominant tree species
= Homalanthus nervosa (Pile)
= Ficus wasa (Autun)
= Ficus sp. (Mapol)
= Adesia sp.** (Wapeli)

Plot 5 (57 species recorded)
Approximate fallow age = 23 yr/1973
Altitude = 5845-950 meters
Dominant tree species
= Macaranga aleuritiodes (Po)
= Pometia pinnata (Wuak)
= Ficus hispidioides (Paghal Toa)
= Garcinia sp. (Nieli)

Plot 6 (47 species recorded)
Approximate fallow age = 23 yr/1973
Altitude = 950-1000 meters
Dominant tree species
= Macaranga aleuritiodes (Po)
= Ficus hispidioides (Paghal Toa)
= Pangium edule (Kuk)
= Garcinia petranda (Telime)

** TEK holds that Gallicolumba jobiensis, Aepypodius arfkianus and Talegalla jobiensis are the primary avian predators of the designated species. None are predicted to frequent secondary growth.

TABLE 5
TRANSECT COUNTS

Common name	700-800m	800-900m	900-1000m	1000-1100m	1100-1200m	1200m
Bush-hen	0/0	1/0	0/1	0/0	0/0	0/0
Spotted Catbird	0/0	0/0	0/2	0/0	5/10	0/0
Buff-faced Pygmy-Parrot	0/3	0/5	2/6	1/6	4/6	0/0
Sooty Owls	0/0	0/0	0/0	0/0	0/0	0/0
White-faced Robin	0/0	0/2	2/2	1/2	7/3	1/3
King BOP	4/55	34/32	27/24	10/19	14/16	4/3
Rusty Whistler	4/1	9/8	14/9	16/16	8/13	8/5
Purple Tailed Imperial Pigeon	0/0	0/0	0/1	0/2	6/2	7/6
Cinnamon Ground Dove	0/0	2/1	1/3	5/2	5/6	0/6
Zoe Imperial Pigeon	57/75	55/59	46/50	41/48	48/40	18/14
Yellow-bellied Gerygone	3/4	10/5	6/3	2/3	5/2	3/0
Sulphur-crested Cockatoo	17/30	18/24	32/42	33/29	35/20	19/11
Stout-billed Cuckoo-shrike	6/22	17/27	11/15	10/14	14/18	6/7
Black-bellied Cuckoo-shrike	6/22	17/27	11/15	10/14	14/18	6/7
Oriental Cuckoo	0/1	0/1	4/3	3/1	5/8	2/2
Pygmy Honeyeater	3/0	8/1	1/3	4/1	0/0	3/0
Satin Flycatcher	29/27	33/26	14/29	20/27	22/20	5/4
New Guinea Bronzewing	5/0	0/0	0/0	0/0	0/0	0/0
Black Kite	0/0	0/0	0/0	0/0	0/1	0/2
White-bibbed Ground-Dove	0/0	0/0	0/0	0/0	0/6	0/0
Papuan Hanging Parrot	1/2	3/2	3/4	3/2	3/3	2/0
Black Fantail	6/9	16/8	6/4	8/17	7/8	4/1

TABLE 5
TRANSECT COUNTS

Common name	700-800m	800-900m	900-1000m	1000-1100m	1100-1200m	1200m
Spotted Babbler	2/0	1/1	3/3	5/5	5/11	0/5
Brown Collared Brush Turkey	1/1	12/3	24/23	28/29	26/20	15/15
Greater Black Coucal	3/0	2/1	0/0	0/0	0/1	0/0
Trumpet Manucode	4/4	9/5	10/15	16/28	19/35	4/15
Black Cuchoo-shrike	22/33	32/30	29/26	25/28	31/29	9/10
Butcher Bird	39/45	6/2	7/0	1/1	0/1	1/1
Chinese Goshawk	0/0	0/0	0/0	0/0	0/0	0/0
Wattled Brush-turkey	0/0	0/0	0/0	0/0	0/0	0/0
Torrent Flycatcher	0/0	0/0	0/0	0/0	0/1	2/4
Double-eyed Fig-Parrot	24/36	19/17	15/15	13/14	21/21	6/6
Pink-spotted Fruit-Dove	2/0	5/1	1/0	1/0	2/2	1/0
Red-cheeked Parrot	0/0	0/0	0/0	0/3	0/0	0/3
Blue Jewel-Babbler	2/0	1/1	3/3	5/5	5/11	0/5
Little Red Lorikeet	5/9	14/4	10/6	2/4	6/10	0/0
White-breasted Fruit-Dove	0/0	2/0	1/0	1/5	16/9	28/39
Rufous-Bell Kookabura	1/0	0/0	0/0	0/0	0/0	0/0
Mountain Kingfisher	6/8	4/9	7/22	8/14	2/2	1/2
Eclectus Parrot	6/12	4/14	12/14	12/20	5/15	6/6
Black-shouldered Cuckoo-shrike	6/22	17/27	11/15	10/14	14/18	5/7
Grey-headed Cuckoo-shrike	6/22	17/27	11/15	10/14	14/18	5/7
Black Butcherbird	17/29	22/28	22/19	14/22	11/15	3/5
Blue-breasted Pitta	10/11	12/23	20/38	17/29	21/28	7/9

TABLE 5
TRANSECT COUNTS

Common name	700-800m	800-900m	900-1000m	1000-1100m	1100-1200m	1200m
Dwarf Fruit-Dove	5/0	4/2	10/6	8/2	8/6	5/2
Noisy Pitta	1/3	2/3	1/0	1/0	0/0	2/0
Common Koel	1/2	1/1	1/7	4/7	4/15	3/4
Papuan Flowerpecker	6/2	11/4	8/5	14/3	13/7	5/4
Pheasant Koel	2/0	3/5	1/8	1/4	6/2	2/1
Scrub Wren	3/0	2/2	3/5	3/0	2/2	0/1
Shovel-billed Kingfisher	0/0	0/1	0/0	1/0	0/0	0/0
Chestnut-bellied fantail	2/7	3/6	9/15	18/14	11/11	6/5
Rufous-backed Fantail	2/7	3/6	9/15	18/14	11/11	6/5
Flame Bowerbird	0/0	0/0	0/0	0/0	0/0	0/0
Mountain Peltops	0/3	1/4	0/3	0/29	0/8	0/3
Hornbill	1/5	2/3	2/4	3/2	4/3	0/0
Gurney's eagle	0/0	0/0	0/0	2/0	0/0	0/2
New Guinea Harpy's Eagle	1/0	0/0	0/0	0/0	0/0	0/0
Sclater's Whistlers	7/7	6/5	7/8	9/4	23/10	14/18
Little Paradise Kingfisher	0/2	3/4	3/3	5/6	5/16	3/3
Common Paradise Kingfisher	0/2	3/4	3/3	5/6	5/16	3/3
Ragglanna BOP	59/70	37/45	48/48	38/47	34/48	20/26
Great Cuckoo-Dove	0/0	0/1	2/3	2/1	2/0	0/2
Yellow-bellied Sunbird	7/18	8/9	13/8	8/11	11/4	4/6
WAPINTOA**	0/0	0/1	1/1	1/2	3/6	1/3
Common Scrub fowl	0/0	0/0	0/0	0/0	0/0	0/0

TABLE 5
TRANSECT COUNTS

Common name	700-800m	800-900m	900-1000m	1000-1100m	1100-1200m	1200m
Wattled ploughbill	0/0	0/0	0/0	0/0	0/0	0/0
Emperor Fairy- wren	8/9	9/0	4/0	1/1	4/1	2/2
Rainbow Lorikeet	27/7	15/12	27/3	17/9	8/9	4/1
Willie Wagtail	1/0	0/0	0/0	0/0	0/0	0/0
Blue-collared Parrot	0/0	0/0	0/0	0/3	0/0	0/3
Marbled Frogmouth	0/0	0/0	0/0	0/0	0/0	0/0
Rufous Owls	0/0	0/0	0/0	0/0	0/0	0/0
New Guinea White Eye	4/0	13/6	11/3	14/14	10/11	12/14
Black-fronted White-eye	4/0	13/6	11/3	14/14	10/11	12/14
Western Mountain White-eye	4/0	13/6	11/3	14/14	10/11	12/14
Tawny Breasted Honeyeater	48/31	32/19	29/27	30/24	22/19	8/6
Northern Scrub Robin	0/0	0/0	0/0	0/0	0/0	0/0
Chestnut-breasted Cuckoo	1/26	3/23	4/10	4/12	4/15	14/12
Ornate Fruit-Dove	2/0	5/1	1/0	1/0	2/2	1/0
Yellow-legged Flycatcher	6/9	5/16	10/10	5/8	6/9	3/3
Olive Flycatcher	6/9	5/16	10/10	5/8	6/9	3/3
Green-backed Gerygone	1/0	8/4	2/1	1/0	4/3	1/1
Dwarf Honeyeater	3/0	8/1	1/3	4/1	0/0	3/0
Red Myzomela	0/0	/0	0/0	0/0	0/10	1/5
Wompoo Fruit Dove	19/35	26/20	30/38	28/33	27/28	12/13
Magnificent BOP	5/10	15/16	20/28	14/23	11/17	2/6
Moustached Tree-swift	0/0	0/0	0/0	0/0	4/1	0/0

TABLE 5
TRANSECT COUNTS

Common name	700-800m	800-900m	900-1000m	1000-1100m	1100-1200m	1200m
Golden backed Whistler	0/0	0/2	0/0	0/2	0/4	2/1
Vulturine Parrot	0/0	0/0	9/3	5/5	16/4	6/14
Black Berrypecker	29/27	20/23	24/28	16/15	20/21	6/9
Spotted Berrypecker	9/9	9/7	5/7	8/7	3/6	0/0
Broad-billed Fairy-wren	8/9	9/0	4/0	1/1	4/1	2/2
Common Smoky Honeyeater	0/0	0/0	1/1	5/1	5/1	2/1
Ornate Melectides	0/0	0/0	1/1	5/1	5/1	2/1
Red-throated Myzomela	0/0	0/0	0/0	0/0	0/10	1/5
Mountain Red-headed Myzomela	0/0	0/0	0/0	0/0	0/10	1/6
Papuan Black Myzomela	0/0	0/0	0/0	0/0	0/10	1/5
Black-browed Triller	13/8	6/3	17/4	10/18	18/12	20/16
Channel-billed Cuckoo	19/3	9/7	0/2	0/1	0/1	0/0
Forbes' Forest Rail	0/9	0/0	1/1	1/1	0/0	2/0
Yellow-browed Melectides	0/0	0/0	0/0	0/0	0/0	0/0
Short-tailed Paradigalla	0/0	0/0	0/0	0/0	0/1	0/0
Rusty Pitohui	22/41	20/26	10/12	7/6	9/3	3/1
Superb Fruit-dove	29/41	42/42	25/32	23/36	30/35	7/14
Dwarf Kingfisher	3/5	10/5	6/2	3/0	4/1	3/0
Azur Kingfisher	3/5	10/5	5/2	3/0	4/1	3/0
Grey Goshawk	0/0	0/0	2/1	0/0	1/2	0/0
Black-mantled Goshawk	0/0	0/0	2/1	0/0	1/2	0/0
New Guinea Flightless Rail	0/0	1/0	0/1	0/0	0/0	0/0

TABLE 5
TRANSECT COUNTS

Common name	700-800m	800-900m	900-1000m	1000-1100m	1100-1200m	1200m
Northern Fantail	19/15	8/3	10/7	9/5	15/4	12/2
Golden Monarch	3/3	4/2	1/1	2/4	5/8	0/1
Scrub White-eared Meliphaga	39/29	26/13	19/22	21/14	17/17	9/4
Black Headed Whistler	7/9	7/12	10/12	4/11	6/11	3/1
King of Saxony BOP	0/0	0/0	0/0	0/0	0/0	0/0
Rusty Mouse Warbler	12/35	15/37	23/35	15/32	21/25	9/16
Black-Billed Cuckoo-Dove	0/0	0/0	0/0	0/0	0/1	0/0
Brown Cuckoo-Dove	26/25	26/25	30/35	24/28	25/25	12/15
Whistling Kite	0/0	0/0	0/0	0/0	0/1	0/2
Long-billed Honeyeater	10/3	5/4	6/2	3/3	13/2	4/3
Papuan Mt Pigeon	0/0	0/0	0/0	0/0	0/0	0/0
Beautiful Fruit-Dove	54/53	39/47	45/44	40/38	40/40	13/18
Crinkle-collared Manucode	4/4	9/5	10/15	16/28	19/35	4/15
Spangled Drongo	41/52	27/31	13/15	7/2	2/1	1/0
White-shouldered Fairy-wren	0/0	4/0	2/0	0/0	0/0	0/0
Crested Pithoui	0/0	0/9	6/13	5/22	13/24	3/16
Mountain Owlet-nightjar	0/0	0/0	0/0	0/0	0/0	0/0
Forest Kingfisher	5/8	4/9	7/22	8/14	2/2	1/2
Sacred Kingfisher	5/8	4/9	7/22	8/14	2/2	1/2
Boyer's Cuckoo-shrike	6/22	17/27	11/15	10/14	14/18	5/7
Little Shrike Thrush	21/11	26/22	33/25	35/36	38/30	13/12
Slaty-chinned Longbill	7/18	8/9	13/8	8/11	11/4	4/5

TABLE 5
TRANSECT COUNTS

Common name	700-800m	800-900m	900-1000m	1000-1100m	1100-1200m	1200m
Dwarf Cassowary	0/0	0/0	1/0	2/1	2/1	2/0
Brush Cuckoo	1/26	3/23	4/10	4/12	4/15	14/12
Dusky Lorikeet	27/7	16/12	27/3	17/9	8/9	4/1
Dwarf Whistler	0/0	0/0	0/0	0/0	0/0	0/0
Long-tailed Buzzard	1/0	0/1	0/0	0/0	3/2	2/1
Belford's Melectides	0/0	0/0	0/0	0/0	0/0	0/0
Palm Cockatoo	0/13	7/8	6/6	2/5	2/1	2/2
Hooded Pithoui	11/15	34/22	35/28	29/21	31/41	17/25
Papuan King-Parrot	2/3	5/3	3/0	3/0	10/7	7/5
Dollarbird	3/1	0/2	4/6	2/2	4/2	2/2
Pheasant Pidgeon	0/0	0/0	0/0	0/0	1/7	0/4
Red-necked Rail	0/9	0/0	1/1	1/1	0/0	2/0
Grass Owls	0/0	0/0	0/0	0/0	0/0	0/0
White-eared Bronze Cuckoo	0/0	0/0	0/0	0/0	0/6	0/6
Brown Oriole	41/48	36/35	28/27	18/25	27/29	13/17
Macgregor's Bower Bird	22/41	20/26	10/12	7/6	9/3	3/1
Black-winged Monarch	11/21	14/11	24/14	17/16	20/18	15/10
Blue-tailed Bee-eater	1/0	3/0	0/0	0/0	0/0	0/0
Island Leaf-Warbler	0/0	0/0	0/0	0/0	0/1	0/0
Fairy Gerygone	1/0	8/4	2/1	1/0	4/3	1/1
Brahminy Kite	1/0	1/0	0/0	1/0	0/0	0/0
Long-tailed Nightjar	0/0	0/0	0/0	0/0	0/0	0/0

TABLE 5
TRANSECT COUNTS

Common name	700-800m	800-900m	900-1000m	1000-1100m	1100-1200m	1200m
Beccari's Scrub-wren	3/0	2/2	3/5	3/0	2/2	0/1
Grey-green Scrub-wren	3/0	2/2	3/5	3/0	2/2	0/1

TABLE 6

ALTITUDE VARIATION BETWEEN TEK and FIELD GUIDES

Genus	Species	Common Name	Hewa Name	Altitude TEK	Altitude Known
Talegalla	jobiensis	Brown-collared Bush-Turkey	Nok Tenia	800-1500m	Sea level - 1800m
Megapodious	frecinet	Common Scrubfowl	Nok Wem	800-1500m	Sea level - 500m; highest =2100m
Aquila	gurneyi	Gurney's Eagle	Nok Toluai	800-1500m	Sea level - 1000m; rarely to 1800m
Otidiphaps	nobilis	Pheasant Pigeon	Nok Kawa	800-1500m	Sea level – 1900m
Gallicolumba	jobiensis	White-bibbed Ground-Dove	Nok Pialu	800-1500m	Sea level – 1600m; rarely to 2400m
Macropygia	nigrirostris	Black-billed Cuckoo-Dove	Nok Paite Afiaiman	800-1500m	Sea level – 2600m
Ptilinopus	rivoli	White-breasted Fruit-Dove	Nok Tsai	800-1500m	200-3400m
Ducula	rufigaster	Purple-tailed Imperial Pigeon	Nok Muf	800-1500m	Sea level – 600m; rarely to1200m
Gymnophaps	albertisii	Papuan Mountain Pigeon	Nok Taitobepba	800-1500m	Sea level to the timberline
Psittrichas	fulgidus	Vulturine Parrot	Nok Awia	800-1500m	Foothills to 1000m; rarely to 2000m

CHAPTER 6

LAND TENURE AND CONSERVATION

If the Hewa can limit the area disturbed by gardening, they can continue to promote the biological diversity currently found on their land. Since they do not employ the more intensive mound gardening system of their highland neighbors, the Hewa must cut multiple gardens and move around their territory to find fertile ground. In order to garden and homestead, each of the Hewa must establish his or her right to use the land. With no written language or judicial system to enforce contracts, the Hewa rely on the traditional rules of land tenure to obtain land use rights.

Traditional land tenure in the South Pacific has been described as an aspect of indigenous life that helps to conserve local resources (Falanruw 1984:351; Kwapena 1982:192). Throughout this region, arable land, fishing grounds and forests are the property of individuals that share a common ancestor (Baines 1990:32). Traditional systems of land tenure restrict access to kinsmen and give them a legitimate stake in the management of their resources. These traditions are part of a system of land use that has allowed many Pacific islanders to sustainably use their land for centuries. Therefore, traditional land tenure is thought to be integral to sustainable land use and has led some analysts to describe traditional land owners as a "special form of conservation NGO" (Baines 1990:32).

Land tenure arrangements in other societies have been described as mechanisms that were developed to minimize risk by apportioning and sharing resources (Gould 1982:73; Richardson 1982:99). Research also indicates that the rules governing land tenure are a vehicle by which a society can regulate land use and protect its resource base (Feeney 1990; McCabe 1990). However, while the flexibility permitted individuals under traditional land tenure is now well known, the relationship between land tenure and conservation is not clear. Analysts have offered few details concerning the specific mechanics of individual land tenure systems that permit this flexibility. The ultimate goal of including indigenous societies in the conservation of their lands is to more effectively conserve these lands under the circumstances found in today's world. It is therefore vital that conservationists obtain a detailed understanding of the land tenure systems associated with the area targeted for conservation.

The traditional rules of Hewa land tenure are based on kinship. The Hewa learn to identify kin and their potential avenues to land so early in life that this knowledge seems innate. It is often difficult for them to communicate the depth of their knowledge to an outsider unaccustomed to the necessity of identifying as many kin as possible. This chapter examines both the relationship between kinship and Hewa land tenure and the potential for this land tenure .

Land Tenure in New Guinea

In Papua New Guinea, customary patterns of land tenure are formally recognized by the state. The Constitution of PNG, "vests local people with ownership of these resources, irrespective of any documentation or registration" (Swartzendruber 1993:4). As much as 97 percent of the land is held by the traditional landowners (Eaton 1982:223; Swartzendruber 1993:4). Since both traditional patterns of ownership and modern law make the sale of land in PNG very difficult, conservationists believe that these institutions will enable traditional landowners to protect their lands and continue to apply sustainable resource techniques (Swartzendruber 1993:5).

However the details of land tenure in New Guinea are not well understood. According to the Conservation Needs Assessment report, "even well intentioned investors have sometimes been confused as to whom they should be negotiating with" (Swartzendruber 1993:5). While land is not the property of any individual, the particulars of each system seem to vary with each of the over one thousand cultures found in PNG. Confusion over landowners' mineral rights has been blamed for the continuing violence in Bougainville (Swartzendruber 1993:5). In spite of such reports, conservationists are optimistic that traditional land rights will be a key component of sustainable land use strategies for PNG (Swartzendruber 1993:5).

Much of the confusion stems from anthropology's interest in recording informant's ideas (as expressed through language) about the principles ordering their society's structure. Thirty years of exploring the ideologies of New Guinea's cultures have not led to a general model of land tenure. However, it is important to recognize that the necessity of taking cultural differences into account varies with the type of question one is asking (Hughes 1988:8). In the case of land tenure, conservationists want to understand the mechanics of a system that permits some individuals the flexibility to use land in different parts of their territory, while restricting access to others. Therefore it may be appropriate for analysts of land tenure to look beyond cultural differences and examine the cross-cultural themes in New Guinea ethnographies that help individuals to organize and restrict land use.

In tribal societies like those found in New Guinea, a system of individual ties to land could be established in a variety of ways. However, this network is usually based on kinship (Hughes 1988:84; Lawrence 1984:46; Bohannon 1968:xi). Historically, anthropologists have seen kinship, at its core, as grounded in biology (Fox 1967:1). Because of the biological "facts of life," kinship is universal and independent of folk-cultural theory (Hughes 1988:84; Bohannon 1968:xi). Since it is naturally bilateral, we expect individuals to identify both paternal and maternal relatives (Radcliffe-Brown 1971:91). When studying land tenure systems based on kinship, it is therefore just as valid to pursue a line of inquiry into how cultures organize themselves around the universals of human birth as it is to pursue a purely cultural explanation.

Ethnographic data for New Guinea suggests that residential groups are not unilineal descent groups (Brown 1978; De Lepervanche 1967:138). Rules for residence and recruitment are consistently described as flexible, based on individual choice, and bilateral (La Fontaine 1973:37). The reality of group composition in New Guinea seems to be that while members espouse a patri-ideological basis for their recruitment, they also consistently recruit maternal kinsmen (Brown 1978:184).

Residential groups are inclusive, consisting of codescendants and their spouses. For example, some of the men surveyed by Strathern exercised their rights to paternal kin's land through ties as a sister's son (Strathern 1972:85). O'Hanlon states that 28 percent of Waghi males claimed land rights due to their relationship as Zs or Zss (O'Hanlon 1989:34). These men are obviously codescendants, related to the common ancestor through a female ancestor.

Hughes suggests that residential patterns and other forms of cooperation emerge because of significant biological connections between the individuals involved (Hughes 1988:86). However, actual residence patterns include interaction with affines (in-marrying spouses) who do not share this common ancestry (Hughes 1988:73). In this case, the significant biological link connecting affines with their co-resident non-kin is their actual or potential offspring (Hughes 1988:78). Since a residential group in New Guinea often organizes its members to cut and fence gardens, all residents benefit from these labors, especially the children who are not yet old enough to take care of themselves. While their children live, affines have a greater common interest in the well-being of their children than they do in residing with distant kinsmen (Hughes 1988:77). Therefore, the residential pattern is a product of common descent, marriage and relatedness to the offspring of each community (Hughes 1988:83).

For example Garia society is a composite of individual groups of kinsmen Lawrence calls "security circles" (Lawrence 1984). The Garia trace membership through both the mother and father's line (Lawrence 1984:43). The size of an individual's security circle (i.e. kindred) is limited only by his ability to identify more distant kin (Lawrence 1984:40). The security circle is not a local group, since it can include all of one's relatives (Lawrence 1984:40). Lawrence writes that they use descent names as a "program for their kinship computer," and use descent names to trace relationships after (more precise) genealogy runs out (Lawrence 1984:46). The identification of distant kinsmen is said by the Garia to be essential to claim land rights outside of their patri-line (Lawrence 1984:123). While both Langness and Brown have argued that the model developed for the Garia had implications for the analysis of social structure throughout New Guinea, an extensive application of the Garia model has not been attempted (Langness 1972:926, Brown 1978:182).

The Hewa

Kinship and descent among the Hewa are also rooted in biology. The Hewa use kinship terms and patrilineally transmitted clan names to identify codescendants – both maternal and paternal. They live and cooperate with both their mother's and father's kin; i.e., the Hewa fit the bilateral model of kinship. Closer kin are identified by using a kinship terminology described as "Iroquois" (Steadman 1980:299). In the Hewa system not only do terms such as father (*aita*) and mother (*ma*) refer to an individual's parents, but are extended to other kin. For example, father also refers to one's father's brother and is extended to the patrilaterally related males of the father's generation. Since women marry young and often survive their first husband, they can have a series of marriages. In the face of this reality, the Hewa also extend the term for father to later spouses of one's mother. Likewise, just as the Hewa extend the term for mother to mother's sister and all matri-laterally related females of mother's generation. It too is extended to the other wives of one's father. However, the extension of a kinship term does not override the rules of kinship. The Hewa use the term "tala" (true) to differentiate between true fathers and metaphorical ones.

Young men who have lost their true father and whose mother has remarried, will often wait until they are teenagers to leave their mother and her new husband and go to live with their codescendants. These young men know that they will derive their political support as adults from their own kin. If their stepfather is not kin, merely extending a kin term as a courtesy will not elicit the his support or the support of his kinsmen. The metaphorical extension of kin terms will not give these young men access to land when the they become an adult.

Territories carry the name of a clan. Usually, a stream or river marks the boundary between the neighboring territories. An individual has the right to use land in any territory if he or she can trace their ancestry to this land through either sex. This right to land use is recognized by all adults. No single person is recognized as the owner of any territory. Instead, all kinsmen are co-owners of their land. In addition, traditional marriage rules prohibit the marriage of any couple that can trace a kinship connection between them. With no common codescendants, the couple and their offspring have access to more lands of various clan affiliations than would be possible if the Hewa married closer kin. However the genealogical knowledge of any Hewa is limited by their memory. Informants are seldom capable of tracing descent beyond the partilinealy transmitted descent names of their father, father's mother, mother and mother's mother.

The Hewa also associate and live with their in-laws. As Hughes indicates, both the kin and the in-marrying spouse have a common interest in the children of the marriage. While the interest in fellow kinsmen lasts a lifetime, it is common to see an in-law move to live with his or her kin after the death of their spouse. Often a mother and her children will move to live with her family following the death of her husband. However, it is not uncommon for this same woman's sons to relocate to live with their father's kin as the boys become young men.

When I began my field work and gathered genealogies, I was unable to critically evaluate the published work on kinship and social structure in New

Guinea. I was especially influenced by the emphasis on patrilineality that has complicated much of the research on kinship and social structure in New Guinea. Indeed, many of my informants used patrilineal descent names when referring to their clan affiliations. However, the Hewa are also members of descent groups traced through their mothers. They live and associate with their paternal and maternal kinsmen. An individual's relationship to these sometimes distant kin is traced through the use of ancestral names. These names identify kinsmen not only through a line of father's fathers, but also the ancestral name of their father's mother, mother's father and mother's mother.

While I was gathering genealogies, this fact initially escaped me. Informants often seemed puzzled when I asked for their "line" or clan affiliation, as if they recognized an affiliation with only one patrilineally identified clan. Early in this process, I had gathered the genealogies for the members of one household, then traveled to another household one day's walk away. The second household interview generated genealogies with identical names to the first household, but with different clan names. Since I was struck by this coincidence, I asked my informants and they explained that the individuals described in each case were identical. The discrepancy in clan affiliations was due to the politeness of my informants. Each informant had emphasized his relationship to the relatives he was currently visiting. If he were related through the father's side, he emphasized the patrilineal name. When related through he mother's side, he emphasized a patrilineal name of his mother. Of course, my informants are equally related to their paternal and maternal kin. My notion of relatedness through males had colored the interviews.

This incident taught me to be explicit about asking for the names of as many clans/descent groups that an individual can identify. Although many informants cannot identify the exact linkage between their families, clan names identify their codescendants. All that is necessary to identify distant kin is the sharing of a patrilineal name. In this way, each individual is at the center of an ever widening group of kinsmen -- to the extent that he or she has a good enough memory to remember the clan names of their ancestors. The ability to recognize many kin allows the Hewa to identify potential allies in fights, contributors to a bride-price and, most importantly, land for gardening and hunting.

The rules of land tenure follow the rules of kinship. A complete accounting of the movements of individual adult males in this study between 1988 and 1996 can be found in Appendix 2. As shown by the data in Table 7, a significant number of men have gained access to land using their maternal and spousal connections. A Hewa family must, on average, cut, plant and harvest four gardens per year in order to feed themselves. Land tenure based on kinship allows the men in my survey the flexibility to obtain sufficient garden land to feed their families. It also allows them to move to safer ground in times of conflict.

Appendix 2 charts the residence of 205 adult males from 1988 to 1996. It shows that individuals make use of both paternal and maternal kin ties to obtain access to land. In addition, many use their wives' connections. In 1988, 120 of 205 males surveyed (59%) used paternal connections to clan lands. By 1996, although the percentage of males using paternal kin ties to obtain land had increased to 63 percent, 75 of the surveyed individuals were using non-paternal kin ties to establish their residence.

A good example of the flexibility and access available through kinship is the first household I lived with in 1988. The house was located on a clan territory designated as Wanakipa Indiap. The household consisted of my chief informant, his uncle (mother's brother), brother in-law, as well as their wives and children. Wanakipa Indiap is my informant's mother's clan land and he was exercising his right to live on this land using maternal kin connections.

By 1996, this household had fissioned. My informant has built a new house in this territory, living with his newly married brother. His brother in-law now lives on his own paternal clan ground. His uncle has separately built a new house on Wanakipa Indiap ground. In this instance, one household has used maternal kinship connections, one used paternal connections and the brother in-law first used his wife's maternal kinship connection and later used paternal connection to establish their homesteads.

Table 7 shows that it is not unusual to use one's spouse or maternal connections to establish a household. The Hewa freely acknowledge that their sisters have full rights to land and resources. In 1988, 62 of the 205 males surveyed (30 percent) used maternal connections to establish residences. In

1996, only 24 percent of these men were living on their maternal kin's land. Likewise in 1988, 11 percent of the men surveyed were living on their wife's land. This percentage increased to 12 percent in 1996.

Discussion

The simplest interpretation of traditional Hewa land tenure is that this system did not evolve as a conservation tool. It was designed to maximize access to land for all kinsmen. Throughout their lives, each and every Hewa learns to identify many codescendants. By understanding and using devices like ancestral names to identify codescendants, the Hewa are able to access the land and social support they need to survive. As the Table 7 shows, men have used both their kinship connections and those of their wives to gain access to land.

Ancestral names provide a convenient memory device allowing men and women to identify a larger number of codescendants than they could using kin terms alone (Steadman 1992). Since clan names are inherited at birth and immutable, there can be no transfer of affiliation to non-kin. Outsiders cannot change their names to obscure a non-Hewa identity. Although there are arguments over genealogies, I have not recorded an instance where one person successfully changed his clan name.

Although the Hewa land tenure system restricts access to land, conservation is a side effect of a system operating for a small scattered population living on relatively infertile ground. Unlike the fertile valleys of highland New Guinea, the Hewa territory is karst, i.e. limestone. It is an uplifted coral reef, covered with a thin veneer of soil, that straddles an active fault line. Even after burning the vegetation and returning some of the elements to the soil, the Hewa can only coax three months of production from this soil. Currently, traditional land tenure has the effect of spreading the Hewa throughout their territory to the empty spaces and fertile soils they require. Given the limits of Hewa technology, this system has effectively provided for their needs.

However, the entire system of land tenure relies on individual memories, voluntary adherence to tradition and the military strength of kinsmen in protecting their land from non-kin. While the threat of violence may deter Hewa theft of Hewa land, it is unlikely that potential violence over land rights is a very strong deterrent to the migration of larger populations from the surrounding highland valleys. It is more likely that the heat, rugged landscape and lack of arable land have combined to discourage an invasion from the surrounding highland societies. Finally because traditional land rights are guaranteed by the PNG constitution, the Hewa have not been subjected to the legislative appropriation of their lands.

In the future, the real threat to conservation will come from a growing population, which may lead to unsustainable gardening practices. The land tenure system's only criteria for access to land is kinship. There is no recognized authority that prohibits the use of land by kinsmen. Soil fertility is a matter of individual judgment, determined by analyzing the type of secondary growth found on the land. While the web of kinship makes it extremely difficult to buy and sell land, it does not limit the number of kinsmen who can ask for access to their lands. Although the interrelatedness of landowners might prevent a "tragedy of the commons" scenario from developing, there are yet no provisions to forestall the shortening of the fallow cycle by kinsmen.

Any population increase that occurs in the Hewa will initially be absorbed by individuals exploring the availability of land in the territory of their more distant kinsmen. Once the optimal land between 700 to 1000 meters has been converted into gardens, the Hewa will expand their efforts and garden at higher and less desirable altitudes. When this land has been converted, the Hewa will be forced to shorten their fallow period. At some point that neither the Hewa nor western science have determined, the scale of this disturbance will mean that the Hewa will cease to be a force for the biological diversification of their land. They will have begun to simplify their environment.

Eventually, unless an innovation is introduced that stabilizes the population and allows the Hewa to garden more intensively, population expansion will permanently alter this landscape. Although the Hewa are aware of the compost mounds used by their highland neighbors, heat and the lack of level ground most likely make this method of intensive gardening impossible. Similar population changes have produced anthropogenic grasslands throughout New Guinea and the tropics, grasslands that are much less diverse than either the primary or secondary forests that now dominate the Hewa landscape. Much of this environmental simplification was accomplished before the arrival of Europeans and under the traditional rules of land tenure.

TABLE 7
Maternal Land Tenure

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
1	Tamilap	Wisip	M	Wisip	M
6	Tamilap	Tsivien	M	Tsivien	M
10	Pawaiip	Tamilap	M	Tamilap	M
26	Wisip	Tamilap	M	Tamilap	M
28	Woni	Tsagiropi	FM	Wkp Abuaf	M
40	Yateiip/Yakasone	Unamip	M	Unamip	M
54	Waipa	Tuki	FM	Tuki	FM
57	Wone	Wone	M	Wone	M
58	Pawaiip	Wone	FMM	Wone	FMM
62	Puali Yain	Puali	M	Puali	M
63	Waipa Lalo	Puali	M	Puali	M
65	Tamilap	Tuki	M	Wisip	FM
68	Tsivien	Tuki	M	Tuki	M
69	Tsivien	Tuki	FM	Tuki	M
73	Tamilap	Tuki	FM	Tuki	FM

CODES: F = father; M=mother; B = brother; W = wife; Z = sister; C = church; J = jail; PM = Port Moresby; D = dead

TABLE 7
Maternal Land Tenure

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
74	Tamikap	Tuki	FM	Walpa	M
87	Tamikap	Puali Yain	M	Puali Yain	M
88	Tamikap	Puali Yain	M	Puali Yain	M
107	Khalaen	Kanaip	M	Kanaip	M
109	Ialí	Kanaip	MM	Puali	MF
110	Ialí	Kanaip	MM	Puali	MF
112	Tamikap	Kanaip	M	Kanaip	M
114	Walpa	Winaa	M	Winaa	M
115	Walpa Lalo	Winaa	M	Winaa	M
116	Walpa Lalo	Winaa	M	Winaa	M
124	Unamip/Isumanip	Kanaip	M	Kanaip	M
134	Isumanip	Lueni	M	Lueni	M
136	Tuki	Woni	M	Woni	M
157	Puali	Folini	M	dead	M

CODES: F = father; M=mother; B = brother; W = wife; Z = sister; C = church; J = jail; PM = Port Moresby; D = dead

TABLE 7
Maternal Land Tenure

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
158	Puali	Folini	M	Folini	M
161	Walpa	Folini	M	Folini	M
171	Tetenam	Wk Abuaf	M	Wk Abuaf	M
178	Pawalip	Wkp Abuaf	M	Wkp Abuaf	M
179	Unamip	Wkp Abuaf	M	Tuki	M
182	Yatelip	Tetenam	M	Tetenam	M
183	Yatelip	Tetenam	M	Tetenam	M
185	Folini	Tetenam	M	Tetenam	M
188	Wasip	Wk Indiap	FMM	Wk Indiap	FMM
191	Wanip	Wk Indiap	M	Wk Indiap	M
194	Wanip	Wk Indiap	M	Wk Indiap	M
196	Folini	Tetenam	M	Tetenam	M
197	Wisip	Wkpa Station	FMM	Wkp Station	FMM
201	Wasip	Utoni	M	Utoni	M

CODES: F = father; M=mother; B = brother; W = wife; Z = sister; C = church; J = jail; PM = Port Moresby; D = dead

CHAPTER 7

RELIGION and CONSERVATION

A recent exhibition at the American Museum of Natural History entitled, "Sacred Mountains of the World," outlined a connection between traditional religious practices and conservation. India's G.B Pant Institute for Himalayan Environment and Development has enlisted the help of a local priest and an ancient Hindu myth to rejuvenate the forests that once covered the Ganges valley (Bernbaum: 1998:84). The Institute has initiated a program of reforestation that draws upon the ancient Hindu myth in which a sage petitions the goddess of the Ganges River to come down from heaven. According to religious texts, the goddess Shiva's hair manifests itself as the trees of the Himalayas and the monsoon rains symbolize her descent to earth. The goddess protects earth in two ways. Shiva's locks (the trees) break the fall of the monsoon rains. In addition, their roots hold the soil in place. If the Himalayan forests are cut down, the Ganges will fall from the heavens as monsoon rains, destroying the earth with floods. "Plant these seedlings for Lord Shiva," the chief priest recently told pilgrims. "You will restore her hair and protect the Land" (Bernbaum 1998:84).

This is precisely the sort of connection that many anthropologists have insisted exists between traditional religion and the environment. Nature and man are integrated, not separated as they have become in modern societies. Religion acts as the mediator between man and environment. By honoring the traditional gods, the people of the Ganges valley protected their land. This tradition allowed for the sustainable use of the river valley for countless generations. Traditional religious practices acted to mitigate man's activities, enabling indigenous societies to live in harmony with their surroundings. In the aforementioned example, the people of the Ganges valley protected their lands through their traditional belief system. Although the intrusion of western materialism and the realities of modern India subverted these traditional practices, the legends are still part of the local culture. Conservationists are hoping to find similar religious practices that promote sustainable lifestyles and can be plugged into modern conservation programs.

This chapter examines two aspects of the traditional Hewa religion, taboos and sacred places, as potential tools in the conservation of biological diversity. After discussing the current research on the relationship between ideology and the conservation of resources, I will examine the potential of Hewa taboos and sacred places to contribute to the conservation of biodiversity within this ecosystem.

Ideology and Conservation

Traditional religious ideology has been described as an indispensable element in indigenous land stewardship. Like the aforementioned example, traditional religions are imbued with natural imagery, often making little distinction between humans and the nature that surrounds them. For example, many New

Guinea societies speak of a kinship between people and their animal ancestors (Bulmer 1982:65). Native religions are said to be full of practices and proscriptions that "guarantee that indigenous man does not plunder the environment" (Maybury-Lewis 1992:55). According to this school of thought, traditional religions help man to "walk in balance" with nature (Bird 1994:24).

This "ecology of the mind" is thought to be so fundamental to indigenous life that it is now being touted as another potential tool for conservation. Statements like, "in our every deliberation, we must consider the impact of our decisions on the next generation," have been interpreted as sustainable-use philosophies (Bird 1994:26). The respect expressed for nature by indigenous man has led most observers to conclude that religion has helped indigenous man balance his needs with those of the other creatures that surround him.

The movement to involve indigenous societies in conservation has prompted a reevaluation of the place of ideology in conservation. Conservationists are placing their faith in the efficacy of practices that have been labeled, but not tested, as conservationist (Lynch 1996). Although traditional societies express a reverence for the environment, such reverence does not necessarily translate into actions that we would classify as aimed at conservation (Hames 1991,1987,1983). For example, it has been proposed that the ancestors of modern day indigenous societies developed an ideology that promotes conservation as a response to their past experiences with overhunting (Martin & Mossiman 1975). However, there is no generally accepted way of determining the correlation between an individual's ideology and his mental state other than through his actions (Hames 1991:175). Tuan, for example, points out that while Confucian ideology reveres nature, it did not stop the Chinese from deforesting large parts of China (Tuan 1968:177). In fact, western man has a very poor record of understanding the thought processes of indigenous man.

Consider the difficulty in extracting a conservation lesson from the Kaiko ritual cycle of the Tesembaga Maring (Rappaport 1967). Rappaport's analysis may be the most famous study of the role of a ritual in a society's apparent attempt at maintaining equilibrium with their environment. Briefly, the Kaiko is a year-long festival that culminates the ritual cycle and is initiated by uprooting a tree – the rumbim – that had been planted at the conclusion of the last fight (Rappaport 1967:153). When planting a rumbim, a man asks for protection of the ancestors and vows to direct his efforts to gardening until a local pig herd has grown sufficiently to be used as payment to allies in the next fight (Rappaport 1967:148). Rappaport, however, sees fighting among the Maring as merely the proximate cause of the initiation of the Kaiko festival (Rappaport 1967:110). The ritual is ultimately initiated by a need to produce an equilibrium between people, pigs, and gardens (Rappaport 1967:3). The killing of pigs for the Kaiko ritual protects people from the possible parasitism and competition from their pigs (Rappaport 1967:3; 1971:21). Indirectly, this protects the environment by helping to maintain extensive areas in virgin forest and assuring adequate cultivation/fallow ratios in the secondary forest (Rappaport 1967:3; 1971:21).

Rappaport's explanation of this ritual has been criticized on several fronts. McArthur criticized his insistence on the importance of the protein furnished to the Tesembaga by the slaughter of pigs (McArthur 1974). Lowman-Vayda has argued that large pig herds are necessary to maintain alliances both in peace and war (Lowman-Vayda 1971). Why, asks Watson, would the Maring increase their pig herds beyond equilibrium in the first place (Watson 1969:529)? However, amidst all of this criticism, it is interesting that none of Rappaport's critics seem to question the premise most important to conservationists: Do the Maring use religious practices to limit human activity and maintain the biological diversity of their environment?

Taboos

Prohibitions against fighting, as in the Kaiko, or against cutting, hunting or harvesting are known as "taboos." Taboos are said to be another expression of ideology that have been touted as one of the mechanisms that helps to maintain the equilibrium between man and his environment (Ross 1978; McDonald 1977; Harris 1974). While prohibitions on hunting or eating certain species have obvious implications for conservation, more obscure taboos have also been connected to indigenous man's ability to live in harmony with nature. Marvin Harris has devoted an entire volume to demystifying these "riddles of culture," by arguing that they enable traditional societies to achieve equilibrium via population control (Harris 1974).

Anthropologists have not universally accepted that the function of taboos is to maintain a balance between traditional societies and their environment. For example, Mary Douglas has argued that taboos function to maintain a given culture by reducing the dissonance and contradiction brought on by the introduction of new experiences that threaten the culture's existing classification and interpretation of events (Douglas 1968:338-39). Radcliffe-Brown argues that taboos "regulate, maintain and transmit from one generation to another sentiments on which the constitution of the society depends" (Radcliffe-Brown 1952:157). However, many anthropologists do subscribe to an ecological explanation of taboos. In many circles, this ecological explanation has evolved from hypothesis to accepted fact (Hames 1991). In turn, this evolution has spurred interest in understanding the workings of taboos and their applicability to conservation.

In spite of scholarly attention, taboos are not proving to be easy templates for conservation. When the focus shifts from ideology to behavior, traditional societies often do not live up to their reputation as conservationists (Knight 1965; Bulmer 1985; Dwyer 1982; Stearman and Redford 1992; Redford 1991). In addition to historical and archaeological evidence implicating pre-industrial societies in a reduction of biodiversity, studies of modern societies are less than conclusive concerning the ability of modern pre-industrial societies to live in harmony with their environment. For example, research has demonstrated that individuals are willing to cheat by violating taboos (Nelson 1982; Hunn 1982).

Much of the research concerning the function of taboos has been conducted among present-day Amazonian societies. Thus far, research concerning the compatibility of traditional taboos with conservation has not been encouraging. For example, if hunting taboos are truly geared toward the maintenance of equilibrium, they should be responsive to the supply of game available to hunters (Hames 1991:186). Yet, Hames's research indicates that only one society, the Cashinahua of the Peruvian rainforsts, have been reported to change the status of game animals from forbidden to edible, according to the supply of the game (Kensinger 1981, in Hames 1991). In this case, the Cashinahua seem to be expanding their diet in response to scarcity. In order to allow game populations to recover, one might expect the Casinahua to use taboos to prohibit the killing of declining game species. Once these populations recover to a level that can support a renewal of Cashinahua hunting, the taboos could be removed or switched to another declining population.

A ten-year study of another South American society, the Siona-Secoya of Equador, led Vickers to conclude that Siona-Secoya movements are dictated by soil fertility, not game depletion (Vickers 1988:1522). He recorded a drastic decline in woolly monkeys, curassows and trumpeters (*Psophia crepitans*) surrounding their village (Vickers 1988:1522). Vickers makes no mention of the Siona-Secoya altering their hunting taboos in response to this decline.

Vickers' work with another Amazonian group, the Scuna, indicates that they use only one-fifth of their territory at any time, moving when subsistence activities can be enhanced by relocation (Vickers 1983:417). Again, the Scuna seem to be motivated by their individual survival needs and not the well-being of their environment. They respond to the cost/benefit ratio of subsistence, moving when energy expended to make a living is greater than the caloric returns from hunting and gardening (Vickers 1983:417). It is not yet known whether the Scuna pursuit of maximizing this ratio is the optimal strategy for conserving biodiversity. However, according to Vickers' study, conservation does not seem to be their motivation.

In a similar fashion, Baksh finds that Peru's Machiguenga base their settlement size and movements on the total resource base of the environment (Baksh 1985:146). As the settlement ages, the resources available in the area decline, and residents must increase their workload in order to maintain their lifestyle (Baksh 1985:146). Increasing one's subsistence effort may mean traveling further to hunt or switching from fish hooks to poison when fishing (Baksh 1985:167). After three years the environment around a Machiguenga settlement was so depleted of game that they spent very little time hunting (Baksh 1985:167). Yet the Machiguenga did not alter their game taboos to prohibit the taking of depleted game or relocate in response to this scarcity.

Finally, Hames has found that Amazonian societies have a tendency to increase the time they allocate to hunting as game is depleted -- exactly the opposite of what would be expected of conservationists (Hames 1987,1991). Rather than passing through areas that have been over-hunted, the Ye'Kwana and the

Yanamamo take game as they encounter it (Hames 1987:103). According to Hames, "it appears that native Amazonians regard protein as sufficiently valuable to intensify their efforts for it in the face of the depletion of game" (Hames 1987:103). In other words, these societies are not using taboos to limit their impact on the game in their territories.

Hewa Taboos and Game Management

A list of the Hewa taboos that I have collected is presented in Table 8. Several things should be noted. First, although I have added some taboos to Steadman's earlier research, the taboos recited by my informants have not changed substantially (Steadman 1971:95-96). Secondly, Steadman notes that one man had prohibited his wives from eating a variety of pandanas and another had prohibited his family from eating breadfruit (Steadman 1971:96). I did not encounter a similar prohibition during my field work.

Before taboos should be labeled as conservation strategies, Hames has suggested that taboos be evaluated in the light of the expectations of modern conservation. If taboos are to be considered as "bag limits," the taboos should be density dependent, i.e., they should change with fluctuations in the populations of prey species (Hames 1991:184).

Although the taboos recorded during Steadman's initial fieldwork are virtually identical to those recorded during my research, there is evidence that the Hewa have eliminated some birds and mammals from their normal range. Interviews with Hewa informants indicate that the cassowary, phalanger, and wallaby have been eliminated from the land on the southern bank of the Laigaip River at elevations below 800 meters. My informants do not expect to find anything below this elevation but the occasional wild pig raiding new or old garden sites. In addition, traditional knowledge indicates and transect counts confirm that species such as the Papuan mountain pigeon, white-bibbed ground dove, pheasant pigeon, black-billed cuckoo-dove, vulturine parrot and the purple-tailed imperial pigeon are relatively rare. In fact, they are not found in the lower (500-800m) elevations of my study area. However, these species can be seen at sea level in other locations (Beehler 1982). While these birds are only killed occasionally, their rarity at the lower extent of their range has not prompted the Hewa to place any limits on their consumption.

If taboos were in place to act as limits on the killing of rare species, then hunting of the above mentioned birds and mammals should be forbidden. However, the Hewa do not prohibit the taking of any birds. During his research, Steadman also recorded a taboo on the consumption of white eggs by men and brown eggs by women (Steadman 1971). I did not record this taboo. This omission may be an error on my part or it may represent a change brought about by the introduction of chickens. Observance of the colored eggs taboo is now no longer a matter of missing the occasional treat, but forfeiting a fairly common source of nutrition.

Most of the food taboos are directed toward women and their consumption of food. These same foods are permitted to men. Explanations of taboos that restrict the diets of women might range from the sociobiological to the psychological "need" to control women. However, controlling the diet of women is not necessarily a conservation measure, especially when there are so few restrictions on the diets of men. Most importantly for conservation, none of the Hewa taboos totally eliminate the killing and consumption of game.

If the taboos in Table 8 are not acting as a brake on exploitation of game, is there any evidence that Hewa hunters are concerned with the conservation of rare species? Conservation-minded hunters should spend more time hunting in areas where game is found in the greatest densities (Hames 1991:183). However, if hunters are primarily concerned with efficiency, they should attempt to shoot game as it is encountered (Hames 1991:183). The Hewa are opportunistic, hunting any of the species they encounter at any altitude. Since the environment below 1000 meters has not been totally changed, some stands of primary forest remain and most hunters walk through a transformed landscape on their way to their preferred hunting sites. Consequently, birds and animals like the wild pigs that can feed in sucessional growth and new garden plots, are encountered at all altitudes. Yet, my informants indicate that they prefer to hunt at higher elevations. In my estimation, this is a matter of efficiency, not an attempt at conservation because higher elevations are richer in game. The willingness of

Hewa hunters to travel to higher altitudes reflects the composition of species found there and not a willingness to conserve these species at lower elevations.

As I have already indicated, Hewa gardening activities occur primarily below 1000 meters (see Chapter 2). This alters the floral composition of the lower elevations and effectively eliminates many species. Although my ethnobotanical data are incomplete, I recorded 75 plants whose fruits are eaten by the cassowary and 30 that are consumed by pigs. Of these, only 21 plants are consumed by both the pig and the cassowary. While pigs thrive in the abandoned garden plots, cassowaries are found only in the oldest secondary forest and primary growth (see Table 3). Since the pig was introduced by humans in prehistory, one possible inference from this data is that the primary forest is not an optimal habitat for pigs. As the Hewa alter this landscape for their use, they are creating an environment that may favor pigs to the exclusion of the cassowary.

In order to encourage greater species diversity, the Hewa would have to let their prime gardening land return to primary forest. While allowing the primary forest to regenerate would help to maintain the level of biodiversity currently found here, such a step would not be in the best economic interest of the Hewa. Their traditional method of gardening allows the Hewa to wrest a living from a forest that is otherwise inhospitable to a hunter-gatherer lifestyle.

Finally, discussions of the effectiveness of taboos as a conservation tool usually center on hunting and the harvesting of plants. Such discussions overlook a taboo that is probably more important for conservation, the post-partum taboo. Traditionally, Hewa males observe a taboo on sexual intercourse with their wives while they were nursing their children. This practice delays sexual intercourse for as long as two years.

The practical impact of post-partum taboos is to limit the number of children a woman could bear. Fewer children means fewer adults and eventually translates into less gardening and hunting. Since the biodiversity enhancing properties of the disturbance created by traditional activities, such as gardening, are directly related to the scale of these activities, limiting population growth will be an essential component of any conservation program. Although the post-partum taboo (along with disease, diet and violence) is an essential element in limiting the population growth of the traditional Hewa families, it is often one of the first traditions to be lost when they embrace Christianity.

Sacred Places

Finally, sacred places such as groves of trees, mountains or lakes have the potential for acting as the native equivalent of a park. The African Biodiversity Support Program alludes to marine conservation in West Africa and territorial protection Ghana, as well as areas of central and southern Africa that have been traditionally protected "sacred" places (Almquist 1994:64-66). Similarly, New Guineans often prohibit hunting on certain tracts of land within their territories (Peni 1982:140; Pokanas 1982:169).

However, in terms of biodiversity conservation, the size of an area to be protected is directly proportional to the effectiveness of this area in the conservation of the species found within it. This fact has been driven home through the many experiments testing Preston's species/area hypothesis. In fact, the Biodiversity Support Program has acknowledged that many of the sacred plots found in traditional African systems would be far too small to act as "substantial reservoirs of biodiversity" (Almquist 1994:64). In order to conserve any given species, it is necessary to preserve enough of its habitat to include the minimum viable population of the species. Therefore, before one can determine the size of the area to be preserved, it is necessary to know both the minimum viable population of the species and natural population densities (Terborgh 1992:200).

Determining the minimum viable population necessary for the preservation of any species is complicated. Each species has a different requirement in regards to the minimum habitat necessary to sustain a population large enough to maintain genetic diversity. In addition, all species experience population fluctuations. Some will fluctuate to levels so low that they are inherently less viable than more stable species (Terborgh 1992:201). Species with widely fluctuating populations may be impossible to conserve on limited habitat. Finally, and perhaps most importantly, the extent to which any particular species will fluctuate is generally unknown to researchers (Terborgh 1992:201).

According to Terborgh, each of the animals inhabiting the Amazonian forest differ by a factor of six in the amount of space that has been calculated to be necessary to support a single reproductive unit (Terborgh 1992:201). As he points out, the minimum reproductive unit for ants is in the tens of thousands, while monkeys are counted in troops and song birds in breeding pairs (Terborgh 1992:202). In order to support a population of 300 jaguars, it would be necessary to set aside 7500 square kilometers in a reserve. As a result, few parks or sacred places would be large enough for viable populations of jaguars (Terborgh 1992:202).

The whole issue of sacred places and biodiversity conservation is complicated by the interconnectedness of the creatures in any environment. Although rarity has been the best predictor of extinction, both rare and plentiful creatures play vital roles in shaping their environments (Terborgh 1992:201). As the TEK of the Hewa and survey data indicate, there is a direct correlation between the biological diversity found in primary and secondary forests and the assemblages of birds that will frequent the habitats. The Hewa are, in effect, predicting the local extinction of 40 percent of the birds, if primary forest habitat is removed.

Likewise, studies of fragmented tropical forests in general indicate that there is a direct correlation between habitat size and the type of birds found there. The larger the habitat, the greater the number of species it could support (Terborgh 1992:201). Large intact areas contain more species with specialized diets. Smaller areas tend to be dominated by common generalist species (Bierragaard 1986; Terborgh & Weske 1969). As the data in Tables 2, 3 and 6 indicate, the species that are missing from fragmented habitats tend to be the agents of seed dispersal.

Sacred Places and Dreams with the Hewa

In Hewa tradition, the concept of sacred places is intertwined with their ideas concerning the spirits that are said to occupy their land. There are no sites that are considered to be sacred by all Hewa and no areas of the forest that are off-limits to hunting or gardening. Instead, each person has sites that are sacred to him personally. These sites are scattered throughout the forest and considered sacred because they are said to be inhabited by an individual's ancestral spirits. However, even these personal sites are not fixed and often change with the manifestation of the ancestors in an individual's dreams. These sites are only sacred to the extent that each is spoken of with respect for the ancestors they represent.

According to my informants, the spirits of their dead ancestors speak to the living through their dreams. The most prominent spirit mentioned by the Hewa as a dream visitor is their father, followed by other dead relatives. The ancestors, known as "Yaunam", usually appear as themselves. However, they are sometimes described as taking on non-human forms. Often they will appear to the living as birds - especially hawks. Ancestors also take the shape of ordinary items of everyday life. Informants mention seeing their ancestors appear as the tobacco plant, one of three varieties of vines (all classified as *Calamus hullrungii* *beccari* by western botanists), any of a number of species of trees of the *Apocynaceae* and *Guttiferae* or canes known locally as Wopiai (used for pig arrows and knives), Mal (also used for knives) and Hohale (used in securing a home's roof thatch). Regardless of their manifestation, when the ancestors appear in your dreams, you ask them to help you.

In order to encourage the ancestral spirits to visit during one's dreams, one might plant wild taro, bamboo or tobacco as an offering. If the ancestors accept, they will appear during a dream and will instruct the dreamer on where to go and what to do. This is one way in which ancestors can help their descendants, by offering advice and warning against violating any of the taboos. In addition, ancestral spirits can give advice on where to find game or warn of an encounter with a wild pig. The spirits will also offer advice on where to plant in your garden and which crops will do best in it.

If a Hewa has been successful in his hunting or gardening, he will thank the ancestors. One way of expressing gratitude is to "sing out" across the valley, announcing the success of your dream quest and thereby publicly thanking your ancestors. Another way of thanking the ancestral spirits is to offer a sacrifice at the many places that the spirits are said to occupy in the forest. Often, these are pools of water. The Hewa claim that the spirits live there and are pleased when offered bits of pig fat or tobacco. By building a fire, throwing a scrap of pig fat into it and chanting, "Yaunam, now I am going to give grease to you," one can please the spirits and watch as the pool rises. According to my informants, people who give thanks to the spirits, are more likely to receive help if they need it in the future.

My informants were unanimous in their assertion that if one obeyed the taboos, the spirits will help you. All said that even if their ancestors' advice did not lead to a successful hunt on the first attempt, they would try again using the strategy prescribed by the spirits. However, when I asked them if they had ever failed completely when using a strategy prescribed by the spirits of their dreams, each admitted that he indeed had. Their standard reply was that someone in their families, most probably their wives, had angered their dead ancestors by breaking a taboo. The ancestors are then consulted and appeased in order to gain their assistance in hunting and gardening. Rather than a sense of awe or timidity, I was struck by the calculating nature of my informants. Whether making a small offering or obeying taboo, they seem to be most interested in securing the spirits help, not in appeasing them. They do not seem to fear retribution and are willing to use bribery to obtain the spirits help in achieving their ends.

Discussion

It will not be easy to overlay the Hewa concept of sacred places or taboos with a modern conservation plan. None of the avian seed dispersal agents is taboo. There are no traditional authorities (no chiefs or police) to enforce the sanctity of taboos. Many informants have freely acknowledged their own past breaking of taboos. Sacred places vary with each individual. The designation of a place as sacred is an individual matter for the Hewa and no place is off-limits to all of the Hewa. While an individual may consider a grove of bamboo sacred to their ancestral spirits, he or she will not attempt to stop a kinsmen from hunting in the same area or turning the area into a garden. At any rate the pools of water and groves of trees identified are rather small. Since there is a direct correlation between the size of an area and the number of species it can sustain, these sacred spaces would be too small to sustain the minimum breeding population of all but the tiniest of species.

Those experienced with development projects are aware of the disastrous results of what project coordinators considered minor tinkering with tradition. Rather than tinker, many now hope that conservation can be fostered by continuing traditions that have been linked, at least theoretically, to managing the environment. These aspects of traditional religion are vital to traditional Hewa life and somehow linked to a landscape that is now a conservation priority. However, given the complexity of ecosystems, it is unlikely that traditional restrictions represented rules for managing this environment.

Perhaps more importantly, both taboos and sacred places continue a tradition of accepting restrictions on one's actions and reverence for ancestors and may present the greatest opportunity for conservationists. So long as both are valued, the Hewa sense of tradition can be appealed to. Their traditions include a freedom to hunt and gather in the forests, plenty of land for establishing a homestead and plenty of birds for adornment. Those Hewa that have visited

Lake Kopiago or Mount Hagen recognize that these valleys are impoverished in terms of birds and game when compared to their homelands. They also understand that the competition for land in these more populated highland valleys requires their neighbors to expend much more time and energy to grow what the Hewa consider to be inferior crops.

While it is difficult to get people of any culture to extrapolate from their actions to the extinction of a species, it does not seem to be difficult to gain popular acceptance with appeals based on feelings of cultural superiority. Appeals to the "good old days" or traditional values have a universal appeal in any culture, especially during times of social upheaval. Since any development scheme that is implemented in the Hewa territory will surely tear at the social fabric of this rather isolated society, perhaps a non-scientific, emotional appeal to tradition will be the most effective way for the Hewa to implement the restrictions necessary to conserve this landscape.

TABLE 8

Hewa Taboos

FORBIDDEN FOODS

For Males and often you boys	For Females
	1 variety of banana (kan): > taali > suk
	1 variety of sugar cane: > aliaa pa
	tobacco (apai)
	two birds: > nuk falaflai > nuk uiliap said to be sexually stimulating
white snakes: > yup homan - poisonous	
black banded snakes > yup yokampia - poisonous	
black snake: > found above 1200 m. > yup yawlapo - poisonous	
wild dog	wild dog

TABLE 8

Hewa Taboos

TEMPORARY RESTRICTIONS FOR BOTH MEN AND WOMEN

1. After eating wild pig:

    a) must not eat Saccharum edule (itsau) for four days

    b) must not eat mushrooms (mikai) for four days

    c) must not work on net bags for five days (applies to females)

    d) must not have sexual intercourse for six days (penalty: pig will leave the area)

2. After a new garden has been planted rats must not be eaten.

TABOOS ON CUTTING TREES

No one is permitted to cut the following trees:

1. Bamboo (me wipai)

2. Podocapaceae Podocarpus sp. (me Auseli)

3. Apocynaceae Alstonia scholaris (meTalu)

4. Bamboo (me Patail)

5. me Awuset (unidentified)

TABLE 8

Hewa Taboos

TEMPORARY RESTRICTIONS FOR MEN

1. After killing a person:

   a) cannot eat pandanus for three days

   b) cannot eat two types of bananas (taali and page) for four days

   c) cannot enter a garden for one month (penalty: pig will ruin garden)

   d) must wash himself every day for five to six days

2. After eating monitor lizard or its eggs: must not enter a garden for five days (penalty: wild pig will ruin garden)

3. After eating bush turkey: must not enter a garden for seven days

4. After eating pandanus con. (ogal mapu): must not enter a garden for one day

5. After a death of a kinsman: must not work in a garden for one to two weeks

CHAPTER 8

SUMMARY AND CONCLUSION

Can the traditional lifestyle of the Hewa provide a blueprint for the conservation of these lands that will be viable in the twenty-first century? I have attempted to answer this question by recording the traditional knowledge of the Hewa concerning the effect of their activities on birds, the primary agents of seed dispersal in PNG's forests. Although the Hewa do not use the language of ecologists, their knowledge of bird behavior is extensive and complements the current research on New Guinea's forests. Here briefly is a summary of my findings concerning the compatibility of traditional Hewa gardening, land tenure and religious practices with conservation.

Gardening and Conservation

Hewa gardening is a source of disturbance in this landscape. When gardens are cut by a small human population that continually moves across the landscape with limited technology, the product is a landscape with tremendous biological diversity. This human generated landscape contains more organisms (greater alpha diversity) and more habitats (gamma diversity) than an unaltered landscape. In this sense, the Hewa are inextricably linked to the biological diversity found in their homeland.

However, a comparison of the biodiversity found within each of the succession regimes created by gardening (beta diversity), shows that each stage of forest regeneration is less diverse than the primary forest. Gardening creates a successional environment that is not used by most of the fruit and nectar eating birds this forest depends on for regeneration. According to the Hewa, removal of the primary forest from a garden site will permanently make this ground uninhabitable to 56 species of birds. Gardening on a large scale could eliminate roughly 33 percent of the species recorded here (Table 2). Shortening the fallow period for gardens to less than twenty years is predicted to remove another 42 species (Table 3).

Therefore, traditional gardening techniques that now help to promote diversity can quickly become agents for environmental degradation, if the conditions under which these techniques evolved change. In fact, gardening as traditionally practiced by the Hewa (i.e., plots are allowed to lie fallow but continually re-cut) has already threatened a few of the birds found at lower elevations (see Table 6). Since these species are subjected to limited pressure from hunters, it may be that their habitat requirements are incompatible with even the limited gardening of the Hewa.

Land Tenure and Conservation

In order for traditional rules of land tenure to be an effective conservation tool, local people must be able to employ these rules to control access to their land. The Hewa limit access to their land to kin and their spouses. Descent names provide a system of identification of both maternal and paternal relatives and allow the Hewa to identify their more distant kinship connections in order to access land.

However, the conservation of biodiversity is not the aim of the Hewa land tenure system. Since each Hewa household must on average cut and harvest four gardens per year to feed itself, it is vital that individuals have access to fertile land. While the traditional system of land tenure prohibits non-kin from using clan lands, it allows unlimited access to kin. By allowing both males and females to use both maternal and paternal kinship to claim land, their traditional land tenure system gives the Hewa the needed flexibility to develop productive gardens.

The current biodiversity can be attributed to a low population density as much as the land tenure restrictions. At present, the level of gardening disturbance enhances the diversity of this landscape. However, any increase in population has the potential to cover the arable land with gardens, as kin exploit increasing distant kinship connections to obtain fertile land. When the primary forest is exhausted, this growing populace will be forced to garden more intensively by shortening the fallow period for gardens to less than twenty years. Biological diversity will become of a victim of a land tenure system designed to maximize access to land for kinsmen, as it accommodates an increasing population.

Religion and Conservation

Although the Hewa express a reverence for the ancestral spirits that inhabit their environment, my research does not indicate that traditional Hewa religious activities are part of a blueprint for conservation. In order to determine the potential of the Hewa religion as a conservation tool, I examined two aspects of traditional religion, taboos and sacred places, that have been proposed as mechanisms used by indigenous societies to manage their resources.

Some conservationists have proposed that sacred places might serve as reservoirs of biodiversity. In order to do so, these areas must be large enough to contain a viable population of the species to be conserved. Since the designation of an area as sacred remains an individual matter to the Hewa and all of the areas I recorded were no larger than a pool of water or a grove of bamboo, these areas are too small to be effective reservoirs for all but the smallest species. None of the sacred places I was shown would support a viable population of birds.

It has also been proposed that taboos are management tools employed by indigenous societies to help to prevent the over-exploitation of game. The Hewa do not prohibit the taking of any species of bird. My informants indicated that in addition to the birds in Table 6, the wallaby, phalanger and cassowary have also been eliminated on the southern side of the Laigaip River at elevations below 800 meters. No taboos have been instituted to prohibit the hunting of these species and there has been no effort to limit the number of gardens cut at these cies and there has been no effort to limit the number of gardens cut at these lower elevations. As TEK indicates, habitat alteration is the greatest potential threat to biodiversity. There are no taboos on gardening in an area that has experienced a decline in diversity.

However, traditional Hewa religion holds two possibilities for conservation. The first is the traditional post-partum taboo. This prohibition on sex effectively spaces the birth of children and limits the number of number of offspring a couple could produce in their lifetime. Fewer children translates into fewer gardens and thereby limits the scale of disturbance to the primary forest. If this practice can be maintained, it will help to slow the growth of the population as western medicines are introduced. The second possibility for conservation lies in the reverence for ancestors found in traditional religion. This might serve as the basis for an emotional appeal aimed at preserving traditional Hewa life in the face of change by preserving the primary forest.

Recommendations for Conservation

At present, we have an inadequate understanding of both the ecosystems to be conserved and the relationship of indigenous lifestyles to the biological diversity to confidently entrust indigenous societies with the conservation of the planet's remaining wild lands. Yet the dynamic nature of ecosystems, while it resists reductionist management, may actually provide a niche for indigenous people in the modern world. As the data from my Hewa informants indicate, tradientist to uncover. TEK can open to analysis the complex web of interactions that comprise the tropical forest and it can do so quickly and cheaply, when compared to the pace and cost of normal field research.

Any successful conservation program will have to limit the environmental disturbance caused by Hewa gardening. Conservation will therefore entail limiting population growth and most likely preclude income from petroleum, mining or timber companies. In order to get the Hewa to agree to such limits, conservation must offer them something tangible for their sacrifice. Therefore I would offer the following recommendations as a means of enlisting Hewa support in conserving their lands.

In nearly every conversation I have had concerning conservation-based development, the Hewa have expressed a desire to establish a medical aid post and a school. Therefore my first recommendation is that a secular medical aid post be established at Wanakipa. The present aid post operated by the Lutheran mission is chronically short of supplies and there are persistent accusations of discrimination in the dispersal of medicine by the orderlies. I am usually better equipped than the aid post for medical emergencies.

A properly supplied and staffed medical post would be a resource for family planning. Even the limited contact with medicine and the abandonment of the post-partum taboo by Christian converts have increased family size. Men and women are aware of the increased workload that accompanies large families. Any mention of birth control measures available to families in the United States when speaking to a Hewa male brings a return visit with their wives in tow to discuss preventing pregnancies. This leads me to believe that men and women are not at odds over the need for family planning and that developing a sustainable population policy will be possible for the Hewa.

My second recommendation is that an "English" school be established at Wanakipa. The Southern Highland Provincial government has sponsored at least two failed tok pisin schools at Wanakipa. Both of the teachers assigned to the school left and were not replaced. Even by PNG standards, Wanakipa is remote. The teachers are not Hewa and have no desire to live in a hot malarial wilderness with nothing to do. Rather than perpetuate this cycle, several promising youths should be identified and educated to become teachers. During their years in school, it may be possible to establish a Peace Corps couple as teachers.

It is very important that the school teach the students to become literate in English. The Hewa learn tok pisin on an informal basis and further instruction is of limited value beyond conversation. However, literacy in English would make possible a number of small-scale economic initiatives based on traditional knowledge that would be compatible will biodiversity conservation.

For example, the Hewa should become familiar with the Insect Farming and Trading Agency of PNG (IFTA). IFTA sells butterflies and insects to collectors around the world and pays individuals throughout PNG to collect insects and their eggs for resale. This seems to be a sustainable income producing activity that places a monetary value on both TEK and an intact forest.

Secondly, I would institute a Hewa naturalists program in conjunction with the University of Papua New Guinea and an outside institution such as a university or museum. These naturalists would be jointly certified by the Hewa and partner institutions to participate in research partnerships and teach a traditional naturalist program at the new Wanakipa school. These positions would preserve the value of TEK and provide some income for participants. Combined with technology such as palm-top computers and satellite phones, the naturalists could participate in research with colleagues from outside of PNG. In addition the naturalist program may offer some small eco-tourism opportunities if a Hewa stop-over can be integrated into the PNG tourist circuit. Although there are no facilities at Wanakipa, the birding is spectacular and with air access to the highlands, it may be possible to integrate the Hewa into travel programs.

Although the 1993 Conservation Needs Assessment described this area as a priority, neither the PNG government nor an NGO has made any attempt to conserve the area. In all likelihood, the funding for the above projects will have to come from an NGO working in concert with the Lutheran and Catholic missions. The missions are the only consistent investors of time and money in the Hewa. My conversations with the visiting doctor lead me to believe that he is aware of the dangers of over-population and would support family planning initiatives. The power of the churches to make or break any initiative is in my estimation considerable and they should be involved in conservation planning.

Finally, and most importantly, it is imperative that the conservation program be initiated immediately, while these small investments will have an impact. There is no movement in PNG to ban missionaries or create wilderness preserves. If we act now, while TEK is vibrant and there is very little money in the local economy, there is a good chance that one of PNG's greatest conservation priorities can be saved. Although this area is remote, I have witnessed the effect of ten years of missionaries, money and outside influences seeping into the Hewa. More homemade shotguns are appearing, couples are raising larger families and more children have the distended bellies of the undernourished. In another ten years, the conservation of the Hewa territory will be even more important to PNG's growing population. However, there is no guarantee that TEK or the Hewa willingness to continue their lifestyle will survive the assault of modern New Guinea.

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APPENDIX 1

TRADITIONAL HEWA KNOWLEDGE OF BIRDS THEIR DIETS AND HABITATS

Appendix 1:TEK of Hewa Birds

Genus	Species	Common name	Hewa name	Altitude	Habitat	Diet
Casuarius	bennetti	Dwarf Cassowary	Tellam	A	LGtf,B	F
Cacomantis	variolosus	Brush Cuckoo	Awenam	A	Ng,Lg,B	I
Pseudeos	fuscata	Dusky Lorikeet	We	A	Lg,B	N
Pachycare	flavogrisea	Dwarf Whistler	Atupupe	N,C	B	I
Henicopernis	longicauda	Long-tailed Buzzard	Fautai	A	B	V
Collocalia	esculenta	Swift	Alabili	A	Lg,B	I
Melidectes	belfordi	Belford's Melectides	Kun	C	B	N/A
Probosciger	aterrimus	Palm Cockatoo	Ime	A	B	S
Pitohui	dicrous	Hooded Pithoui	Isinam	A	Lg,B	A/F
Alisterus	chloropterus	Papuan King-Parrot	Ke,Laikai	N,C	B	S
Eurystomus	orientalis	Dollarbird	Kalapanau	A	Lg,B	I/V
Otidiphaps	nobis	Pheasant Pidgeon	Kawa	N,C	B	S/F
Rallina	tricolor	Red-necked Rail	Kokoma	A	K,Lg,B	I/G
			Kulakula	C	B	
Tyto	capensis	Grass Owls	Nilawi	A	B	V
Chrysococcyx	meyerii	White-eared Bronze Cuckoo	Iitali	N,C	B	I
Egretta	novaehollandiae	White-faced Heron	Abi	A	W	V
Oriolus	szalayi	Brown Oriole	Krifau	A	K,Lg,B	F/I
Amblyornis	macgregoriae	Macgregor's Bower Bird	Labinam	C	B	F/I
Monarcha	frater	Black-winged Monarch	Lekio	A	B	A/I
Merops	philippinus	Blue-tailed Bee-eater	Pelapela	H,N	Ng,Lg,B	I
Phylloscopus	trivirgatus	Island Leaf-Warbler	Ponaitetela	N,C	Lg,B	I

CODES: S=seeds, F=fruit, A=arthropods,I=insects, N=nectar,V=vertebrates, L=lichens, G=generalist.Altitude: A=all;H,N=500-1000m;N,C=1000+: Habitat B=primary forest;Lg=old garden;K=kunai;W=water; t=very old;f=few

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Genus	Species	Common name	Hewa name	Altitude	Habitat	Diet
Gerygone	palpebrosa	Fairy Gerygone	Philopatu	A	K,Lg	I
Haliastur	indus	Brahminy Kite	Plalimatal	A	Ng,W	A/V
Caprimulgus	macrurus	Long-tailed Nightjar	Luakanalu	H,N	Ng,K	I
Amauromis	olovaceus	Bush-hen	Meanalu Hot	N,C	Lgt,B	I/G
Alluroedus	melanotis	Spotted Catbird	Meanalu Cold	N,C	Lgt,B	F/A
Micropsitta	puslo	Buff-faced Pygmy-Parrot	Masitu	N,C	Lgt, B	L
Tyto	tenebricosa	Sooty Owls	Nilawi	A	B	V
Tregellasia	leucops	White-faced Robin	Meanatal	A	B	I
Cicinnurus	regius	King BOP	Nanam	A	Lgt,B	F/A
Pachycephala	hyperythra	Rusty Whistler	Noloplopnam	A	Lg,B	I
Ducula	rufigaster	Purple Tailed Imperial Pigeon	Muf	N,C	B	F
Gallicolumba	rufigula	Cinnamon Ground Dove	Meapulu	A	Lgtf,B	S
Ducula	zoeae	Zoe Imperial Pigeon	Neki	A	Lgtf,B	F
Gerygone	chrysogaster	Yellow-bellied Gerygone	Petapeten	A	Lg,B	I
Cacatua	galerita	Sulphur-crested Cockatoo	Numa	A	Lgt,B	S
Coracina	caeruleogrisea	Stout-billed Cuckoo-shrike	Yatini	A	Lgtf,B	A/F
Coracina	montana	Black-bellied Cuckoo-shrike	Yatini	A	Lgtf,B	A
Cuculus	saturatus	Oriental Cuckoo	Palepe	A	Lg,B	I
Oedistoma	pygmaeum	Pygmy Honeyeater	Peteta	A	K,Lg	N/I
Myiagra	cyanoleuca	Satin Flycatcher	Pakatu	A	Lgt,B	I
Henicophaps	albifrons	New Guinea Bronzewing	Sisifu/Nipalia	A	Lgt,B	S/F
Milvus	migrans	Black Kite	Simapanal	A	Ng,Lg,B	A/V

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Gallicolumba	jobiensis	White-bibbed Ground-Dove	Pialu	N,C	B	F
Loriculus	aurantiifrons	Papuan Hanging Parrot	Maunai	A	Lgt,B	N/I
Rhipidura	threnothorax	Black Fantail	Pusisa	H,N	Lgt,B	I
Ptilorrhoa	leucosticta	Spotted Babbler	Nisuau	A	B	A
Talegalla	jobiensis	Brown Collared Brush Turkey	Tenia	A	B	G
Centropus	menbeki	Greater Black Coucal	Tei	H	K,Lg,B	A/V
Manucodia	keraudrenii	Trumpet Manucode	Teti	A	Lg,B	F
Coracina	melaena	Black Cuchoo-shrike	Teta	A	K,Lg,B	A/F
Cracticus	cassicus	Butcher Bird	Tui	H,N	K,Lg,B	A/F
Accipter	soloensis	Chinese Goshawk	Tetiei	H,N	Ng,Lg,B	V
Aepypodius	arfakianus	Wattled Brush-turkey	To	N,C	B	G
Monachella	muellerianna	Torrent Flycatcher	Efaneni	A	W	I
Cyclopsitta	diophthalma	Double-eyed Fig-Parrot	Faghai	A	Lgf,B	F
Ptilinopus	perlatus	Pink-spotted Fruit-Dove	Fatula	A	B	F
Geoffroyus	geoffroyi	Red-cheeked Parrot	Kialkai	N,C	B	F/S
Anas	waigiuensis	Salvadori's Teal	Apumat	A	W	W
Dendrocygna	eytoni	Plumed Whistling duck	Apumat	A	W	W
Ptilorrhoa	caerulescens	Blue Jewel-Babbler	Nisuau	A	B	A
Charmosyna	josefinae	Josephine's Lorikeet	Orlau	N,C	B	N
Charmosyna	pulchella	Little Red Lorikeet	Orlau	A	B	N
Charmosyna	placentis	Red-flanked Lorikeet	Orlau	A	B	N
Charmosyna	wilhelminae	Pygmy Lorikeet	Orlau	C	B	N

CODES: S=seeds, F=fruit, A=arthropods,I=insects, N=nectar,V=vertebrates, L=lichens, G=generalist.Altitude: A=all;H,N=600-1000m;N,C=1000+; Habitat B=primary forest;Lg=old garden;K=kunai;W=water; t=very old;f=few

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Genus	Species	Common name	Hewa name	Altitude	Habitat	Diet
Ptilinopis	rivoli	White-breasted Fruit-Dove	Tsal	N,C	B	F
Dacelo	tyro	Rufous-Bell Kookabura	Yamyali Uwowla	H,N	Lgt,B	A/V
Halcyon	megarhyncha	Mountain Kingfisher	Yamyali	A	Lgf,B	A/V
Eclectus	roratus	Eclectus Parrot	Yalio	N,C	Ltgf,B	S/F
Coracina	morio	Black-shouldered Cuckoo-shrike	Yatini	A	Lgtf,B	A
Coracina	schisticeps	Grey-headed Cuckoo-shrike	Yatini	A	Lgtf,B	F
Cracticus	quoyi	Black Butcherbird	Puka	A	Lg,B	G
Pitta	erythrogaster macklotii	Blue-breasted Pitta	Wai	A	Lgtf,B	I/A
Aegotheles	insignis	Feline Owlet-nightjar	Yalipap	A	B	I
Ptilinopus	nanus	Dwarf Fruit-Dove	Wallap	A	B	F
Pitta	versicolor	Noisy Pitta	Waiwala	A	Lgtf,B	I/A
Eudynamys	scolopacea	Common Koel	Wanainam	A	Lgt,B	I/G
Dicaeum	pectorale	Papuan Flowerpecker	Wesanalu	A	Ng,Lg,B	F/A
Centropus	phasianinus	Pheasant Koel	Winlainam	A	Lgt,B	G
Sericornis	virgatus	Scrub Wren	Wisinep	A	Lgt,B	I
Lorius	lory	Western Black-Capped Lory	We	A	Lg,B	N
Clytoceyx	rex	Shovel-billed Kingfisher	Pabuka	A	B	A/V
Rhipidura	hyperthra	Chestnut-bellied fantail	Anapf	A	Ng,Lg,B	I
Rhipidura	rufidorsa	Rufous-backed Fantail	Anapf	A	Ng,Lg,B	I
Egretta	picata	Pied Heron	Abf	A	W	V
Sericulus	aureus	Flame Bowerbird	Sipap	C	B	F/A
Peltops	montanus	Mountain Peltops	Telian	A	Ng,Lg,B	I

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Genus	Species	Common name	Hewa name	Altitude	Habitat	Diet
Rhyticeros	plicatus	Hornbill	Tellme	A	B	F/G
Aquila	gurneyi	Gurney's eagle	Tolual	N,C	B	V
			Tietia	N,C	Ng,Lg,B	
Harpyopsis	novaeguineae	New Guinea Harpy's Eagle	Unkau	A	Lgt,B	V
Pachycephala	soror	Sclater's Whistlers	Uwalsia	A	Lgt,B	I
Tanysiptera	hydrocharis	Little Paradise Kingfisher	Yamyali Compata	N,C	B	A/V
Tanysiptera	galatea	Common Paradise Kingfisher	Yamyali Compata	N, C	B	A/V
Paradisaea	raggiana	Raggianna BOP	Yau	A	Lgf,B	F/A
Reinwardtoena	reinwardtii	Great Cuckoo-Dove	Yekowa	A	B	F
Nectarina	jugularis	Yellow-bellied Sunbird	Yaunam	A	Lgtf,B	N/A
		WAPINTOA**	Wapintoa	N,C	B	I
Megapodius	freycinet	Common Scrub fowl	Wem	N,C	B	G
Eulacestoma	nigropectus	Wattled ploughbill	Wipinam	N,C	B	I
Malurus	cyanocephalus	Emperor Fairy- wren	Isisapi	H,N	Ng,Lg,B	I
Trichoglossus	haematodus	Rainbow Lorikeet	We	A	Lg,B	N
Rhipidura	leucophrys	Willie Wagtail	Mopagalaio	A	K	I
Porzana	tabuensis	Spotless Crake	Tai Tai Nok	H	K,Kt	I/G
Geoffroyus	simplex	Blue-collared Parrot	Kialkai	N,C	B	S
Podargus	ocellatus	Marbled Frogmouth	Mok	A	Lgf,B	I/V
Ninox	rufa	Rufous Owls	Nilawi	A	B	V
Zosterops	Novaeguinneae	New Guinea White Eye	Yenuk	A	Lgt,B	G
Zosterops	artifrons	Black-fronted White-eye	Yenuk	A	Lgt,B	G

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Zosterops	fuscicapillus	Western Mountain White-eye	Yenuk	A	Lgt,B	G
Xanthotis	flaviventer	Tawny Breasted Honeyeater	Tobialbak	A	K,Lg,B	G
Drymodes	superciliaris	Northern Scrub Robin	Akupana	A	B	I
Cacomantis	castaneiventris	Chestnut-breasted Cuckoo	Awenam	A	Ng,Lg,B	I
Ptilinopus	ornatus	Ornate Fruit-Dove	Fatula	A	B	F
Microeca	griseoceps	Yellow-legged Flycatcher	Polipata	A	Lgtf,B	I
Microeca	flavovirescens	Olive Flycatcher	Polipata	A	Lgtf,B	I
Gerygone	chloronotus	Green-backed Gerygone	Philopatu	A	K,Lg	I
Oedistoma	iliolophus	Dwarf Honeyeater	Peleta	A	K,Lg	N/I
Myzomela	cruentata	Red Myzomela	Ititapi	C	B	N/I
Egretta	garzetta	Little Egret	Abi	A	W	V
Egretta	alba	Great Egret	Abi	A	W	V
Ptilinopus	magnificus	Wompoo Fruit Dove	Alualu	A	Lgtf,B	F
Cicinnurus	magnificus	Magnificent BOP	Awoo Pitai	A	Lgt,B	F/A
Hemiprocne	mystacea	Moustached Tree-swift	Itain	A	Ng,Lg,B	I
Pachycephala	aurea	Golden backed Whistler	Atupe	A	Ng,Lg,B	I
Psittrichas	fulgidus	Vulturine Parrot	Awia	N,C	B	F
Melanocharis	nigra	Black Berrypecker	Telivi	A	Lgtf,B	F
Rhamphocharis	crassirostris	Spotted Berrypecker	Eli Hot	A	Lgt,B	F
Malarus	grayi	Broad-billed Fairy-wren	Isisapi	H,N	Ng,Lg,B	I
Melipotes	fumigatus	Common Smoky Honeyeater	Itali	N,C	B	F
Melectides	torquatus	Ornate Melectides	Itali	N,C	B	N/A

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Myzomela	eques	Red-throated Myzomela	Ititapi	C	B	N/I
Myzomela	adolphinae	Mountain Red-headed Myzomela	Ititapi	C	B	N/I
Myzomela	nigrita	Papuan Black Myzomela	Ititapi	C	B	N/I
18/12Lalage	atrovirens	Black-browed Triller	Keketla	A	K,Lg,B	F/A
Scythrops	novaehollandiae	Channel-billed Cuckoo	Kghal	H,N	Ng,Lg,B	I/G
Rallina	forbesi	Forbes' Forest Rail	Kokoma	A	K,Lg,B	I/G
Melidectes	rufocrissalis	Yellow-browed Melectides	Kun	C	B	N/A
Paradigalla	brevicauda	Short-tailed Paradigalla	Kwal	C	B	F/A
Pitohui	ferrugineus	Rusty Pithoui	Labinam	A	K,Lg,B	F/I
Ptilinopus	superbus	Superb Fruit-dove	Luapa	A	Lgtf,B	F
Ceyx	lepidus	Dwarf Kingfisher	Manepnam	A	Lg,B	A/V
Alcedo	0azurea	Azur Kingfisher	Manepnam	A	Lg,B	A/V
Accipter	novaehollandiae	Grey Goshawk	Masual	N,C	B	V
Accipter	melanochlamys	Black-mantled Goshawk	Masual	N,C	B	V
Megacrex	inepta	New Guinea Flightless Rail	Meanalu Hot	H,N	K	I/G
Rhipidura	rufiventris	Northern Fantail	Metaghalip	A	Lg,B	I
Monarcha	chrysomela	Golden Monarch	Mogalpupe	A	Lg,B	A/I
Meliphaga	albonotata	Scrub White-eared Meliphaga	Nlatill	A	K,Lg,B	F/I
Pachycephala	monacha	Black Headed Whistler	Noanimano	A	Lg,B	I
Pteridophora	alberti	King of Saxony BOP	Maikun	C	B	F/I
Crateroscelis	murina	Rusty Mouse Warbler	Osaunam	A	Lgt,B	I
Macropygia	nigrirostris	Black-Billed Cuckoo-Dove	Paite Allainam	N,C	B	F

CODES: S=seeds, F=fruit, A=arthropods,I=insects, N=nectar,V=vertebrates, L=lichens, G=generalist.Altitude: A=all;H,N=500-1000m;N,C=1000+; Habitat B=primary forest;Lg=old garden;K=kunai;W=water; t=very old;f=few

Appendix 1:TEK of Hewa Birds

Genus	Species	Common name	Hewa name	Altitude	Habitat	Diet
Macropygia	amboinensis	Brown Cuckoo-Dove	Paite Fiwow	A	Lgtf,B	F
Haliastur	sphenurus	Whistling Kite	Simapanai	A	Ng,Lg,B	A/V
Melilestes	megarhynchus	Long-billed Honeyeater	Sisinek	A	K,Lg,B	I/F
Gymnophaps	albertisii	Papuan Mt Pigeon	Talifefa	N,C	B	F
Ptilinopus	pulchellus	Beautiful Fruit-Dove	Taunam	A	Lg,B	F
Manucodia	chalybata	Crinkle-collared Manucode	Teti	A	Lg,B	F
Dicrurus	hottentottus	Spangled Drongo	Tetikai	H,N	Ng,Lg,B	I
Malurus	alboscapulatus	White-shouldered Fairy-wren	Tualiko	H,N	Ng,Lg,B	I
Pitohui	cristatus	Crested Pitohui	Yaipof	A	B	A
Aegotheles	albertisi	Mountain Owlet-nightjar	Yalipap	A	B	I
Halcyon	macleayii	Forest Kingfisher	Yamyali	A	Lgf,B	A/V
Halcyon	sancta	Sacred Kingfisher	Yamyali	A	Lgf,B	A/V
Coracina	boyeri	Boyer's Cuckoo-shrike	Yatini	A	Lgtf,B	A/F
Colluricincla	megarhyncha	Little Shrike Thrush	Yaulo	A	Lgt,B	A
Toxorhamphus	poliopterus	Slaty-chinned Longbill	Yaunam	A	Lgtf,B	N/A
Sericornis	beccarii	Beccari's Scrub-wren	Wisinep	A	Lgt,B	I
Sericornis	arfakianus	Grey-green Scrub-wren	Wisinep	A	Lgt,B	I

CODES: S=seeds, F=fruit, A=arthropods,I=insects, N=nectar,V=vertebrates, L=lichens, G=generalist.Altitude: A=all;H,N=500-1000m;N,C=1000+: Habitat B=primary forest;Lg=old garden;K=kunai;W=water; t=very old;f=few

APPENDIX 2

THE RESIDENCE OF SELECTED HEWA MALES 1988-1996

Appendix 2 :Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
1	Tamilap	Wisip	M	Wisip	M
2	Wisip	Wisip	F	Wisip	F
3	Tali	Wisip	M	Foimi	W
4	Wisip	Wisip	F	Wisip	F
5	Tsivien	Tsivien	F	Tsivien	F
6	Tamilap	Tsivien	M	Tsivien	M
7	Wasip	Wasip	F	Wasip	F
8	Tamilap	Tamilap	F	Tamilap	F
9	Tamilap	Tamilap	F	Dead	D
10	Pawaip	Tamilap	M	Tamilap	M
11	Wisip	Wisip	F	Tuki	W
12	Utoni	Utoni	F	Dead	D
13	Utoni	Utoni	F	Utoni	F
14	Utoni	Utoni	F	Kanaip	W
15	Utoni	Utoni	F	Utoni	F

CODES: F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 :Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
16	Utoni	Utoni	F	Utoni	F
17	Utoni	Utoni	F	Utoni	F
18	Utoni	Utoni	F	Dead	D
19	Iali	Utoni	M	Dead	D
20	Iali	Utoni	M	Dead	D
21	Walpa Lalo	Walpa Lalo	F	Sisimen	M
22	Walpa Lalo	Utoni	F	Dead	D
23	Walpa Lalo	Utoni	FM	Walpa	W
24	Walpa	Utoni	W	Walpa	F
25	Utoni	Utoni	F	Puali	M
26	Wisip	Tamitap	M	Tamitap	M
27	Yatelip	Tsagiropi	F	Galaga	M
28	Woni	Tsagiropi	FM	WKA	M
29	WkA	Tsageropi	M	WKI	W

CODES: F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 :Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
30	Yatelip	Tsagiropi	F	dead	D
31	Kanaip	Galaga	F	Galaga	F
32	Kanaip	Galaga	F	Kanaip	F
33	Kanaip	Kanaip	F	Kanaip	F
34	Yatelip	Yatelip	F	Yatelip	F
35	Yatelip	Galaga	F	Yatelip	F
36	Isumanip	Galaga	F	Isumanip	F
37	Kanaip	Galaga, Ambi	F	Galaga, Ambi	F
38	Unamip	Unamip	F	Dead	D
39	Unamip	Unamip	F	Unamip	F
40	Yatelip/Yakasone	Unamip	M	Unamip	M
41	Unamip	Unamip	F	Dead	D
42	Unamip	Unamip	F	Unamip	F
43	Unamip	Unamip	F	Tamliap	W
44	Unamip	Unamip	F	Dead	D

CODES F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 :Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
45	WK A	Unamip	W	Dead	D
46	Unamip	Unamip	F	Unamip	F
47	Unamip	Unamip	F	Wk station	C
48	Arini	Unamip	W	Unamip	W
49	Unamip	Unamip	F	Unamip	F
50	Unamip	Papubuk	F	Unamip	F
51	Unamip	Unamip	F	Unamip	F
52	Wisal	Unamip	W	Port Moresby	PM
53	Unamip	Unamip	F	Dead	D
54	Walpa	Tuki	FM	Tuki	FM
55	Katillap	Tamilap	M	Wone	W
56	Katillap	Wone	BW	Wone	BW
57	Wone	Wone	M	Wone	M
58	Pawaip	Wone	FMM	Wone	FMM

CODES: F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
59	Puali No	Puali No	F	Puali No	F
60	Puali No	Puali No	F	Puali No	F
61	Wasip	Puali No	ZH	Puali No	ZH
62	Puali Yain	Puali No	M	Puali No	M
63	Walpa Lalo	Puali No	M	Puali No	M
64	Tsivien	Wanip	W	Wanip	W
65	Tamilap	Tuki	M	Wisip	FM
66	Tuki	Tuki	F	Tuki	F
67	Walpa	Tuki	W	Tuki	W
68	Tsivien	Tuki	M	Tuki	M
69	Tsivien	Tuki	FM	Tuki	M
70	Wk Abuaf	Wk Abuaf	F	Wk Abuaf	F
71	Tuki	Tuki	F	Dead	D
72	Puali Yain	Puali Yain	F	Dead	D
73	Tamilap	Tuki	FM	Tuki	FM

CODES: F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 :Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
88	Tamilap	Puali Yain	M	Puali Yain	M
89	Puali Yain	Puali Yain	F	Puali Yain	F
90	Puali	Puali Yain	F	Puali Yain	F
91	Wisip	Winaa	W	Winaa	W
92	Wisip	Winaa	BW	Jail	J
93	Wisip	Winaa	BW	Jail	J
94	Wisip	Winaa	BW	Jail	J
95	Tuki	Winaa	FM	Jail	J
96	Winaa	Winaa	F	Dead	D
97	Iali	Winaa	W	Winaa	W
98	Kanaip	Kanaip	F	Dead	D
99	Iali	Kanaip	M	Dead	D
100	Kanaip	Kanaip	F	Kanaip	F
101	Tsivien	Kanaip	W	Puali	M
102	Kanaip	Kanaip	F	Kanaip	F

CODES: F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 :Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
74	Tamilap	Tuki	FM	Walpa	M
75	Walpa	Tuki	FM	Dead	D
76	Tuki	Tuki	F	Tuki	F
77	Puali Yaln	Puali Yaln	F	Puali Yaln	F
78	Puali Yaln	Puali Yaln	F	Puali Yaln	F
79	Puali Yaln	Puali Yaln	F	dead	D
80	Puali Yaln	Puali Yaln	F	Puali yaln	F
81	Puali Yaln	Puali Yaln	F	Dead	D
82	Puali Yaln	Puali Yaln	F	Dead	D
83	Puali Yaln	Puali Yaln	F	Puali Yaln	F
84	Puali Yaln	Puali Yaln	F	Dead	D
85	Puali Yaln	Puali Yaln	F	Puali Yaln	F
86	Puali Yaln	Puali Yaln	F	Puali Yaln	F
87	Tamilap	Puali Yaln	M	Puali Yaln	M

CODES: F=father; M=mother. B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
103	Kanaip	Kanaip	F	Kanaip	F
104	Kanaip	Kanaip	F	Dead	D
105	Fawip Nomiep	Fawip Nomien	W	Fawip Nomien	W
106	Kanaip	Kanaip	F	Kanaip	F
107	Khalaen	Kanaip	M	Kanaip	M
108	Fawip Pavien	Fawip	F	Fawip Pavien	F
109	Iali	Kanaip	MM	Puali	MF
110	Iali	Kanaip	MM	Puali	MF
111	Tamliap	Kanaip	W	Kanaip	W
112	Tamliap	Kanaip	M	Kanaip	M
113	Wina	Wina	F	Winaa	F
114	Walpa	Winaa	M	Winaa	M
115	Walpa Lalo	Winaa	M	Winaa	M
116	Walpa Lalo	Winaa	M	Winaa	M

CODES: F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
117	Opalpa	Opalpa	F	Opalpa	F
118	Opalpa	Opalpa	F	Opalpa	F
119	Opalpa	Opalpa	F	Opalpa	F
120	Opalpa	Opalpa	F	Opalpa	F
121	Opalpa	Opalpa	F	Opalpa	F
122	Utoni	Opalpa	W	Opalpa	W
123	Kanalp	Kanalp	F	Kanalp	F
124	Unamlp/Isumanlp	Kanalp	M	Kanalp	M
125	Kanalp	Kanalp	F	Kanalp	F
126	Kanalp	Kanalp	F	Kanalp	F
127	Yatellp/Yakasone	Kanalp	W	Kanalp	W
128	Tamllap	Kanalp	F	Kanalp	F
129	Puall Yaln	Puall Yaln	F	Dead	D
130	Puall Yaln	Puall Yaln	F	Puall Yaln	F
131	Puall Yaln	Puall Yaln	F	Puall Yaln	F

CODES: F=father; M=mother; B= brother W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
132	Puali Yain	Puali Yain	F	Puali yain	F
133	Kanalp	Kanalp	F	Kanalp	F
134	Isumanip	Lueni	M	Lueni	M
135	Woni	Woni	F	Woni	F
136	Tuki	Woni	M	Woni	M
137	Tuki	Woni	F	Woni	F
138	Woni	Woni	F	Woni	F
139	Woni	Woni	F	Woni	F
140	Pawalip	Woni	M	Dead	D
141	Wone	Wone	F	Wone	F
142	Wone	Wone	F	Wone	F
143	Woni	Woni	F	Woni	F
144	Wone	Wone	F	Wone	F
145	Wone	Wone	F	Wone	F

CODES: F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 :Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
146	Wone	Wone	F	Wone	F
147	Wone	Wone	F	Wone	F
148	Wone	Wone	F	Wone	F
149	Wone	Wone	F	Wone	F
150	Woni	Woni	F	Dead	D
151	Woni	WK Indiap	FFM	Wone	F
152	Woni	Woni	F	Folini	W
153	Wone	Wone	F	Folini	W
154	Folini	Folini	F	Folini	F
155	Folini	Folini	F	Folini	F
156	Folini	Folini	F	Dead	D
157	Puali	Folini	M	dead	M
158	Puali	Folini	M	Folini	M
159	Folini	Folini	F	Folini	F
160	Tenip	Tenip	F	Wka Station	C

CODES: F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 :Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
161	Walpa	Folini	M	Folini	M
162	Walpa	Folini	M	Dead	D
163	Woni	Folini	W	Folini	W
164	Wkp Abuaf	Wkp Abuaf	F	Wkp Abuaf	F
165	Wk Indiap	Wk Abuaf	W	Wk Abuaf	W
166	Wk Indiap	Wkp Abuaf	W	Dead	D
167	Wk Abuaf	Wkp Abuaf	F	Wk Abuaf	F
168	Wk Abuaf	Wkp Abuaf	F	Wkp Abuaf	F
169	Tuki	Wkp Abuaf	M	Tuki	F
170	Wkpa	Wkp Abuaf	F	Wk Abuaf	F
171	Tetenam	Wk Abuaf	M	Wk Abuaf	M
172	Wk Abuaf	Wkp Abuaf	F	Wk Abuaf	F
173	Wk Indiap	Wkp Abuaf	W	Wk Abuaf	W
174	Wk Abuaf	Wkp Abuaf	F	Wk Abuaf	F

CODES: F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 : Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
175	Wk Abuaf	Wkp Abuaf	F	Wk Abuaf	F
176	Wk Abuaf	Wkp Abuaf	F	Wk Abuaf	F
177	Opilitap	Wkp Abuaf	W	Dead	D
178	Pawalip	Wkp Abuaf	M	Wkp Abuaf	M
179	Unamip	Wkp Abuaf	M	Tuki	M
180	Wk Abuaf	Wkp Abuaf	F	Wk Abuaf	F
181	Folini	Tetenam	M	Dead	D
182	Yatelip	Tetenam	M	Tetenam	M
183	Yatelip	Tetenam	M	Tetenam	M
184	Wk Abuaf	Tetnam	MM	Wkp stn	L
185	Folini	Tetenam	M	Tetenam	M
186	Mapun	Wisip	W	Wkp Station	C
187	Wk Indiap	Wk Indiap	F	Wk Indiap	F
188	Wasip	Wk Indiap	FMM	Wk Indiap	FMM
189	Wk Indiap	Wk Indiap	F	Wk Indiap	F

CODES: F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 :Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
190	Wk Indlap	Wk Indla	F	Dead	D
191	Wanip	Wk Indlap	M	Wk Indlap	M
192	Tuki	Wk Indlap	W	Tuki	F
193	Wk Indlap	Wk Indlap	F	Wk Indlap	F
194	Wanip	Wk Indlap	M	Wk Indlap	M
195	Wk Indlap	Wk Indlap	F	Wk Indlap	F
196	Folini	Tetenam	M	Tetenam	M
197	Wisip	Wkpa Station	FMM	Wkp Station	FMM
198	Tetenam	Tetenam	F	Tetnam	F
199	Utoni	Utoni	F	Utoni	F
200	Wisip	Wkpa Station	F	Wkp Station	F
201	Wasip	Utoni	M	Utoni	M
202	Folini	Utoni	W	Dead	D
203	Tamilap	Utoni	W	Ambi w's line Kaniap Olum	W

CODES: F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail;PM=Port Moresby; D=dead

Appendix 2 :Male Residency 1988-1996

Individual #	Reference Clan	1988 Ground	1988 Ground link	1996 Ground	1996 Ground link
204	Wkp Abuaf	Tetenam	M	Dead	D
205	Utoni	Utoni	F	Dead	D

CODES: F=father; M=mother; B= brother; W=wife; Z=sister; C=church; J=jail; PM=Port Moresby; D=dead

BIOGRAPHICAL SKETCH

William H. Thomas was born in Youngstown Ohio on [redacted]. He graduated from Cardinal Mooney High School in 1972. In 1976 he earned a B.A. in Economics at Marietta College in Marietta Ohio. He entered Arizona State University in 1986, earning a Master of Arts in Anthropology in 1989. After several expeditions to Papua New Guinea, he returned to the university full time in 1995 to complete his doctorate. Since 1978, he has worked as a carpenter and a boat builder.