Conserving Papua New Guinea's forest fauna through community planning

Tanya Leary[1] and Ted Mamu[2]

[1]NSW National Parks and Wildlife Service, PO Box 95, Parramatta NSW 2124, Australia.

[2]WWF Kikori Integrated Conservation and Development Project, PO Box 8280, Boroko, NCD, Papua New Guinea.

ABSTRACT

Despite being classified as one of the world's mega-diversity hotspots, the basic biology and ecology of most PNG forest vertebrate species are completely unknown, which hampers sound planning for conservation of PNG's forest fauna. Although almost 70% of PNG still retains its forest cover, PNG supports a surprisingly high proportion of threatened mammals and birds, which are comparable to the proportion of threatened species in Australia – 27% of PNG's mammals and 4% of PNG's birds are considered critically endangered, endangered or vulnerable compared with 22% and 5% respectively of Australia's mammals and birds. Degradation and loss of habitat by the partial or total removal of forest cover (from clear-fell logging, selective logging and clearing for shifting agriculture and oil palm plantations) is the most significant threat currently posed to PNG's forest fauna. Hunting may also pose a threat for some of the larger, highly sort after game species, such as tree kangaroos and cassowaries. An overview is provided of PNG's legislation for protected areas development and we outline our experiences in the facilitation of community planning for Wildlife Management Area establishment and management by local landowners in the Mt Bosavi area of Southern Highlands Province. For Wildlife Management Areas, the ownership of the land, the development of management rules and the enforcement of management rules remains in the hands of the customary landowner. The participatory community planning process that we developed to try to overcome some of the factors which have led to failure of WMAs elsewhere in PNG is outlined in this paper. In our opinion the only successful conservation areas in PNG will be those developed on land still held in customary ownership by landowners committed to conservation. We also believe that the planning process we developed can be used by local communities (with minor alterations) to undertake sustainable land and resource-use planning that can achieve broad scale conservation outcomes that do not necessarily result in the establishment of protected areas. While establishment of conservation areas by committed landowners may be part of the answer to achieving conservation of PNG's forest fauna, we also highlight research priorities which will aid the assessment of the effectiveness of conservation areas, and help to determine what other off-reserve measures may need to be taken to ensure effective conservation of PNG's fauna. We believe that the key to answering some of the fundamental biological and ecological questions necessary for the adequate conservation of PNG's fauna lies in building the capacity of PNG biologists and in securing adequate funds for them to undertake long-term research.

Key words: conservation, Papua New Guinea, community planning, Wildlife Management Areas, research needs, Mt Bosavi, Intergrated Conservation and Development Projects, capacity building, vertebrates.

Introduction

Papua New Guinea (PNG), Australia's closest neighbour, is considered to be one of the world's mega-diversity hotspots (Mittermeier and Mittermeier 1997). Although its land area is less than 0.3% of the earth's surface area and about 6% of the area of Australia, it supports a high proportion of the world's plant and animal life and is comparable to Australia (Table 1).

Australia supports far more non-forested habitat types than PNG. Almost 70% of PNG (Sehkran and Miller 1994) is covered in forest of some type compared with around 21% of Australia (BRS 2003). PNG contains one of the largest relatively undisturbed patches of tropical rainforest in the world. Numerous vegetation classifications have been proposed for PNG (eg. Lane-Poole 1925; Brass 1959; Johns 1972, 1976; Paijmans 1976; Clunie 1976; Hammermaster and Saunders 1995), but there is no widely accepted system of vegetation classification (Johns 1993). This illustrates one of the problems of assessing the future of the forest fauna of PNG. Nonetheless, a number of generalised forest formations can be drawn from the numerous classifications (Table 2). Since PNG supports such an extensive forest area it would be easy to jump to the conclusion that PNG forest fauna is not facing serious conservation threats. An examination of the IUCN Red List reveals that for at least the better known mammals and birds the level of threat is comparable to Australia (Table 3). Twenty-seven per cent of PNG's mammals and 4% of PNG's birds are considered to be critically endangered, endangered or vulnerable compared with 22% and 5% for Australia's mammals and birds respectively (IUCN 2002).

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Table 1: Comparison of number of species supported by PNG and Australia (Derived from: Mittermeier and Mittermeier 1997; Bonaccorso 1998; Flannery 1995; Menzies 1996; Churchill 1998; Strahan 1995; and Nowak 1991).

Taxa (Group)	Australia		Papua New Guinea	
	Approximate total number of species	Percentage of world total	Approximate total number of species	Percentage of world total
Higher plants	15,638	6	15,000 – 21,000	9
Amphibians	196	5	200	5
Reptiles	755	12	305	5
Birds	751	8	762	8
Mammals	282	6	242	5
Bats	77	8	91	9
Rodents (Muridae)	55	5	74	7

Table 2: Generalised forest formations in PNG. (Drawn from Sekhran and Miller 1994, and Saulei and Beehler 1993).

Forest formation	General description
Mangrove Forest	Typically inundated daily by salt or brackish water.
Lowland Broadleaf Swamp Forest	Inundated for part or much of the year, but is highly variable in structure and species composition.
Monsoon Forest	Occurs near sea level in areas with <2.5m of rain per year and a prolonged dry season. These have been heavily exploited for timber. Relatively open canopy, 20-30m high.
Lowland Tropical Rainforest	Below 1000m and receiving > 2.5m of rain per year. Can be split into forests below 500m that receive more than 3.5 m of rain (Lowland Wet Forest) and those below 1000m that receive between 2.5 and 3.5m of rainfall (Lowland Humid Forest). Canopy is usually closed and high (35-45m). Much of the Lowland Humid Forest is scheduled for timber extraction.
Lower Montane Forest	Lying between ca. 1000 – 2000m elevation. Lower Montane Wet Forest receives more than 3.5m of rain and Lower Montane Humid Forests receive less than 3.5m of rain. The latter is the zone of maximum environmental impact from subsistence agriculture. Variable in structure and canopy height.
Mid-montane Forest	Occurs between ca. 2000 – 2500m and is typically everwet (perhumid). Often with broken and uneven canopies. Also subject to extensive clearing for subsistence agriculture and settlement in the interior of the country.
Upper-montane Forest	Occurs between ca. 2500m and 3200m and primarily composed of gymnospermous canopy tree species. Low canopied and structurally simple.
Sub-Alpine Forest	Occurs on mountain tops above 3200m to the tree line at around 3900m. Species poor and generally with a dwarf canopy height of 8 –12m.

Table 3: Number and proportion of Australian and Papua New Guinean IUCN red listed threatened mammal and bird species. (Source: IUCN 2002 and Birdlife International 2000).

IUCN Red list category	Number of Birds (%)		Number of Mammals (%)	
	Australia	PNG	Australia	PNG
Extinct	7 (0.9)	No data	19 (6.7)	No data
Critically Endangered	2 (0.3)	1 (0.1)	8 (2.8)	7 (3.3)
Endangered	11 (1.5)	2 (0.3)	19 (6.7)	12 (5.7)
Vulnerable	24 (3.1)	29 (3.8)	31 (11)	38 (17.9)
LR/cd	-	-	2 (0.7)	0
LR/nt	25 (3.3)	30 (3.9)	47 (16.7)	28 (13.2)
Data Deficient	0	19 (2.5)	5 (1.8)	14 (6.6)

(Notes: LR/cd = Lower Risk/ conservation dependent; LR/nt = Lower Risk/ near threatened. The number and proportion of threatened and data deficient PNG mammals is probably underestimated as the last IUCN assessment of PNG mammals was undertaken in 1996 prior to a number of taxonomic and status revisions eg. Menzies (1996), Bonacorso (1998) and Van Dyck (2002). Total number of mammal species for PNG is based on Flannery (1995) (212 species) rather than Table 1 which incorporates recent taxonomic changes. Birdlife International (2000) was used for IUCN review of bird listings and is therefore more current).

State of knowledge of PNG's vertebrate fauna

Birds are the best known animal group in PNG as evidenced by the range of books produced over the years including Gould (1888), Mayr (1945), Iredale (1956), Gilliard (1967), Rand and Gillard (1969), Mackay (1970), Gould and Rutgers (1970), Peckover and Filewood (1976), Cooper and Forshaw (1997), Department of Education (1981), Beehler *et al.* (1986), Coates (1985, 1990) and Coates and Peckover (2001). The state of taxonomic and ecological knowledge of all other groups of PNG fauna is extremely poor. Parnaby (1991) lamented the deplorable state of knowledge of the taxonomy of Australian bats and the fact that as many as 20 of the 25 Australian bat genera require further taxonomic clarification. Many of these genera include PNG species. The taxonomic concerns of Parnaby (1991) and Reardon (1999) for bats become even more apparent in bats and other mammals in PNG, and applies to many frog, and reptile genera (Allison 1993).

Papua New Guinea mammal genera requiring further clarification include *Nyctimene, Miniopterus, Macroglossus, Hipposideros, Dendrolagus, Rattus, Stenomys, Hyomys, Hydromys,* and *Parahydromys.* Some of these are currently being revised (N. Irwin Pers. Comm. James Cook University, and K. Helgen Pers. Comm. University of South Australia), but others still need attention. The objectives of further taxonomic research need to include clarification of species boundaries in problematic species groups and field criteria for the identification/separation of similar species.

Until recent years, field biologists have been hampered by a lack of adequate field guides (with the exception of birds). For example, the only reptile group that has any sort of field guide are snakes (O'Shea 1996). Allison (1993) concluded that a number of reptile and amphibian genera are poorly defined and further taxonomic work is likely to split large genera into better defined smaller genera, increasing significantly the number of species known for PNG. In addition, a number of species are probably species complexes that will require careful morphological and biochemical analysis, additional fieldwork and collecting to resolve. Allison (1993) also predicted that many species await discovery. The most recent frog guide is that of Menzies (1976) which covers only 70 common frog species, and much of the taxonomy within it is now dated.

Mammals have likewise suffered from a dearth of field guides. While Menzies (1991) and Flannery (1990, 1995) provided a significant step towards producing a systematic synthesis of New Guinea mammals, some of the taxonomy is now dated, *e.g.* after the *Melomys*/ *Paramelomys* revision of Menzies (1996) and the *Murexia*/ *Antechinus* revisions of Van Dyck (2002). Flannery's work (1990, 1995), which represented the first synthesis of all mammal groups, lacks dichotomous keys and, in many cases, lacks sufficiently detailed descriptions to allow species separation within difficult groups, such as rodents and bats. Bonaccorso (1998) considerably improved the situation for bats. The earliest mammal field guide was that of Menzies and Dennis (1979) on the rodents of PNG, which contains dichotomous keys, but it is now dated due to recent taxonomic revisions and descriptions of new species.

Menzies (1993), in a review of the history of mammalogy in New Guinea from 1726 to 1993, concluded that most of the scientific papers written prior to 1950 tended to be brief, inadequate descriptions of new taxa which added little to the knowledge of the biology of New Guinea mammals. Many of these earlier taxonomic descriptions also lacked precise locality data and this has added to the difficulty of synthesizing information on the distribution of PNG vertebrate fauna. Information on the distribution of mammals, reptiles and amphibians is extremely poor. For example, the distribution maps of many mammals in Flannery's (1995) text is shown by only a handful of scattered localities with no clear biogeographic pattern. This is partly due to the lack of survey or collecting effort in many parts of PNG, and to the fact that many of the earlier naturalist/ museum collectors did not provide precise locality data for the specimens that they collected. For example, many type specimen localities are recorded vaguely as "south coast of New Guinea" (Milne-Edwards 1877) or "upper Vanapa River, south east Papua New Guinea" (Thomas 1897).

The PNG Conservation Needs Assessment (Beehler 1993a) attempted, amongst other things, to map major areas of PNG which were unknown to science (*i.e.* areas from which plants and terrestrial vertebrates had not been collected). Sixteen major areas were mapped that are probably biogeographically or ecologically distinct from the nearest studied areas. Areas from which no scientific collections have been made covered more than 30% of PNG (Sekhran and Miller 1994).

The number of collecting localities with precise locality data is not very high for most vertebrate fauna. One of the most recent comprehensive field guides (Bonaccorso 1998) is only based on 736 localities, and Allison (1993) estimated that amphibians and reptiles have been collected from around 800 localities throughout PNG. Most museum collectors, or ecologists undertaking survey in PNG, did not collect detailed abiotic and vegetation data at survey sites and many failed to record precise locality data, which means that it is still not possible to undertake detailed analysis of distributional data on many vertebrate species. Fundamental distributional questions remain unanswered for most vertebrates other than birds. An indication of the poor state of knowledge is given by the fact that almost every survey undertaken in the Kikori Basin (Southern Highlands and Gulf Provinces) by World Wide Fund for Nature (WWF) over the past eight years has resulted in major extensions of geographical and altitudinal range and discovery of undescribed species of plants, mammals, freshwater fish and frogs (*e.g.* Baker 1997, Leary and Seri 1997, Leary *et al.* 1996, Jenkins *et al.* 2000; Allen 1996a,b,c). In limited survey work in the Kikori Basin over the past two years, at least 28 species of undescribed frogs have been discovered (Richards 2002).

The basic biology and ecology of most forest vertebrate species are completely unknown. There is little available information on population dynamics, life histories, specific habitat requirements, home range, food requirements, predators, and competitive interactions with ecologically similar species. Despite being the best known vertebrate group, Beehler (1993b) concludes that there are major gaps in the ornithological knowledge for conservation purposes. He broadly classified these gaps

into four major themes: (a) distribution (both generalised biogeographical distribution and species distribution); (b) population estimates of the rarest and most obvious PNG endemics such as the New Guinea harpy eagle *Harpyopsis novaeguineae* and the southern crowned pigeon *Goura scheepmakeri*; (c) life cycles and population dynamics of large/and or rare species; and (d) seasonal and age - related movements.

Faunal Links between PNG and Australia

The level of endemism of PNG fauna is high but it varies among vertebrates: mammals ~ 57%, birds ~ 44%, lizards ~ 60%, snakes ~ 33%, and amphibians ~ 67% (Miller *et al.* 1994; Mittermeier and Mittermeier 1997). A number of forest-dwelling species are shared with Australia; 32% of PNG's bats also occur in Australia (Bonaccorso 1998). Thirty-eight bird species occur both in PNG and north Queensland. More importantly, there is a number of species (*e.g.* the black flying-fox *Pteropus alecto* and the large-eared flying-fox *P. macrotis* – T. Leary, pers. obs.) that appear to make short foraging movements between Australian islands, such as Boigu Island in Torres Strait and PNG, and a number of Australian breeding land bird species which spend the non-breeding season in PNG (Beehler *et al.* 1986). Most of these migrants inhabit non-forest or forest edge habitats (*e.g.* sacred kingfisher *Halcyon sancta* and rainbow bee-eater *Merops ornatus*). However, some migrants do winter in the forest itself, *e.g.* Australian paradise kingfisher *Tanysiptera sylvi*, rufous fan-tail *Rhipidura rufifrons*, blue-breasted pitta *Pitta erythrogaster* and black-faced monarch *Monarcha melanopsis* (Beehler *et al.* 1986) and therefore the conservation of PNG's forest is of direct relevance to conservation of Australia's forest fauna.

Threats to forests and forest fauna

Degradation and loss of habitat by the partial or total removal of forest cover is the most significant threat currently posed to PNG's forest fauna, other than global climate change. Filer (1994) argued that this takes three main forms and estimates the area of forest impacted annually. These are given below with comments by the authors:

1. Total and permanent removal of forest cover for: a) commercial agricultural operations (about 10,000 ha/yr); b) industrial logging (5-6,000 ha/yr); and c) the construction of economic infrastructure (including large-scale mining facilities) (approx. 10,000 ha/yr). (In recent years there has been considerable concern in PNG, that the rate of conversion of lowland rainforest to oil palm plantations has increased, and the estimate of 10,000 ha/yr for commercial agriculture may be an underestimate. In addition to permanent removal of forest cover, some mining projects result in additional downstream degradation of forests, particularly through alteration of river flows from tailings dumping and siltation that results in flooding of some areas not previously inundated.)
2. "Selective" logging activities of prime timber species (in excess of 100,000 ha/yr). Much of this "selective" logging activity result in serious environmental degradation. Some of the impacts result from lack of directional felling and lack of the cutting of vines that bind the canopy. This leads to the toppling of undersized trees and creates larger than necessary canopy gaps, which then alters the forest floor micro-climate. Excessive use of bulldozers leads to soil compaction that prevents regeneration. Much selective logging ignores existing logging regulations, such as the prohibition of logging on slopes over 30 degrees. High levels of mortality of residual trees are caused by current methods of selective logging. Cameron and Vigus (1993) estimated that as much as 70% of trees in the original forest are so severely cut and damaged after selective logging, that they do not survive the following 10 years.
3. Shifting cultivation by customary landowners for subsistence purposes also results in the clearing of forest cover and it has been estimated to be as much as 200,000 ha/yr (Filer 1994). However, recent studies show that only 3% of land cleared for agriculture in the last 20 years had not previously been used for agriculture (Filer and Sekhran 1998). Shifting cultivation may not be contributing as much to the deforestation of primary rainforest as previously thought.

It is difficult to obtain accurate estimates of the total area of forest that has already been logged over, and the amount of forest that is suitable for commercial timber exploitation and there appears to be considerable variation in estimations. The PNG Forest Authority (1996) estimated that there are potentially 26.2 million hectares of forest that is suitable for commercial exploitation. The total forest estate was estimated by Sehkran and Miller (1994) to be around 36 million hectares and hence the PNG Forest Authority estimate of forests potentially suitable for commercial timber exploitation would represent 73% of total forest cover. Conflicting estimates cited in Sehkran and Miller (1995) for accessible and operable forests for logging are around 41%, and may be in fact as low as 18% if sustainability is taken into consideration.

McAlpine and Quigley (1998) estimated that 3.5 million hectares had been logged over or converted to other land uses by 1996, and Hunt (2002) estimated that a further one million hectares has been logged since 1996, leaving (according to National Forest Authority (1996) estimates), a total of 21.9 million hectares available to commercial exploitation. Of this, 10.6 million hectares has been acquired by the PNG Forest Authority, while 6.1 million hectares are allocated under permit to existing operations by some 23 parent companies at 90 sites (Hunt 2002).

The majority of the selective logging (96.3%) is occurring in lowland tropical rainforest, and Sekhran and Miller (1994) estimated that only 3.4% is occurring in lower montane tropical rainforest and 1.3 % in lowland broadleaf swamp forest. Those communities and species restricted to these lowland rainforests would therefore appear to be the most threatened. While there has been some research on the impacts of logging on plant diversity and regeneration (Buenaflor 1989, Buenaflor and Tiki 1989, Siaguru 1992, Nir 1992, Cameron and Vigus 1993, Saulei *et al.* 1999), there has almost been no research on the effects of logging on animals (Sekhran and Miller 1994) and more research is needed to support short-term observations and anecdotal evidence on the impacts of logging of fauna and to provide a greater management guidance to current logging practices.

There has also been no research at all on the impacts of conversion of forest to oil palm plantation on biodiversity and environmental quality in general. Research is needed on these impacts, as is research that quantifies the monetary value of subsistence uses (eg for food, medicine and building materials) that is lost when forest is converted to other uses. Less than 10% of the PNG population is engaged in salaried employment and the majority of the population engages in a subsistence lifestyle which involves agriculture, collection of wild food plants and hunting and/or fishing. Forest fauna is an important source of protein for many local communities, although the level of hunting varies widely across the country. Flannery (1995) argued that hunting has been a crucial factor in the local extinction of some larger species of mammal (Flannery 1992a,b, 1994a,b).

There is much anecdotal evidence that over-hunting (especially in areas of high human population density where shotguns have become more common) has contributed to the rarity and sometimes local extinction of large mammals, such as tree kangaroos (up to 8 species of *Dendrolagus*), forest wallabies (three species of *Dorcopsis* and two species of *Dorcopsulus*), pademelons (four species of *Thylogale*), the long-beaked echidna (*Zaglossus bruijni*) and cuscuses (at least two species of *Phalanger* and one species of *Spilocuscus*). There is also much anecdotal evidence to suggest that over-hunting has likewise contributed to the rarity and local extinction of a number of birds species including: the southern cassowary *Casuarius casuarius*, northern cassowary *Casuarius unappendiculatus*, Salvadori's teal *Anas waigiuensis*, black honey buzzard *Henicopernis infuscatus*, New Guinea harpy eagle, vulturine parrot *Psittrichas fulgidus*, palm cockatoo *Probosciger aterrimus*, southern crowned pigeon, and Victoria crowned pigeon *Goura victoria* (Birdlife International 2000). There is also archaeological evidence to suggest that human activities contributed to the extinction of PNG's megafauna (Flannery 1994a,b).

Forest fauna is culturally important to Papua New Guineans. Melanesians traditionally held (and to a large extent still hold) a strong cultural attachment to many species, with feathers, skins, beaks and bones of a wide range of species being used for personal adornment, decoration, weapons and tools. Many species of forest fauna are important as clan and tribal totems, as symbols of wealth and prestige, for purposes of social exchange (including the payment of bride price) and as spiritual idols and mythological and supernatural explanations of their origins and natural phenomenon. Strategies for the conservation of PNG's forest fauna need to bear these attachments and uses by customary landowners in mind.

Customary ownership

One of the main reasons that PNG has retained much of its biodiversity stems from the fact that about 97 % of all land in PNG is still held in customary tenure and includes almost all of the forested land in PNG. Customary ownership does not relate just to the land, but to all the things that it contains, such as water, plants, animals, and rocks. Customary ownership also extends to things such as knowledge and rituals. Ownership may be either individual or by groups. A family, extended family, a sub-clan, a clan or even a group of clans may hold collective ownership. Customary ownership of land may be further complicated by the fact that although land or other resources may be the property of one particular person or group, other people may have claims to the use of that land or resource. In some cases, the rights to the use of a resource may also bestow the right to make decisions with regard to the allocation of that resource. Filer and Sekhran (1998) argue that the term customary land tenure/ownership is misleading, and that rather than say that land is an object over which individuals and groups exercise rights, it would be more appropriate to say that social relationships within and between local communities are normally grounded in the landscape. Consequently western approaches to conservation that entail alienation of land into government owned and managed reserves are inappropriate to Papua New Guinea and conservation initiatives must entail, amongst other things, understanding these complex "social relationships grounded in the landscape".

Policy, international conventions and treaties, and legislation for protected area development

The recognition of the importance of pursuing conservation and sustainability objectives in PNG is exemplified by the fact that the fourth goal of the nation's constitution states: "*Natural Resources and Environment: We declare our fourth goal to be for Papua New Guinea's natural resources and environment to be conserved and used for the collective benefit of us all and be replenished for the benefit of future generations*".

Sekhran and Miller (1994) argue that the success since independence in translating these constitutional ambitions into practice has been limited despite the strong framework for conservation implied in the national consititution and current legislation. They argue that part of the problem is that conservation objectives have in the past mostly been pursued in isolation from other imperatives such as landowners' demands for social and economic development, and the lack of human and financial resources for conservation. More recent approaches to conservation have, however, tried to take into account these imperatives.

Papua New Guinea is party to a number of international conventions and treaties aimed at conserving biodiversity including:

- Convention of Biological Diversity;
- World Heritage Convention;
- The RAMSAR Convention on Wetlands of International Importance (1992);
- The Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES);
- The Convention on Conservation of Nature in the South Pacific (Apia Convention);
- The Convention on the Conservation of Migratory Species of Wild Animals; and
- The International Plant Protection Convention (1951).

Papua New Guinea has three national legislations under which protected areas can be declared: the *National Parks Act (1982), the Fauna Protection and Control Act (1966)* and the *Conservation Areas Act (1980, 1992)*. Under the *National Parks Act (1982)* there are only four National Parks declared in PNG on government land (the ownership of some of these is disputed by customary landowners) and these cover an area of less than 127 km^2 (<0.3% of the land area) (Sekhran and Miller 1994). Customary landownership is enshrined in the PNG Constitution and cultural identity of Papua New Guineans, alienation of further land from customary ownership is unlikely, and also in the opinion of the authors, undesirable because of the significance of land to people's cultural identity. To many Papua New Guineans, the whole concept of national parks is an enigma because it is inconceivable that they could be taken out of the landscape.

The majority of PNG's existing conservation areas consist of Wildlife Management Areas (WMAs). These remain in customary ownership and it is the customary landowners who decide upon the rules for the utilization and protection of fauna and fauna habitat within them. These areas are gazetted under the *Fauna Protection and Control Act (1966)*, and enforcement of the rules for the management of the WMA is in the hands of local landowners or their appointed committees. There are currently 22 WMAs in PNG and these cover an area of about 2.5% of the country. Two large WMAs, Tonda WMA and Maza WMA (both in Western Province), which are respectively coastal alluvial wetlands and shallow marine environments, make up more than 73% of the total area covered by WMAs. The majority of WMAs are less than 10,000 ha and do not conserve the entire range of forested habitat types in PNG and are unlikely to conserve large, highly mobile species. Many of these WMAs also appear to be merely "paper parks" with no real management activity occurring on the ground.

The *Conservation Areas Act (1980, 1992)* makes provision for the establishment of Conservation Areas on customary, government or privately owned land, and can protect a wider range of natural and aesthetic values than WMAs. A management plan needs to be developed for each area in consultation with customary landowners and management of the area, in accordance with the plan, is the responsibility of the government rather than the customary landowners. Despite being passed in 1980 and amended in 1992, no Conservation Areas have been gazetted to date, which may indicate that these too may be felt by many Papuan New Guineans to be inappropriate.

Integrated conservation and development projects

A number of approaches has been taken in PNG in the past few years to achieve conservation outcomes. Foremost of these have been "Integrated Conservation and Development" (ICAD) projects, which have been instigated largely by non-government conservation organisations but also by the Department of Environment and Conservation. As the name suggests these projects aim to integrate conservation and development and were initially developed in countries other than PNG (mostly in Africa) and focused on government-run and owned conservation areas and the land adjacent to them. (Their implementation in PNG is not, however, focused on government-owned and run reserves, but on land held in customary ownership).

One of the main issues in ICAD projects is the need to make people benefit in development terms from the conservation activities that are undertaken (Wells and Brandon 1992; Sekhran 1996; Van Helden 1998; Ellis 1997). There has been a variety of approaches to implementing the development component of ICADs in PNG. These range from direct provision of social development projects, such as literacy education and health projects, to provision of infrastructure, such as water supplies, to the development of income-generating opportunities for landowners such as eco-tourism lodges, small scale-sawmill projects and butterfly farming. The Bismarck-Ramu Group (previously ICAD) has rejected the notion that the simple provision of benefits, economic or social, can meet the development imperatives of ICADs. It has been working through a genuinely participatory community development process. This has sought to "empower communities through a process of critical self-reflection leading to action, so that they have control over their own development" (Ellis 1997). Alongside this community development process has been a conservation education program which "aims to build the conviction sufficient to ensure ongoing support for a conservation decision" (Ellis 1997).

There have been at least eleven terrestrial ICAD projects in the past decade (Filer and Sekhran 1998) which are achieving various levels of success. Filer and Sekhran (1998) highlighted some of the critical questions that most ICAD projects are still grappling with. These are listed in italics, with our comments and some thoughts of others.

- *How to reconcile the different criteria used for ICAD project site selection – most notably the extent of local initiative, the measurement of biodiversity values and the threat posed by large-scale logging operations.* The dilemma of how to reconcile different criteria used for ICAD project site selection was highlighted by the conflicts arising in the PNG "Conservation Needs Assessment" (CNA). The CNA was designed as a first step towards the design of a "Representative System of Protected Areas" for PNG. The main forum for participation of stakeholders was a workshop held in Madang, in April 1992, which resulted in a vocal conflict between natural scientists and national NGO representatives. The national NGO representatives questioned both the capacity and the right of the scientists to determine national priorities. Brown and Holzknecht (1993) argue that the conflict between the biologists and the NGO representatives at the workshop was due to the vast difference in assumptions that each group was making about the "wider pattern of stakeholder relationships in the conservation business" (Filer and Sekhran 1998). Brown and Holzknecht (1993) and Filer and Sekhran (1998) suggest that at one level this was an argument about which stakeholders had the right or responsibility to decide on the designation of conservation areas. They concluded that the "top-down planning approach" taken by professional conservation managers and natural scientists needed to be modified, and the selection of conservation areas had to be based on some assessment of "social feasibility", as well as purely biological criteria. Filer and Sekhran (1998) argued that the critical question is

the manner in which social and cultural factors, including the attitudes of local resource owners, might be combined with biophysical criteria and used to determine the "conservation values" of different areas.

There has also been considerable debate as to whether ICAD projects should be situated in areas where there are existing or proposed logging concessions. While these are obviously the most threatened areas, they are also the ones most likely to contain communities which are politically divided over whether or not to engage in industrial logging. Other major factors mitigating against siting ICAD projects where logging is proposed include the fact that landowner's expectations (for money, goods, infrastructure and services) in these areas are generally high. They often believe that they will reap high royalty payments from logging and achieve unrealistic infrastructure development, such as roads, health facilities and schools, as a benefit from logging. (It must be noted that these expectations are rarely satisfactorily met by the largely foreign owned logging companies, despite promises made to landowners prior to signing of logging agreements). This has meant that conservation organisations have felt that conservation incentives of ICAD projects need to be able to compete with these raised expectations. Few (if any) business enterprises being promoted by conservation organizations are likely to be able to meet these expectations, and few ICAD projects have adequate resources to meet these expectations in other ways, which suggests that ICADs may need to reconsider attempts to compete with logging projects.

- *How to secure a lasting commitment to conservation by several neighbouring communities whose members have no traditional basis for active co-operation in the management of natural resources and who may be sooner or later offered the temptation of substantial rents from large-scale logging operations (Sekhran, 1996).*

Filer (1994) identified that a "deep sense of mistrust" formerly separated Melanesian communities, and together with the pervasive syndrome of jealousy and suspicion that another community may be benefiting more from a "conservation project" presents problems for conservation initiatives in PNG which rely on an alliance of clans to establish a conservation area. Van Helden (1998) discussed, with regard to the highland communities of the Bismark-Ramu area, that "even if a decision at the clan alliance level is made to preserve communal lands, the limited identification by individuals with the larger inclusive groups - let alone abstractions like the "nation" or humanity" is a potential problem…. The lack of identification and competition between people makes the idea of "a common good" which is so important to conservation, difficult to sell".

Many groups working in conservation in PNG believe that the only way to develop a lasting commitment is to foster and develop a conservation conviction in local communities through "conservation education" which goes further than merely environmental awareness programs, and avoids paternalism or preaching. There is less agreement, however, on how this might be achieved. One thing that is clear is that a conservation education program, which is suitable for one area, may not be suitable for another. PNG's diversity of language and traditional culture, coupled with the wide regional variations in the experience of "development" and the wide variation in access to the cash economy, means that no one approach, or even mixes of approaches, to fostering a conservation conviction is likely to be applicable to all of PNG.

- *Where to find the funds required to create and sustain the kinds of development assistance which will last long-enough for resource owners to develop their own capacity to manage an "ICAD" project on their own account;*

Donor funding cycles are generally short (2–3 years) and experience in PNG has shown that lasting conservation outcomes take longer than this funding cycle. Some projects have been going for ten years and are only now starting to achieve conservation outcomes.

Other critical questions that ICADs are still grappling with, and have been highlighted by Filer and Sekhran (1998) include:

- *How to avoid the development of a "project dependent" mentality which turns "development packages" into a form of ransom paid to customary owners for the global benefits of conservation (Orsak 1996).*
- *How donor agencies can enter into "conservation covenants" with customary landowners under legislation which appears to prohibit anyone except an automatic citizen (or the state of PNG) from doing so"*

Van Helden (1998) based his analysis of the likelihood of an ICAD project succeeding on the assumption that three broad conditions need to be in place:

1. Biodiversity of sufficient significance to warrant investment by the international conservation community;
2. Relative security of resource tenure, i.e. there are not conflicting and overlapping claims to "ownership" of the same piece of land and that pressure on resources (both from within the landowning community and from outside it, such as from squatters and resource developers) are not so great that they make conservation impossible; and
3. The landowning communities have sufficient motivation and the ability to participate in such a project, i.e. there is sufficient cohesion within the community and there exists the ability to make and enforce decisions and to jointly undertake activities.

These conditions rarely all fall into place, and when they do, they can give rise to some further problems. For example, ascertaining whether an area has biodiversity values of sufficient significance to attract international attention often entails undertaking biodiversity surveys. For many landowners, their first contact with ICAD projects has been negotiation to undertake a biodiversity survey and then the survey personnel themselves. Often biodiversity surveys have been conducted by expatriate scientists whose general appearance of wealth contrasts sharply with the simpler lifestyles of local communities. Expectations of unrealistic benefits arising from the biodiversity surveys generally arise. Even biodiversity surveys conducted largely by PNG biologists using expensive equipment and eating imported food tend to raise development expectations to unrealistic levels, i.e. ones that ICAD projects cannot meet.

Few biologists are experienced community development workers, and it is common for well-meaning biologists to raise community expectations. Such suggestions as "this would be a great site for an eco-tourism lodge" can later create problems for conservation projects. Particularly when there is no road transport or no reliable flights to the area, and if there are, they are far too expensive to make a lodge competitive with other tourism destinations within the country. Suggestions to individuals that it would be better for them to log their own timber, rather than allow foreign logging companies to log their forests, have lead to expectations that ICAD projects will deliver small-scale sawmills to communities that are in isolated areas, where there is no local market and no infrastructure to get their sawn timber to existing markets. Feasibility studies of eco-enterprises need to be carefully implemented so that they avoid raising community expectations and avoid creating a sense of disillusionment within the local community when an enterprise is found not to be feasible. One example of where a feasibility study led to raised expectations, and subsequent disillusionment, is a crayfish farming feasibility study conducted in the Mt Bosavi area. A crayfish specialist assessed the stocks in the area before a detailed economic analysis was conducted. His presence in the area, and enthusiasm for crayfish farming, raised expectations to such a level that a number of men actually hand dug large holding ponds. A subsequent economic feasibility study showed that it would cost more to fly the crayfish to market in a provincial town than the price they could fetch at market.

WWF experiences in the facilitation of community planning for WMA establishment and management

The experiences outlined in this section are from our joint experiences with communities as a part of the Kikori Integrated Conservation and Development Project (KICDP) which is a joint initiative of WWF (originally WWF-US, and now WWF-International) and the PNG Department of Environment and Conservation with funding from the Kutubu, Gobe and Moran Joint Venture Partners. The area that the KICDP works in covers 2.3 million hectares and is essentially the watershed of the Kikori/Heggigio Rivers in Southern Highlands and Gulf Province (Figure 1).

Before the project started, there were already two Wildlife Management Areas established within the project area: Neiru (Aird Hills) WMA in Gulf Province, and Lake Kutubu WMA in Southern Highlands (Figure 1). Neither could be classified as anything more than reserves on paper. At the start of the KICD Project, the majority of the landowners was unclear of the boundaries of the WMA, the purpose for which the WMA was established, what the rules were and even who in fact had established the WMA. One of these WMAs did have a WMA committee, but the committee was unsure of its role, and had not met for a long time. This same WMA did not have any rules gazetted. The second WMA did have rules gazetted, but these were never enforced, and there was no functioning WMA Committee. Attempts to revitalise these WMAs in general failed,

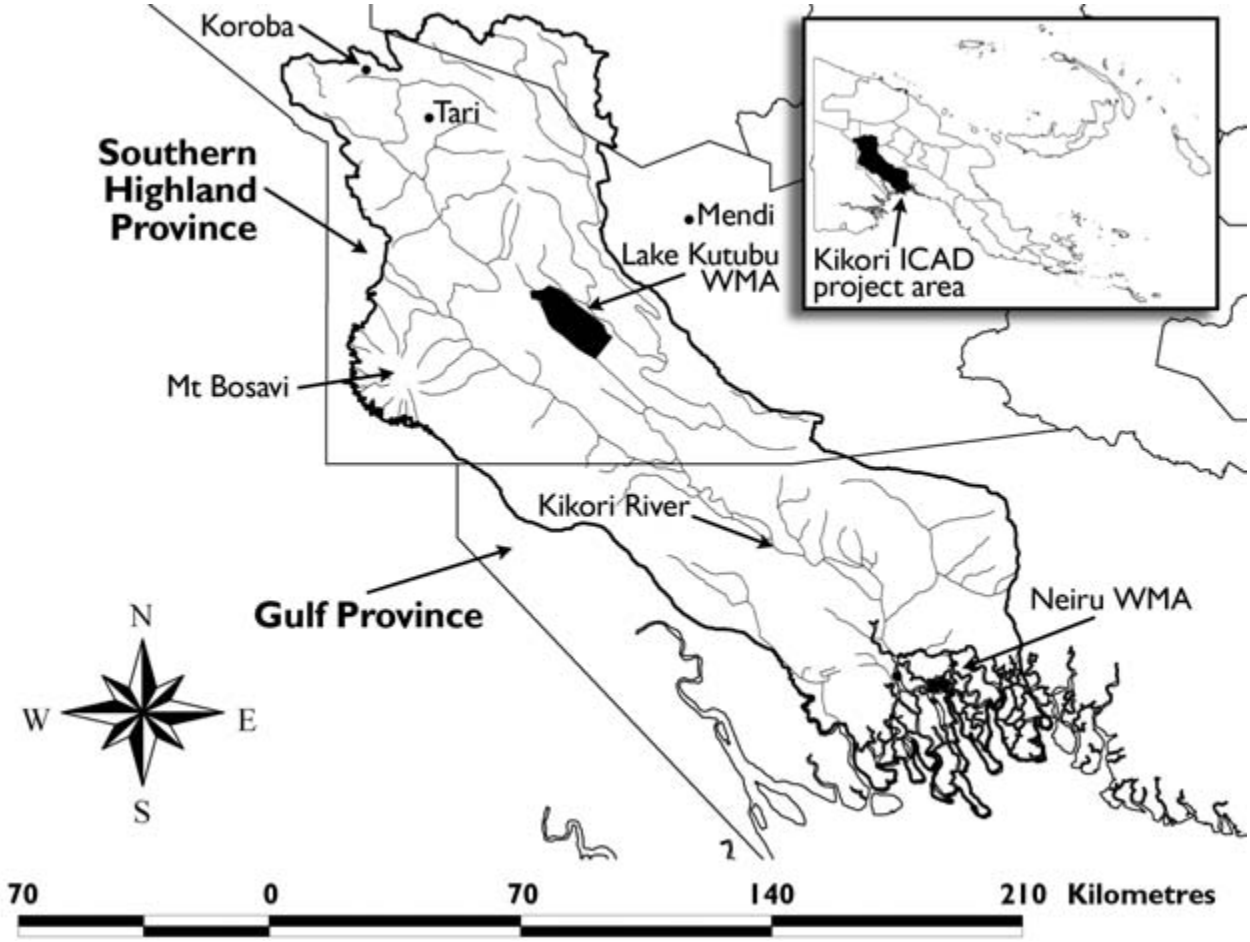

Figure 1. Kikori Integrated Conservation and Development Project area.

although one of these WMAs was for a short period of time revitalised by the establishment of a new WMA committee, and rules and fishery management were implemented.

Contributing factors to the failure of these and other WMAs in PNG that we have observed to be nothing more than "paper parks" include:

1. Communities were unaware of other options for managing their natural resources sustainably.
2. WMAs were established by a few leaders within the community without adequate consultation or understanding of the concept of a WMA by all landowners.
3. WMAs were promoted by outside agencies and the landowners believed that the WMA belonged to the outside agency rather than to the landowners.
4. WMAs were established in the belief that the landowners would obtain some sort of monetary or material benefit from the establishment of the WMA either through charging fees/ fines or through the association of development and income-earning projects with the WMA. When these benefits did not materialise interest in the WMA diminished.
5. WMAs were established without considering all the stakeholders and their use or interest in the land over which the WMA is established.
6. WMA committee members make decisions about the establishment, rules and running of the WMA without consultation with the wider landowning community.
7. WMA committees were unclear of their role and responsibilities and how to enforce the WMA rules.
8. The WMA committee is not representative of all the landowners (*e.g.* women, clans or communities may be omitted from representation on the committee).
9. There is lack of transparency about how the WMA committee makes decisions.
10. The WMA committee misuses funds obtained from fines/penalties or from grant agencies and is not trusted or respected by the community.
11. There is an underlying land-ownership dispute within the area over which the WMA has been declared.
12. There is not a tradition of working together with neighbouring landowning groups and there is a sense of mistrust.

Our involvement in facilitating community planning for the establishment and management of WMAs arose from a declaration by local landowners at a cultural festival. They declared that they wished to protect much of Mt Bosavi, and subsequently a landowner association (Kosua Orogo Resource Owners Association - KORA) requested assistance from WWF to do this. They declared that they wished to protect Mt Bosavi from logging, as at that time a Korean company had been trying (illegally) to negotiate a logging concession in the foot hills of Mt Bosavi.

Concerned at the failure of WMAs elsewhere in PNG, we endeavoured to develop a planning process that would provide information to landowners to try to ensure that they:

1. were aware of the options available for sustainable management of their resources;
2. considered all stakeholders in the land and the resources on the land;
3. reflected upon their current and past use of the land and how they would like to continue utilising resources from the land;
4. looked in detail at any resource management issues they may be facing;
5. developed management regimes that would be likely to last and to achieve the sustainable management of resources that they were concerned about; and
6. developed a management structure that reflected both traditional and contemporary values.

Background on the Mt Bosavi area

Mt Bosavi is a collapsed extinct volcano that is an outlier to the cordillera that runs down the centre of New Guinea. The mountain rises to 2754 m and lies in Southern Highland Province. The Bosavi area is sparsely populated and most of the villages lie between 800 and 1000 m with a population of around 6,660 (National Statistics Office 2000). There are more than 20 villages on the foot slopes of Mt Bosavi. They range in size from one or two families to around 200 people, but most are less than 100 people. Traditionally, villages were based around a central longhouse ("aa" in Kaluli language) where both men and women resided on separate sides of the long-house, but more recently family homes have become more common, though some communities still retain their long-house. There are four main languages spoken in the Mt Bosavi area: Kaluli, Kasua, Sonia and Aimele, but the majority of our work was with Kaluli and Kasua speakers. (Kaluli has four dialects: Ologo, Walulu, Kugenesi and Kaluli).

The Bosavi area is remote, even by PNG standards, with no road or water access. There is a number of grass or mud airstrips scattered through the area, and these are serviced by small aeroplanes on irregular schedules. There are two primary schools in the area and for much of the time these were closed due to lack of teaching staff. There are only two health clinics staffed by a single registered nurse each and these often had no or, at best, very limited medical supplies.

The forests of the Mt Bosavi area are largely intact and support a high diversity of fauna and flora including:

a. two rare and critically endangered rodents - *Pogonomelomys bruijni* known from only three other locations, and *Leptomys signatus* known from only two other (Leary and Seri 1997, T. Leary unpublished survey data);
b. an endemic bird species, Campbell's fairywren *Malurus campbelli*, which is known only from the Bosavi- Nomad River area (Burrows 1995);
c. a number of restricted range endemic bird species such as Carola's parotia *Parotia carolae* and the black sickle bill *Epimachus fastuosus* (Burrows 1995);
d. the greatest diversity of moth species of any place surveyed in PNG to date (Orsak and Eason 1995).

In addition, the mountain is significant to Bosavi people not only as the source of all their drinking water, and as an important hunting area, but culturally and spiritually. Traditionally when Kaluli men hunted on the mountain they had to perform certain rituals and had a completely separate language that was only to be used on the mountain (Schieffelin 1976). Land is extremely important to the people of Bosavi, and Schieffelin (1976) points out that "Kaluli relationships to their land – they way they perceive it and feel about it – is fundamentally important to understanding their experience".

The planning process

The original WMA proposal for Mt Bosavi from the local community covered an extremely large area, and involved more than 15 small villages and landowning clans. After initial discussions, landowners decided that were not happy about planning or making decisions about other people's land and split this larger proposal into a number of smaller proposals based on traditional affiliations that generally covered 1 – 3 villages, but may have covered as many as 11 clans (Table 4 and Figure 2).

WWF asked KORA to confirm that there was widespread community interest and support for establishing a WMA before WWF conducted any awareness activities/ workshops in the area. Once there was confirmation that there was widespread interest, WWF commenced a series of workshops and meetings with local communities. The workshops were participatory in nature and allowed all landowners to discuss and examine the establishment of the proposed WMAs.

Although these workshops are described in a linear fashion below, they did not necessarily proceed in a linear fashion, as in many cases it was necessary to go back to a previous step when a community was unclear or divided on an issue or wanted to refine its decisions.

The literacy rate in PNG is generally low, and in the remote Bosavi area, the literacy level is estimated to be as low as 10%. Many older people and particularly women also do not speak "tok pisin", the lingua franca of the highlands. This meant that workshops and activities needed to rely heavily on visual aids, and translation of our "tok pisin" into the local language ("tok ples"). Often our discussions needed to be translated into more than one language. Luckily, many Papuan New Guineans speak a number of languages (some people speak as many as six or seven languages) and translators were never an issue for our workshops. Often members of the KORA executive acted as translators during our workshops. Workshops were held either in villages (generally in the local church, but sometimes out of doors) or at a camp in the proposed WMAs. Attendance at these ranged from 10-20 people to over 100. On some occasions separate meetings were held with women only, to encourage their greater participation.

The workshops

WWF staff conducted introductory workshops that provided an overview of the laws pertaining to protected area management in PNG and other options for sustainable resource management including re-enforcement of traditional conservation methods and areas such as "ples tambu" and "masalai ples". WWF staff never advocated the establishment of a WMA, or any other type of protected area for that matter,

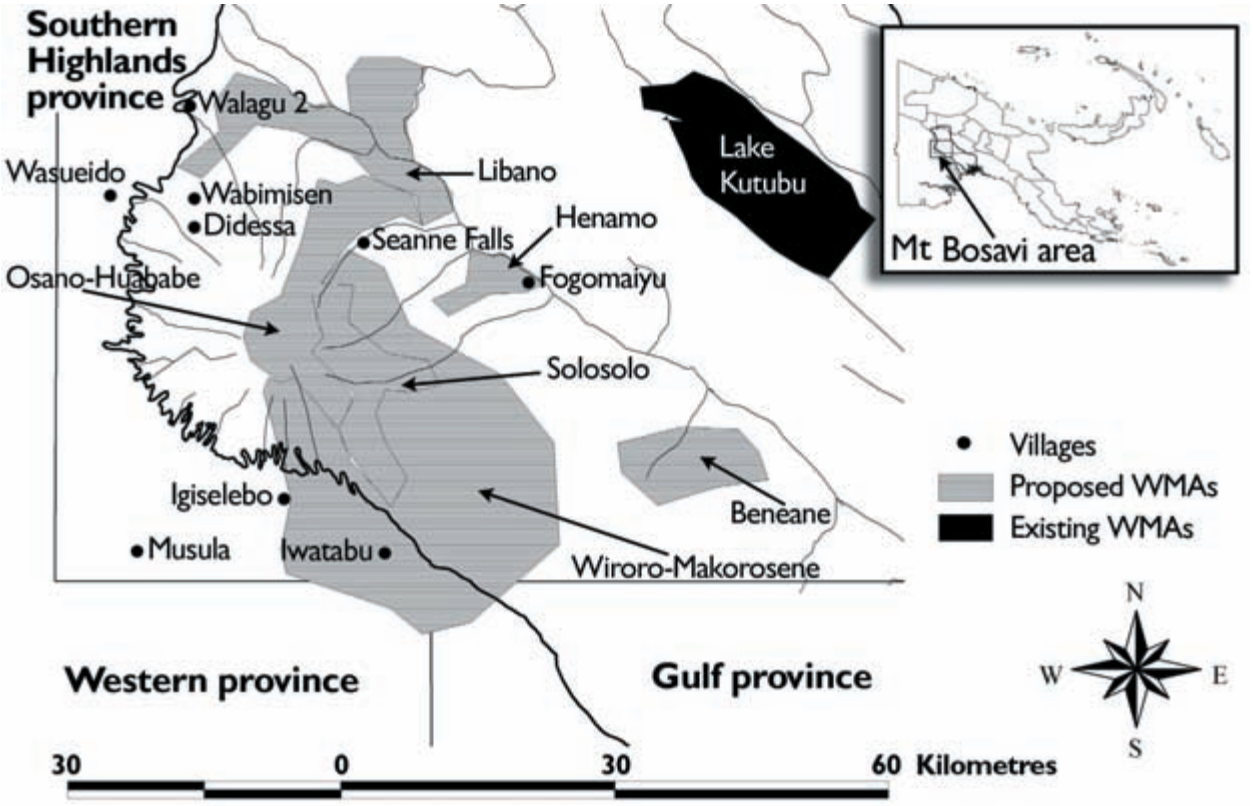

Figure 2. Proposed Wildlife Management Areas (WMAs) in the Mt Bosavi area.

Table 4: Proposed Bosavi WMAs

Name of WMA	Approximate Area (ha)	Villages proposing	Number of clans involved
Libano	8,250	Wabimisen Walagu 2 Fogomaiyu	11
Henamo	4,600	Fogomaiyu	5
Osano-Huababe	9,100	Seanne Falls Igiselebo	7
Wiroro-Makrosen	40,700	Iwatabu Fogomaiyu	6
Solosolo	9,100	Musula	3
Beneane	3,450	Fogomaiyu	2
Agoro	Boundaries not identified yet – but will abut with Solosolo	Didessa	10
Gamudo, Gemi, Mt Tubi, and Suli	Boundaries not identified yet – only introductory workshop held	Wasueido Amine	8

but saw its role as a provider of information that landowners may not have access to, upon which landowners could decide how they wished to proceed. In all cases where landowners decided to develop a protected area, the landowning clans opted for the establishment of a WMA.

The workshops were designed to ensure that landowners had a good understanding of what exactly a WMA was, what establishment would mean to the landowners, and what steps they would need to take if they decided to establish a WMA. At this stage, WWF tried to dispel any misconceptions that communities may have had about the benefits they would obtain from establishing a WMA. Some communities believed that they would obtain money, cargo or at least projects from WWF if they established a WMA. These introductory workshops also encouraged landowners to articulate the reasons why they wished to establish a WMA.

At the conclusion of every workshop, WWF facilitated participants to develop action plans of the next step that they needed to complete if they wished to pursue establishment of their proposed WMA. Foremost of these was generally to ensure that wider discussions were held in the community about what they had heard in the workshop. WWF continually stressed that the decision to establish a WMA cannot be made by one person, or the few people at the meetings or workshops, but needed to be taken by their clan as a whole. After the introductory workshop, WWF held no further workshops unless it received a letter of request for assistance to plan for the establishment of the WMA, from the landowning clans. If WWF did receive a letter, KORA executive (who were members of that community or nearby communities) were often asked to verify that wider discussions in the community or clan had been held, and that there was general agreement to proceed, and that there were no land disputes over the intended WMA.

The first planning workshop reviewed the material provided in the introductory workshop, and facilitated community members to identify landowning clans and individuals and other potential stakeholders in the area, such as people who may not be landowners, but may have usage rights such as hunting rights or rights to collect certain plants for building materials in this area. The idea of doing this was not so much to establish who the actual landowners were, but to get the community to reflect on who else might be affected if they continued to go ahead with their WMA proposal. Ultimately the aim was to try to ensure that anyone who was a stakeholder in the area was consulted and could be brought into the planning process.

The next step was to establish the boundary of the area. This was done using a variety of methods such as using bush materials (*e.g.* leaves and branches) to represent the area on the ground or by making a sketch map of the area. Bosavi people have an intimate knowledge of their land. Bosavi people know the course of every creek and stream and give a name to each, as well as to every area of land. Important landmarks such as prominent hills have names of their own and some places are named after important events that occurred there.

Landowners were asked to reflect upon and depict past and present land and resource use of the area. Bosavi people know the resources of their area in detail, such as where to find the right bark for flooring the house, or where to find particular plants to use to treat an illness. Many Bosavi men have an excellent knowledge of the ecology of vertebrate species that are hunted for game and are well aware of the distribution and abundance of particular species. For example, some men have detailed knowledge of which species of tree certain species of birds will flock to in a certain season, and know which berry bearing shrub to set traps around for a particular marsupial.

The land-use information was transferred to the sketched boundary maps. Later these were transferred to topographic maps with the assistance of some landowners who were familiar with reading topographic maps and landmarks that were not detectable from topographic maps (*e.g.* places named after events) were later mapped using a GPS. The intent of this planning step was to ensure that the people in the workshops did not make rules that precluded use of resources that they wished to

continue using once the WMA was established. This was particularly the case for those resources for which women have the primary responsibility of collecting. Men tended to do much of the talking and decision-making and it was important that any decisions that were made took into account the often less-vocal needs of women.

Later workshops reviewed this information, and began to look at resource management issues and problems, and identified declining fauna and flora. WWF facilitated landowners to undertake a root cause analysis of these problems and issues and had them reflect on sustainable resource management practices. Communities were encouraged to analyse traditional and present management practices. One of the major realisations for many community members was that conservation and sustainable resource management practices were not new foreign ideas, but something that they and their ancestors had been practising for many generations. The fact that so much primary rainforest remains, and that so many species have survived, is a testament to this.

WWF then facilitated reflection by landowners on which resource management problems/issues and root causes can practically be managed and which cannot. A set of rules or management actions were then drafted by the landowners and penalties for breaking the rules set. These often went through many drafts. Examples of some of the types of rules developed in different WMA areas are given below:

1. It is prohibited to use shotguns or home-made guns within the WMA, but it is permissible to use bow and arrows, spears and bush traps;
2. It is prohibited to kill Raggiana bird-of-paradise *Paradiseae raggiana* and freshwater crocodiles *Crocodylus novaeguiniea*.
3. It is prohibited to collect the eggs of dwarf cassowary *Casuarius bennetti*, megapodes *Megapodius freycinet* and brown-collared brush turkey *Talegella jobiensis*. It is also prohibited to kill southern cassowaries *Casuarius casuarius* that are incubating eggs or rearing chicks.
4. It is prohibited to use fishing nets in Libano, Bion, Kulu and Afum rivers/creeks. It is permissible to use traditional fish traps ("trap bilong tumbuna"), hooks and lines, and spears. Dive masks can be used in all of these creeks except Afum.
5. It is prohibited to kill tree kangaroos (*Dendrolagus* species).
6. It is prohibited to clear ground for large food gardens (such as banana plantations), but it is permissible for landowners to make small subsistence gardens in secondary forest.
7. Logging is prohibited from the area.
8. Landowners can only kill the following wildlife species in the WMA six times per year: wild pigs, ***Basiaba,*** Salvator's monitor (*Varanus salvatori*), tree kangaroos (*Dendrolagus dorianus*, *Dendrolagus spadix* and *Dendrolagus goodfellowi*), ***Kosala*** (*Candoia carinata*) cuscuses (*Phalanger* and *Spilocuscus* species), palm cockatoo (*Probosciger aterrimus*), ***Hakabi'*** (southern crowned pigeon - *Goura scheepmakeri*), horn-bills (*Rhyticeros plicatus*), ***Kabaleo*** (*Megapodius freycinet*), brush turkey (*Talegalla fuscirostris*), ***Nene*** (*Aepypodius arfakianus*), eagles, and pigeons.
9. All hunting is prohibited in the WMA.

Next we facilitated the community in designing an appropriate management body for the WMA. Most WMAs in PNG are managed by a WMA committee of landowners. In some areas, the manner in which a WMA Committee is established is not transparent and this has often led to later dissatisfaction with the committee. To avoid problems observed elsewhere in PNG, landowners were asked to consider how they could make the committee work well, and what kinds of rules they might want to establish for the smooth running of the committee. Some committees elsewhere have stagnated because the committee members do not understand their role and responsibilities, or because the landowner community did not have processes established whereby they could dismiss committee members who were not adequately representing the landowners' views or reporting on the committee's activities. Rules articulated by communities include: how the committee was to be elected or nominated, how each clan or community should be represented, how the committee would report to the landowners, what sort of things would result in the dismissal of committee members etc.

The final workshop reviewed and revised outputs from previous workshops (some of which had already been revised a number of times to ensure consensus), and an application developed for submission to the Department of Environment and Conservation (DEC). Once the application was received by DEC, an officer from the Department generally visited the area to ascertain that the rules, committee members and boundary were agreed to by all of the community and to confirm that there was no land dispute over the area.

While awaiting gazettal of the WMA (which has proven to be a lengthy period), WWF then facilitated the committee and the community to look more closely at the roles and responsibilities of the WMA committee and to self-assess the skills they possessed and any training needs they might have. The landowners developed their own training plan. WWF then developed training courses or accessed trainers to implement the training plan.

Some lessons learnt

The planning process took much longer than we anticipated due to the need for the community to discuss issues at length and reach consensus. Moving at the pace of the community is important because it allows consensus to be built. We believe that it is important for outsiders, facilitating community discussions and planning, not be seen to be promoting WMAs or any other protected area, as this tends to disempower the community.

One outcome of our facilitation of planning was that neighbouring clans and communities heard about what we were doing and also requested our assistance to facilitate planning to establish WMAs on their land. The demand for our assistance has far outweighed our ability to provide assistance, as we found that there is in many communities a genuine concern about declining wildlife and sustainable resource management. Future

work by WWF will focus on further development of training materials and providing training to community leaders, such as the executive of KORA, so that they can facilitate this planning process themselves with less assistance from WWF. A resource book with facilitation notes for workshops is currently in preparation.

The planning process that we have employed has applications beyond the development of WMAs and could equally be employed with some minor alterations by communities wishing to undertake sustainable land-use planning that does not necessarily result in the establishment of a WMA. It is our belief that sustainable land-use planning by local communities, may result in at least the same conservation outcomes as WMA establishment, and may have broader conservation outcomes across the wider landscape.

While establishment of WMAs and other protected areas partially meet conservation of forest and forest fauna objectives, in isolation, it is unlikely that they will achieve conservation of all forest fauna (particularly large highly mobile species and species that undertake seasonal and altitudinal movements in pursuit of food sources). Other mechanisms will be needed. Hunt (2002) argues that forest certification and promotion of small-scale "eco-forestry" may be a more cost-effective means of achieving conservation goals than the creation of new protected areas, although he acknowledges that protected areas will still be required. Current, large-scale industrial forestry practices appear to be both highly destructive and non-sustainable, and a change in practices is clearly needed. Unfortunately neither the National Forest Authority or the Department of Environment and Conservation have adequate resources to enforce the current "logging code of practice", which if adhered to would considerably reduce the impacts of logging.

There has been a number of proposals for a representative reserve system and priorities for conservation in PNG including proposals by Specht *et al.* (1974), Diamond (1976), Parsons (1983), Beehler (1985), the Conservation Needs Assessment (Alcorn (1993) and Beehler (1993a) and the most recent BioRap biodiversity assessment (Nix *et al*. 2000, Faith *et al.* 2001a,b,c,d). However, they all fail to adequately take into account the level of landowner interest in conservation and the development aspirations of local communities, and fail to incorporate some assessment of "social feasibility" as argued by Brown and Holzknecht (1993). While these assessments may act as pointers as to where Department of Environment and Conservation and conservation NGOs may wish to initiate discussions with landowners and assess "social feasibility", without the interest, commitment and conservation conviction of local communities, establishment of conservation areas of any sort is doomed to failure. Concern has often been expressed that assessments of these types can potentially take away resources for conservation from local communities who have shown a real interest or commitment to establishing conservation areas or sustainable management regimes, if their area is not rated highly. We believe that landowner interest and commitment to conservation is the most important factor for long-term success of conservation areas and should be heavily weighted when considering conservation area priorities for PNG. The most recent BioRap assessment does offer flexibility in this matter and is not a static assessment. Conservation priorities can be re-assessed as new areas are gazetted and/or landowner interest in conservation areas has been articulated. The BioRap assessment may potentially be flexible enough to incorporate some sort of social feasibility assessment, other than the opportunity cost of logging and agriculture for conservation area establishment.

Some research priorities for PNG's forest fauna

While establishment of conservation areas by committed landowners or broad-scale land and resource-use planning by local communities may be part of the answer to achieve conservation of PNG's forest fauna, the current level of scientific knowledge of PNG's fauna is inadequate to assess the effectiveness of conservation areas, but also to determine what other measures may need to be taken to ensure effective conservation of PNG's fauna.

There is a number of basic distributional and ecological questions that need to be answered to design effective conservation areas. Research needs to bear in mind that effectively-designed conservation areas are meaningless without the support and commitment of customary landowners and the conservation conviction to implement them. There are also the complex issues of raising community expectations of benefits from conservation which need to be born in mind when conducting research. Perhaps one way in which these issues can be addressed is by biologists utilizing landowner research facilities, such as those at Crater Mountain WMA, to conduct their research. Benefits from conservation flow to local communities from the guest houses used by visiting scientists, and the employment of local landowners as trained local observers.

The PNG Conservation Needs Assessment (Beehler 1993a; Allison 1993) made a number of recommendations for research priorities for PNG's vertebrate fauna in general which have largely not been acted upon. We have incorporated four of these recommendations, along with our own, that we consider to be of importance:

1. Undertake taxonomic revision of poorly understood groups. This should include at least the amphibian and reptile genera identified by Allison (1993) and the mammal genera identified above. Taxonomic revisions should include an emphasis on identifying characteristics useful for the field identification of species. Field guides and identification manuals for rodents, frogs and reptiles could then be produced. The caution by Parnaby (1991) that consistent morphological differences may not exist for all species should be taken into account.
2. Undertake systematic vertebrate fauna surveys in the areas identified as poorly known to science by the Conservation Needs Assessment with specific focus on the more elusive and/or rare species of mammal and bird. Identifying priorities should be heavily based on landowner interest and commitment to conservation, the CNA process, and the systematic survey work recently conducted in some of these areas by conservation organisations (*e.g.* work at Crater Mountain by Research and Conservation Foundation

and Wildlife Conservation Society, work in the Kikori Basin/ Mt Bosavi area by World Wide Fund for Nature (Leary *et al.* 1996, Leary and Seri 1997), and work in the Lakekamu Basin by Conservation International and Foundation for People and Community Development Inc. (Mack 1998). Such survey work needs to collect precise locality data, physical and abiotic data at survey sites, and a series of referenced voucher specimens need to be collected at each site to provide a baseline for assessing future trends in faunal assemblages and to ensure that subsequent taxonomic revisions do not invalidate survey results. It is imperative that survey results are published so that they are not lost in the extensive "grey" literature (unpublished reports) being produced by NGOs.

3. Undertake systematic fauna survey in areas that are, or are likely to be, threatened by logging and oil palm plantation establishment, *e.g.* in lowland rainforest where logging concessions are being or likely to be negotiated so that, at least, the fauna can be documented before it is lost to logging, and at the best, areas of high conservation significance can be conserved.
4. Undertake ecological studies of keystone, highly mobile and threatened species – especially large charismatic species that are likely to have large home ranges. Information on the ecology of such species is essential if conservation areas are to be designed to protect them. Beehler (1993b) highlights the need to study the elevational and geographic movements of montane forest birds that depend on fruit and nectar. Different age groups appear to move in differing patterns and El Nino events may influence major non-annual movements. These movements need to be taken into account when designing conservation areas to protect fauna that is not sedentary.
5. Long-term population studies of keystone vertebrates in regenerating forest patches, *e.g.* especially areas regenerating after logging.
6. Studies to examine the impacts of large scale industrial logging on mammals, amphibians, and birds of the forest interior.
7. Studies to examine the impacts of conversion of forests to oil palm plantations on vertebrate fauna on a regional scale.
8. Studies that document the monetary value of subsistence values that are lost when forest is converted to oil palm plantations or logged.
9. Studies that examine the impacts of "eco-forestry" or small scale selective logging (that only removes a few trees per hectare) on mammals, amphibians, and birds of the forest interior. (We are currently studying the impacts of eco-forestry on bats and rodents, but more studies are needed in different forest environments.)
10. Detailed ecological and population studies on highly sort after game species, such as tree kangaroos, forest wallabies, cuscuses, cassowaries, Goura pigeons, so that recommendations for sustainable harvest/hunting by local landowners can be made.
11. Distribution and habitat modelling of species for which there is adequate existing information, *e.g.* some birds and mammals as a result of the extensive Archbold Expeditions. This may lead to further detailed survey/ research work to determine what factors have led to patchy distribution of some species, such as Pesquet's parrot *Psittrichas fulgidus*, or what factors result in the abrupt end of the range of a species when there appears to be suitable forest type continuing for hundreds of kilometres.
12. Studies that examine the effectiveness of WMA rules in conserving selected fauna species on a regional scale, *e.g.* whether or not WMAs act as sources for large game species that are hunted outside of the reserve.
13. Studies that focus on the interactions between rainforest flora and fauna, *e.g.* pollination and seed dispersal studies, and research on diet and seasonal reproductive cycles, and diet and patterns of movement among keystone mammals and birds. The results of such studies have implications for the design of conservation areas, for improved forest and logging management practices and post-logging regeneration.

Some cautionary notes for biologists

Biologists proposing to work in PNG need to consider the potential damage that they may do to conservation initiatives and they should ensure that they take all steps necessary to minimize the risk of raising community expectations. The timing of biodiversity surveys within ICAD projects is critical. They should not be the first encounter with local communities of an ICAD project as they are likely to raise community expectations to unreasonable levels. Landowners are often suspicious of the underlying motive of biologists, and research is generally of little relevance or interest to landowners. Many landowners' experience with expatriate surveys has related to resource exploitation (*i.e.* prospecting or timber surveys), and interest by a group of expatriate scientists is likely to make them suspicious that the scientists have ulterior motives or will benefit financially from these surveys. When conducting fauna and flora survey work in PNG, we have often been asked whether the specimens that we are taking will be sold. We explain that these will be lodged in the museums in Port Moresby or the National Forest Institute in Lae, but we are not sure that this is always believed. It seems that no amount of preparation/discussion and involvement of landowners in survey will allay fears that biologists have ulterior financial motives for conducting surveys. Over the years, prior to surveys we have produced pictorial leaflets in tok pisin (the PNG lingua franca), held slide shows, spent days in villages discussing why we would like to carry out survey, involved community members and leaders with extensive traditional knowledge in the surveys and had community development workers from the area explain the purpose of a proposed survey. Despite this, many surveys have resulted in an unexpected claim for financial "compensation". We believe that this is largely due to do with the timing of

the survey. Survey, or even research work, should not be conducted before a relationship has been developed with the local landowning community. Ideally, surveys should only be at the request of landowners. This means that survey work is likely to occur late in a conservation project. For example, after three years of facilitating planning by local landowners to establish a WMA in the Libano River area (Southern Highlands Province), landowners requested World Wildlife Fund for Nature to conduct biodiversity survey on their land. None of the problems faced elsewhere when conducting biodiversity were encountered during this survey, which took place in August 2003. Landowners were involved in the planning of the survey and facilitated discussions were held prior to the survey to ascertain what information the community would like to obtain from the biodiversity survey, how they might use this information, which knowledgeable landowners should be involved in the survey, and to determine what information might feasibly be obtained from the survey.

The need to build capacity of PNG terrestrial vertebrate biologists

A small number of PNG nationals have extensive vertebrate field survey experience and the skills necessary to confidently identify terrestrial vertebrate fauna groups to the species level. There are no PNG nationals working as vertebrate taxonomists. Some of the issues relating to raised expectations would be negated if more of the research and survey work needed for conservation was conducted by PNG biologists.

Although a relatively large number of PNG biology students graduate each year, few end up working as field biologists on terrestrial vertebrates. Those PNG biologists lucky enough to find employment with national institutions, such as the Department of Environment and Conservation, the PNG National Museum and Art Gallery, Wau Ecology Institute, the University of Papua New Guinea, and the University of Technology (Lae) are hampered by lack of funds and consequently have conducted few surveys in the past few years that have not been sponsored by outside organisations. Likewise, most biology undergraduates obtain little practical field experience on terrestrial vertebrates due to funding constraints at the University of Papua New Guinea and the University of Technology.

In recent years the American Wildlife Conservation Society (WCS) has run a number of courses for undergraduate biology students of PNG and Papua (Indonesia) to provide additional experience in conducting field survey, identification of fauna and flora, experimental design and statistical analysis of research projects. While these courses have provided excellent additional training and experience for PNG field biologists, only so much can be learned and experienced in a short course. There is a need to build the capacity of PNG field biologists by enabling them to gain much more experience. One way NGOs that are undertaking conservation program in PNG can achieve this aim is to develop Conservation Science programs within their projects that include survey and research components. Although many NGO conservation organisations have included survey work, many were conducted by overseas researchers without PNG counterparts. In our opinion, survey work should meet two aims – achieving an understanding of the biodiversity significance of an area, and building the capacity of PNG biologists. This will mean that new approaches to conducting survey will be needed since getting a survey completed in a short period of time is not really compatible with transferring skills to PNG biologists. However, the timing of biodiversity survey in conservation projects needs careful consideration.

Menzies (1993) concluded that most of the papers written on New Guinea mammals are taxonomic and based on material shipped to overseas institutions. In a review of research papers published between 1960 and 1990, he calculated that an average of 6–8 papers were published per annum and that, of these, only 1 to 3 per year were based on long-term field studies. Long-term field studies are the only way that knowledge of the biology of most PNG forest fauna will be improved.

Long-term field studies require long periods of time in the field, or many revisits over seasons and years, and relatively few visiting zoologists can afford to spend such periods of time in the field, and the cost of travel to and from PNG is high. Building the capacity of PNG nationals to undertake long-term field studies, and the provision of adequate funding for them to undertake these studies, seems to be the only viable solution to filling the vast gaps in the knowledge of the majority of forest vertebrate groups. Another essential ingredient to obtaining a greater understanding of the ecology of many species is enlisting the support and documenting the knowledge of good hunters and other landowners with detailed ecological knowledge of certain species. Care, however, needs to be taken to ensure that those informant's intellectual property rights are protected.

Biodiversity survey and research has not been given a high priority by the PNG government since it has more pressing issues and priorities in health, education and law and order, and it seems likely that the government will never be in a position to allocate adequate funding towards such research and survey work. The most plausible source of funding is likely to be international NGOs and international aid donors. While some international NGOs working in PNG have contributed to raising the capacity of PNG biologists to conduct research and survey, greater emphasis should be given by them. Some NGOs, such as Conservation Melanesia, WWF, and WCS have provided funding for a small number of scholarships for Honours degree research and Masters degrees. More is needed. Other options for building greater capacity lies with overseas academic and research institutions and museums building meaningful and beneficial partnerships with PNG national institutions.

Many visiting academics and researchers who visit PNG for short periods point out that they have only limited research funds themselves. However, employing a young PNG biologist for a year is only likely to cost in the

vicinity of $AUD 8-10,000 a year which is not a great amount given the research budgets of some institutions. Universities, museums and other overseas institutions need to be provided greater encouragement to form meaningful partnerships with PNG government and NGO institutions, to provide the mentoring and field experience for PNG biologists, and sufficient funds for them to conduct mutually-beneficial survey and research programs.

Once adequate field guides are available for most PNG vertebrate fauna groups it will be far easier for PNG nationals to conduct research and survey work without the input of specialised expatriate taxonomists. The key to answering some of the fundamental questions necessary for the adequate conservation of PNG's fauna lies in building the capacity of PNG biologists and in securing adequate funds for them to undertake long-term research.

References

Allen, G. R. 1996a. Two new species of Rainbowfishes (Melanotaenia: Melanotaenidae), from the Kikori River system, Papua New Guinea. *Revue of Freshwater Aquariology* **23**: 9 - 16.

Allen, G. R. 1996b. *Oxyeleotris caeca,* a new species of blind cave fish (Eleotridae) from Papua New Guinea. *Revue of Freshwater Aquariology* **23 (1-2)**:43 - 46.

Allen, G. R. 1996c. Supplemental survey of fishes of the Kikori River Basin, Papua New Guinea. Unpublished report to WWF.

Alcorn, J.B. (ed.) 1993. *Papua New Guinea Conservation Needs Assessment Volume 1.* Biodiversity Support Program and Government of Papua New Guinea, Department of Environment and Conservation. Corporate Press Inc, Landover, Maryland.

Allison, A. 1993. Biodiversity and Conservation of the fishes, amphibians and reptiles of Papua New Guinea. Pp. 157 – 226 in *Papua New Guinea Conservation Needs Assessment Volume 2* edited by B. M. Beehler. Government of Papua New Guinea, Department of Environment and Conservation, Port Moresby.

Baker, W. 1997. Rattans and rheophytes - Palms of the Mubi River. *Principes* **41(3) :** 148 - 157.

Beehler, B. M. 1985. *Conservation of New Guinea forest birds ICBP technical publication No. 4*. International Council for Bird Preservation, Cambridge, UK.

Beehler, B. M. (ed.) 1993a. *Papua New Guinea Conservation Needs Assessment Volume 2.* Biodiversity Support Program and Government of Papua New Guinea, Department of Environment and Conservation. Corporate Press Inc, Landover, Maryland.

Beehler, B. M. 1993b. Biodiversity and Conservation of the warm-blooded vertebrates of Papua New Guinea. Pp. 77 – 156 in *Papua New Guinea Conservation Needs Assessment Volume 2* edited by B. M. Beehler. Government of Papua New Guinea, Department of Environment and Conservation, Port Moresby.

Beehler, B. M., Pratt, T. K. and Zimmermann, D. A. 1986. *Birds of New Guinea*. Princeton University Press, Princeton, New Jersey.

Birdlife International 2000. *Threatened Birds of the World.* Lynx Edicions and Bird Life International, Barcelona, Spain and Cambridge, UK.

Bonaccorso, F. J. 1998. *Bats of Papua New Guinea*. Conservation International Tropical Field Guide Series. Conservation International, Washington DC.

Brass, L. 1959. Results of the Archbold Expedition No. 79. Summary of the Fifth Archbold Expedition to New Guinea, 1956-1957. *Bulletin of the American Museum of Natural History* 127**:** 145-216.

Brown, M. and Holzknecht, H. 1993. An assessment of institutional and social conservation issues in Papua New Guinea. Pp. 57 – 110 in *Papua New Guinea Conservation Needs Assessment Volume 1 : Conservation Issues, CNA workshop and recommendations* edited by J. A. Alcorn. Government of Papua New Guinea, Department of Environment and Conservation, Port Moresby.

BRS 2003. Australia's State of the Forest Report 2003. National Forest Inventory, Bureau of Rural Science, Canberra, Australia.

www.affa.gov.au/corporate_docs/publications/pdf/rural_science/forest_vegetation/state_of_the_forest

Buenaflor, V. 1989. Logging in Papua New Guinea. United Nations Development Project/ Food and Agriculture Organisation, Rome.

Buenaflor, V. and Tiki, T. 1989. Forest management research and development, Papua New Guinea: logging studies in Vanimo lowland forests. FAO: DP/84/0003, Working Document 7. UNDP/FAO, Lae.

Burrows, I. 1995. A field survey of the avifauna of the Kikori River Basin. Unpublished Report to WWF Kikori Integrated Conservation and Development Project.

Cameron, A. L. and Vigus, T. 1993. Papua New Guinea volume and growth study: regeneration and growth of the moist tropical forest in Papua New Guinea and the implications for future harvest. Unpublished reports to the World Bank. Division of Wildlife and Ecology, CSIRO, Canberra.

Churchill, S. 1998. *Australian Bats.* Reed New Holland, Sydney.

Clunie, N. M. U. 1976. *Botanical and Ecological Survey of the Nakanai Plateau, New Britain. Ecological Progress Report No. 2.* Division of Botany, Department of Forests, Lae.

Coates, B. J. 1985. *Birds of Papua New Guinea. Volume One: Non-Passerines.* Dove Publishers, Alderley, Queensland.

Coates, B. J. 1990. *Birds of Papua New Guinea. Volume Two: Passerines.* Dove Publishers, Alderley, Queensland.

Coates, B. J. and Peckover, W. S. 2001. *Birds of New Guinea and the Bismarck Archipelago: a photographic guide.* Alderley, Queensland.

Cooper, W. T. and Forshaw, J. M. 1977. *The Birds of Paradise and Bower Birds*. Collins, Sydney.

Department of Education 1981. *Birds of the Aiyura Valley (Eastern Highlands, Papua New Guinea)*. Government Printer, Port Moresby.

Diamond, J. M. 1985. A proposed natural reserve system for Papua New Guinea. Unpublished report.

Ellis, J. A. 1997. *Race for the rainforest II : Applying lesson learned from the Lak to the Bismarck-Ramu Integrated Conservation and Development Initiative in Papua New Guinea.* PNG Biodiversity Conservation and Resource Management Programme. Department of Environment and Conservation/ United Nations Development Programme – Global Environment Facility, UNOPS-PNG/93/G31, Waigani, PNG.

Faith, D. P., Nix, H. A., Margules, C. R., Hutchinson, M. F., Walker, P. A., West, J., Stein, J. L., Kevesten, J. L., Allison, A. and Natera, G. 2001a. Introductory paper – The BioRap biodiversity assessment and planning study for Papua New Guinea. *Pacific Conservation Biology* **6**: 279 - 88.

Faith, D. P., Margules, C. R., Walker, P. A., Stein, J. L., and Natera, G. 2001b. Practical applications of biodiversity surrogates and percentage targets for conservation in Papua New Guinea. *Pacific Conservation Biology* **6**: 289 – 303.

Faith, D. P., Margules, C. R. and Walker, P. A. 2001c. A conservation plan for Papua New Guinea based on biodiversity trade-offs analysis. *Pacific Conservation Biology* **6**: 304 - 324.

Faith, D. P., Walker, P. A. and Margules, C. A. 2001d. Some future prospects for systematic biodiversity planning in Papua New Guinea – and for biodiversity planning in general. *Pacific Conservation Biology* **6**: 325 - 343.

Filer, C. 1994. The nature of human threat to Papua New Guinea's biodiversity endowment Pp. 187 – 199 in *Papua New Guinea Country Study on Biological Diversity*, edited by N. Sekhran and S. Miller. Colorcraft Ltd, Hong Kong.

Filer, C., and Sekhran, N. 1998. Loggers, donors and resource owners. *Papua New Guinea Country Study - Policy that works for forest and people. Series No 2.* National Research Institute, Port Moresby and Institute for Environment and Development, London. Russell Press, Nottingham, UK.

Flannery, T. F. 1990. *Mammals of New Guinea.* Robert Brown & Associates, Sydney.

Flannery, T. F. 1992a. New Pleistocene marsupials (Macropodidae: Diprotodontidae) from subalpine habitats in Irian Jaya. *Alcheringa* **16**:321 - 331.

Flannery, T. F. 1992b. Taxonomic revision of the *Thylogale brunii* complex (Macropodidae: Marsupialia) in Melanesia with a description of a new species. *Australian Mammalogy* **15**: 7 - 23.

Flannery, T. F. 1994a. The fossil land mammal records of New Guinea: a review. *Science in New Guinea* **20**: 39 – 48.

Flannery, T. F. 1994b. *The Future Eaters*. Reed Books, Melbourne.

Flannery, T. F. 1995. *Mammals of New Guinea – Revised and Updated Edition.* Robert Brown & Associates, Sydney.

Gilliard, E. T. 1969. *Birds of Paradise and Bowerbirds*. Wiedenfield and Nicolson, London.

Gould, J. 1888. *The birds of New Guinea and the adjacent Papuan Islands, including many new species recently discovered in Australia. Volume 1* [facsimile]. London, UK.

Gould, J. and Rutgers, A. 1970. *Birds of New Guinea – Illustrations from the lithographs of John Gould.* Methuen & Co Ltd. London.

Hammermaster, E. T. and Saunders, J. C. 1995. *Forest resources and vegetation mapping of Papua New Guinea.* PNG Resource Information System Publication No. 4. Australian Agency for International Aid, Canberra.

Hunt, C. (ed.) 2002. *Production, privatization and preservation in Papua New Guinea forestry.* Instruments for sustainable private sector forestry series. International Institute for Environment and Development, London.

Iredale, T., 1956. *Birds of New Guinea Volume 1 and 2*. Georgian House, Melbourne.

IUCN 2002. *2002 IUCN Red List of threatened species.* International Union for Conservation of Nature and Natural Resources. www.redlist.org

Jenkins, A., Bustard, P. and Allen, G. R. 2000. Two new species of freshwater gudgeons (Eleotrididae: Mogurnda) from Lake Kutubu, Papua New Guinea. *Ichthyological Exploration of Freshwaters* **10:** 447 - 454.

Johns, R. J. 1972. Vegetation. Pp. 1163 –1170 in *Encyclopedia of Papua New Guinea Volume 2* edited by P. Ryan. Melbourne University Press, Melbourne.

Johns, R. J. 1976. A provisional classification of the montane vegetation of New Guinea. *Science in New Guinea* **4**: 105 – 107.

Johns, R. J. 1993. Biodiversity and Conservation of the Native Flora of Papua New Guinea. Pp. 15 – 76 in *Papua New Guinea Conservation Needs Assessment Volume 2* edited by B. M. Beehler. Government of Papua New Guinea, Department of Environment and Conservation, Port Moresby.

Lane-Poole, C. E. 1925. The Forest Resources of the Territories of Papua and New Guinea. Report to the Parliament of the Commonwealth of Australia. Melbourne: Government Printer, State of Victoria.

Leary, T., Naug, R., and Price, J. 1996. Kikori Integrated Conservation and Development Project: Sustaining the Environment and Promoting Conservation and Sustainable Development Alongside the Kutubu Joint Venture Petroleum Development. Pp. 805 – 814 in *Petroleum Exploration, Development and Production in Papua New Guinea: Proceedings of the Third Petroleum Convention, Port Moresby* edited by P.G. Buchanan. Port Moresby.

Leary, T. and Seri, L. 1997. An annotated checklist of mammals recorded in the Kikori River Basin, Papua New Guinea. *Science in New Guinea* **23 (2)**: 79 – 100.

Mack, A. (ed.) 1998. *A biological assessment of the Lakekamu Basin, Papua New Guinea. Rapid Assessment Program Working Paper No. 9.* Conservation International, Washington, DC.

Mackay, R. D. 1970. *The birds of Port Moresby and district.* Nelson, Melbourne.

Mayr, E. 1945. *Birds of the South-west Pacific*. MacMillan, New York.

Menzies, J. I. 1976. *Handbook of common New Guinea frogs*. Wau Ecology Handbook No. 1. Wau Ecology Institute, Papua New Guinea.

Menzies, J. I. 1991. *A handbook of New Guinea marsupials and monotremes*. Kristen Press, Madang, PNG.

Menzies, J. I. 1993. A history of mammalogy in New Guinea from 1726 to 1993. *Science in New Guinea*. **19(3):** 115 –122.

Menzies, J. I., 1996. A systematic revision of *Melomys* (Rodentia: Muridae) of New Guinea. *Australian Journal of Zoology* 44: 367 – 426.

Menzies, J. I. and Dennis, E., 1979. *Handbook of New Guinea Rodents*. Wau Ecology Institute Handbook No. 6.

McAlpine, J. and Quigley, J. 1998. *Forest Resources of Papua New Guinea: Summary Statistics from the Forest Inventory Mapping System.* Canberra: AusAID/ Port Moresby: Papua New Guinea National Forestry Service.

Miller, S., Hyslop, E., Kula, G. and Burrows, I. 1994. Status of biodiversity in Papua New Guinea. Pp. 67 – 95 in *Papua New Guinea Country Study on Biological Diversity* edited by N. Sekhran and S. Miller. Colorcraft Ltd, Hong Kong.

Milne-Edwards, A. 1877. Notes sur quelques mammifères nouveaux provenant de l Nouvelle Guinée. *Seances de l'Academie des Sciences* **85**: 1079-1081.

Mittermeier, R. A., and Mittermeier, C. G. 1997. *Megadiversity - Earth's Biologically Wealthiest Nations*. Quebecor Printing Inc., Canada.

National Statistics Office 2000. PNG 2000 Census - Preliminary Figures. www.pngbd.com/travel/tourism_guide_tpa/populationbystatisticalllg5.html

Nir, E. 1992. Natural regeneration of *Nothofagus*. *Klinki* **4 (4):** 38 – 53.

Nix, H. A., Faith, D. P., Hutchinson, M. F., Margules, C. R., West, J., Allison, A., Kesteven, J. L., Natera, G., Slater, W., Stein, J. L. and Walker, P. 2000. *The BioRap Toolbox – A National Study of Biodiversity Assessment and Planning for Papua New Guinea.* Consultancy report to the World Bank. Centre for Resource and Environmental Studies, Australian National University, Canberra.

Nowak, R. M. 1991. *Walker's Mammals of the World Fifth Edition. Volumes 1 and 2.* The John Hopkins University Press, Baltimore and London.

Orsak, L. J. 1996. Changing people's values in how natural resources are used in rural Papua New Guinea. Unpublished discussion paper, Christensen Research Institute, Madang.

Orsak, L. J. and Eason, N. 1995. An assessment of the moth fauna (Lepidoptera: Heterocera) of Kikori Basin (Gulf, Southern Highlands Provinces), Papua New Guinea. Unpublished report to WWF Kikori Integrated Conservation and Development Project.

O'Shea, M. J. 1996. *A Guide to the Snakes of Papua New Guinea.* Independent Publishing, Port Moresby.

Paijmans, K. 1976. *New Guinea Vegetation.* Australian National University Press, Canberra.

Parnaby, H. 1991. Sound species taxonomy is crucial to the conservation of forest bats. Pp 101–112 in *Conservation of Australia's Forest Fauna,* edited by D. Lunney. Royal Zoological Society of New South Wales, Mosman, NSW.

Parsons, M. J. 1983. A conservation study of the birdwing butterflies *Ornithoptera* and *Troides* (Lepidoptera: Papillionidae) in Papua New Guinea. Final report to Department of Primary Industry, Papua New Guinea.

Peckover, W. S. and Filewood L. W. C. 1976. *Birds of New Guinea and tropical Australia*. A. H. & A. W. Reed Pty Ltd, Sydney.

PNG Forest Authority 1996. *The National Forest Plan for Papua New Guinea.* Papua New Guinea Forest Authority, Boroko, PNG.

Rand, A. L. and Gillard, E. T., 1967. *Handbook of New Guinea Birds*. Weidenfeld and Nicholson, London.

Reardon, T. 1999. Taxonomy and selection of taxa for this action plan. Pp. 6 – 14 in *The Action Plan for Australian Bats* edited by A. Duncan, G. Baker and N. Montgomery. Environment Australia, Canberra.

Richards, S. 2002. *Rokrok – An Illustrated Guide to the Frogs of the Kikori River Basin.* WWF PNG, Port Moresby.

Saulei, S. and Beehler, B. M. 1993. Biodiversity and conservation of humid forest environments of Papua New Guinea. Pp. 423 – 434 in *Papua New Guinea Conservation Needs Assessment, Volume 2* edited by B. M. Beehler. Government of Papua New Guinea Department of Environment and Conservation, Port Moresby.

Saulei, S., Parsons, M. and Petasi, I. 1999. Forest regeneration ten years after clear-fell logging in the Gogol Valley, Madang Province: implications for the 35-year forest cutting cycle in Papua New Guinea. *Science in New Guinea* **24**: 119 - 134.

Sekhran, N. 1996. *Pursuing the "D" in Integrated Conservation and Development Projects (ICADs) : Issues and Challenges for Papua New Guinea,* Rural Development Forestry Network Paper 19b. Overseas Development Institute, London.

Sekhran, N. and Miller, S. 1994. *Papua New Guinea Country Study on Biological Diversity*. Colorcraft Ltd, Hong Kong.

Schieffelin, E. L. 1976. *The Sorrow of the Lonely and the Burning of the Dancers.* University of Queensland Press, St Lucia, Queensland.

Siaguru, P. 1992 Effect of shade and shadow on lowland tree seedlings in Papua New Guinea. Unpublished PhD Thesis Department of Plant and Soil Science, University of Aberdeen, Scotland.

Specht, R. L., Roe, E. M. and Broughton, V. H. 1974. Conservation of major plant communities in Australia and Papua New Guinea. *Australian Journal of Botany Supplementary Series* **7**: 591 - 605.

Strahan, R. (ed.) 1995. *The Australian Museum Complete Book of Australian Mammals – Revised Edition.* Reed Books, Chatswood.

Thomas, O. 1897. Mammals from New Guinea. *Annali dei Museo Civico di Storia Naturale, Genova* **19 (series 2)**: 617 – 622.

Van Dyck, S. 2002. Morphology based revision of *Murexia* and *Antechinus* (Marsupialia: Dasyuridae). *Memoirs of the Queensland Museum* **48 (1):**239 – 330.

Van Helden, F. 1998. *Between Cash and Conviction : The social context of the Bismarck-Ramu Integrated Conservation and Development Project.* National Research Institute Monograph No 33. Paragon Printers, Canberra.

Wells, M. P. and Brandon, K., 1992. *People and Parks: Linking Protected Area Management with Local Communities.* The World Bank, the World Wildlife Fund, and the US-Agency for International Development, Washington, DC.

APPENDIX I

Whilst it is easy to think of PNG forests as being largely untouched, many areas are threatened by large scale industrial logging.

Photo: G. Ellis

"Selective logging" in lowland rainforest in Gulf Province.

Photo: G. Ellis

Some species although heavily hunted such as the ground cuscus *Phalanger gymnotis* do not appear to be threatened.

Photo: T. Leary

The silky cuscus *Phalanger sericeus* is hunted for both meat and its fur which is used in "bilums" (woven bags).

Photo: T. Leary

APPENDIX I

Hunting for large game has resulted in at least local extinction of some species in heavily hunted areas.

The landowner holding the shotgun is Selegobia, who has been instrumental in the establishment of Libano WMA due to his concern that fauna is declining in his area from over-hunting.

Photo: T. Leary

Forest fauna is of cultural significance to most Papua New Guineans - feathers, skins and beaks and bones are used for personal adornment.

The headdress of this Western Highland man is made up of the skins and feathers of more than nine species of bird and one species of cuscus.

APPENDIX I

Lake Kutubu Wildlife Management Area in Southern Highlands Province incorporates all of Lake Kutubu and the forests surrounding it. The lake supports 22 species of fish, 12 of which are endemic to the lake.

Photo: G. Ellis

Mt Bosavi looms in the background and much of it is proposed to be declared a WMA by local landowners.

Photo: T. Leary

Local landowners drawing sketch maps of their proposed Wildlife Management Area during a planning workshop as women and children look on.

Photo: T. Leary

APPENDIX I

Neiru (Aird Hills) WMA covers the hills in the background of this photo.

Photo: T. Leary

Long-house or "Hausman" on the lower Mubi River.

Photo: T. Leary

Leptomys signatus is one of seven species of mammal listed as critically endangered on the IUCN Red List.

Photo: M. Pennay

The groove-toothed shrew mouse *Microhydromys richardsoni* was known from only five widespread records. The mouse pictured here is the sixth specimen recently captured on the Darai Plateau in Gulf Province.

Photo: M. Pennay