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Hunting of Wildlife in Tropical Forests

Implications for Biodiversity and Forest Peoples

Elizabeth L. Bennett
John G. Robinson

September 2000

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The World Bank





THE WORLD BANK ENVIRONMENT DEPARTMENT

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1. *Biodiversity Conservation in the Context of Tropical Forest Management*
2. *Hunting of Wildlife in Tropical Forests—Implications for Biodiversity and Forest Peoples*

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Preface

This paper is based on a recently-published book (Robinson and Bennett 2000a), and is drawn mainly on the work of the following authors published therein: Michael Alvard, Philippe Auzel, Richard E. Bodmer, Lynn Clayton, Bryan Curran, Ruben Cueva L., Heather Eves, John H. Fanshawe, John E. Fa, Cheryl Fimbel, Clare D. FitzGibbon, P. Bion Griffin, Marcus B. Griffin, John Hart, Kim Hill, Jeffrey P. Jorgenson, Ullas Karanth, Margaret F. Kinnaird, Rob L. Lee, Frans T. Leeuwenberg, M.D. Madhusudan, Patricio Mena V., E.J. Milner-Gulland, Hezron Mogaka, Andrew Noss, Adrian J. Nyaoi, Timothy O'Brien, Jonathan Padwe, Carlos Peres, Pablo E. Puertas, Jhanira Regalado B., Richard Ruggiero, Jephthe Sompud, Jody R. Stallings, Allyn MacLean Stearman, Wendy Townsend, Leonard Usongo,

David S. Wilkie and ourselves. To keep the paper concise, references are only included at key points in the text, but the work of the above authors in helping to formulate the broader ideas in this paper is warmly acknowledged. All references used in the preparation of this paper, whether or not they are directly cited in the text, are included in the bibliography.

Many thanks go to Paul Elkan for providing the material for Box 4.3.

We would especially like to thank Kathy MacKinnon for inviting us to write this paper, and for all of her skills and time in editing it. We would like to thank her and Tony Whitten for their ideas, and for facilitating its production.

Executive Summary

The international community has often responded to the steady loss of tropical forests by adopting policies that promote sustainable use of such forests as a conservation tool. Protecting forests alone is not enough since overhunting in many tropical countries is seriously depleting populations of many forest animals (the “empty forest” phenomenon). Loss of wildlife threatens survival of the whole forest ecosystem as crucial pollinators, dispersers and browsers are lost, thereby reducing species diversity and curbing the ability of the forest to maintain itself, and to regenerate after disturbance. It also adversely affects rural communities who rely on forest wildlife for food, income and their culture. Wild meat provides more than 50 percent of the protein for many tropical forest peoples, and is often a mainstay of their subsistence and cash economy.

People have hunted wildlife ever since they first inhabited tropical forests some 40,000 years ago. Today, however, such hunting is rarely sustainable. This is due to:

- *Changes in the physical environment.* Declining areas of forest lead to decreases in wildlife populations and a smaller resource base for hunters. Greatly increased access into the remaining forests allows in more hunters, reduces areas where animals are free from hunting pressure, facilitates market hunting, and stimulates a cascade of social, technological and economic changes, all of which increase hunting levels.
- *Changes in the social environment.* Human populations in tropical forests have increased and become more sedentary. Increasing sedentarism reduces hunting sustainability and increases reliance on agriculture which leads to further increased human population densities and increased market involvement. Immigration increases population densities, and changes the pattern of wildlife harvests. Immigrants tend to hunt a narrower range of species, disregard local hunting taboos and practices, convert the forest to other land uses, and regard wildlife as “pests.” Both expanding local populations and increased immigration decrease hunting sustainability.
- *Changes in the cultural environment.* Social taboos against hunting certain species are breaking down, systems of traditional hunting territories are disappearing, and traditional hunting methods and practices are declining. Advances in hunting technology, especially the spread of shotguns and wire snares, result in hunting being less discriminating and more efficient. These technologies require money for purchase. This often comes from selling wildlife, thereby establishing a spiral of increasing harvest rates.
- *changes in the economic environment.* Hunting of wildlife in tropical forests is becoming commercialized. Commercialization results in increasing harvest rates through

increased hunting intensity by local people, and the entrance of non-resident commercial hunters. Increased income of consumers also changes hunting patterns. In Africa and Asia in particular, increased income leads to an increased demand for wild meat.

Given the pace of change in tropical forest countries, a wide range of solutions is needed. These include the establishment and effective management of protected areas, and the improved management of forests and wildlife at national and local levels. As the rate of forest loss increases, proper land use planning is essential to ensure that protected areas and extractive reserves are included as part of a sustainable landscape.

The problem of hunting is multi-faceted and complex. Solutions must be area specific, and based on detailed knowledge of hunting patterns, ecology of hunted species, and local cultural, economic and political conditions. This paper offers a set of recommendations to different players at national and local levels to promote the sustainability of hunting and provide ecological, socioeconomic and cultural benefits.

- *National governments should:* establish a network of effectively managed protected areas, including areas where hunting is not allowed or is very strictly limited; protect additional areas as extractive reserves to supply the subsistence needs of local hunting communities; ensure that the legal, technical and administrative mechanisms and trained personnel are in place for enforcement of protected area regulations; include local communities in decision making and management regarding hunting, while ensuring that checks exist to prevent over-exploitation; ensure that laws exist to protect vulnerable species from hunting and prevent or strictly control

wildlife trade and the sale of modern hunting technologies; minimize building of roads through protected areas; establish regulations so that logging companies are responsible for preventing hunting by their staff; support research and monitoring into the effects of hunting, with results fed back into management decisions to promote sustainability; and promote education and awareness programs on conservation of wildlife at all levels.

- *Local communities and agencies working with them should:* establish a system of land use that supports local protected areas and contiguous extractive reserves, including local support mechanisms for effective protection and local participation in co-management; ensure that community members are involved in monitoring, management and decision making regarding hunting; encourage practices to reduce the use of harmful technologies, and to prevent hunting of vulnerable species; establish registers of local residents allowed to hunt in extractive reserves and mechanisms to exclude outsiders; and establish mechanisms to reduce or stop sales of wildlife out of local hunting areas.
- *Timber companies working in tropical forests should:* enact, comply with and enforce regulations to prevent company workers from hunting and from buying wild meat from local people; provide fresh protein supplies to all staff and workers to remove need for wild meat; prevent company vehicles from carrying wildlife and wild meat; close all non-essential roads after logging; protect key areas for wildlife within logging concessions including salt licks, important breeding areas and riverine reserves; and create a system of unlogged blocks within concessions as refuges for animals less tolerant of logging disturbance.

- *NGOs and academic institutions should:* act as intermediaries between government and international agencies, local communities and logging companies to ensure that proper management systems are established which are enforceable, locally acceptable, and achieve biodiversity conservation and the sustainable supply of wild meat to local communities; promote and conduct research at many levels; promote and conduct long-term monitoring in collaboration with local communities and/or protected area staff; disseminate the results of research and monitoring; promote and conduct education and awareness campaigns at all levels from local communities to policymakers; support extension programs in local communities to encourage alternative livelihoods and reduce use of wild meat; and encourage and train professional field staff skilled in addressing both biological resource use and local development needs.
- *International donors should:* ensure that the issue of hunting is addressed in *all* conservation and development programs for tropical forest areas, including environmental impact assessments; ensure that development programs are based on what is biologically feasible, and are appropriate in the local political, social and cultural context; promote conservation education and extension programs to reduce hunting to sustainable levels, and to promote alternative sources of food and income; and promote the establishment and proper management of a system of totally protected areas and complementary extractive reserves.

1 Introduction

The importance of wildlife to people

Tropical forests are rich in biodiversity, and the use of wildlife in human culture is widespread. The impact of humans on wildlife is so pervasive that the very survival of many animal species in the world's tropical forests depends on our understanding and better managing that use. Moreover, the inter-relationships of wildlife and humans in such forests are so intricate that the social and economic well-being of humans in tropical forest countries often depends on good management of wildlife and other natural resources.

Importance of wildlife as a resource

Wildlife in tropical forests is an important resource for local communities living in, and around, those forests. Wild species are hunted for food, sale, social and cultural reasons and because they are agricultural pests.

Nutritional value

In at least 62 countries world-wide, wildlife and fish contribute a minimum of 20 percent of the animal protein in rural diets. Wildlife provides significant calories to rural communities, as well as essential protein and fats (Anstey 1991, Bennett and others 2000, Townsend 2000). For example, ten indigenous groups in Latin America consume an average of 59.6 g of protein per person per day from wild meat, a figure well above the required minimum animal protein levels for healthy subsistence. In West Africa, 25 percent of protein requirements are met by wild meat, and in Liberia 75 percent of the country's meat is from wild animals. In Sarawak, 67 per cent of the meals of Kelabits contain wild meat, and it is their main source of protein. Throughout the tropics, studies show that individual hunters take significant numbers of animals to provide this amount of protein (Table 1.1) (Robinson and Redford 1991, Bennett

Table 1.1 Number of mammals killed per hunter per year (*Hunters are from indigenous forest communities, hunting entirely or predominantly for subsistence.*)

<i>Ethnic group</i>	<i>Country</i>	<i>Number of all mammals > 1 kg</i>	<i>Reference</i>
Huaorani	Ecuador	20.9	Mena and others 2000
Aché	Paraguay	33.0	Hill and Padwe 2000
Siriono	Bolivia	36.3	Townsend 2000
Xavante	Brazil	119.7	Leeuwenberg and Robinson 2000
Iban	Sarawak, Malaysia	16.6	Bennet unpublished data
Kelabit	Sarawak, Malaysia	51.1	Bennet unpublished data
Lun Dayah	Sabah, Malaysia	13.4	Bennet unpublished data
Murut	Sabah, Malaysia	17.1	Bennet unpublished data
Wana	Sulawesi	1.82	Alvard 2000

and others 2000, FitzGibbon and others 2000). In Amazonas State, Brazil, the rural population annually kills about 3.5 million vertebrates for food. More than 13,600 animals are harvested from the Arabuko-Sokoke Forest in Kenya each year, and in Sarawak, Malaysia, subsistence hunters take a minimum of 23,513 tons of wild meat per year. With such offtake rates, the effects of hunting on wildlife populations can be considerable.

Economic value

For many rural communities, wildlife is an essential source of animal protein which would otherwise have to be raised or bought. If this wild meat had to be replaced with domestic meat, the cost would be significant. In Sarawak, Malaysia for example, the value of wild meat consumed by rural people is about US\$75 million per year (WCS and Sarawak Forest Department 1996).

As well as meeting subsistence needs, hunting can also be a major source of income for rural peoples from sale of meat and pelts, or sale of animals as pets and trophies (Bodmer and others 1994, FitzGibbon and others 2000, Noss 2000). In Tahuayo, lowland Peru, 1,278 animals or 22 tons of wild meat are extracted annually from a 500 km² area; 14 percent is consumed locally, the remaining 86 percent is sold for more than US\$17,000 per year. Each gun owner in Bomassa, Congo, sells meat worth about US\$395 per year. In the Arabuko-Sokoke Forest in Kenya, local hunters can earn US\$275 per year by selling meat, in an area where the

average annual per capita income is US\$38. In the Central African Republic, hunters earn US\$9.30 per week from snaring wildlife when average local wages are US\$2 to US\$13 per week.

For many tropical forest peoples, the distinction between subsistence and commercial use is blurred, with meat from the forest supplementing both diets and incomes. The combined subsistence and commercial value of wild meat produced by a tropical forest can be very significant (Table 1.2). The total volume and value of wild meat production at regional level are startling. For the whole of the Amazon Basin, the value of wild meat harvested exceeds US\$175 million per year, and the total wild meat extracted from the Congo Basin is estimated to exceed one million tons per year (TCA 1995, Wilkie and Carpenter 1998). Even though wild meat is usually considered a "minor forest product," and not included in most estimates of Gross Domestic Product (GDP), its value within local and national economies is considerable.

Social and cultural values

In addition to providing meat and income, hunting remains an important social and cultural tradition for many tropical forest peoples. Acquisition of animal trophies as cultural artefacts or for personal adornment (such as feathers, skins, and teeth) is a widespread practice throughout tropical forest regions. In many cultures animals and hunting are inextricably woven into the world view: to be a hunter is essential in gaining respect,

Table 1.2 Combined subsistence and commercial value of wild meat produced per km² of tropical forests per year

Area	Value of wild meat/km ² /yr	Sustainability of hunting	Reference
Korup National Park, Cameroon	\$106	No	Infield, 1998
Arabuko-Sokoke Forest, Kenya	\$94	No	FitzGibbon et al., 1995
Ituri Forest, DR of Congo	\$318	?	Wilkie, 1989
Tahuayo, Peru	\$42	No	Bodmer et al., 1994
Tahuayo, Peru	\$31	Yes	Bodmer et al., 1994

achieving manhood or winning a bride.

Hunting can also be essential for other cultural events, such as the naming of children. As a result, people in tropical forests hunt, even when they have alternative sources of nutrition or income (Bennett and others 2000, Eves and Ruggiero 2000, Hill and Padwe 2000, Jorgenson 2000, Lee 2000, Madhusudan and Karanth 2000).

Importance for pest control

Wildlife can be significant pests on agricultural crops and livestock. Animals are trapped or actively hunted to reduce pest populations and minimize agricultural damage. Frequently, such hunted wildlife is subsequently consumed, sold or otherwise used.

Sometimes snares or poisons set to control common agricultural pests accidentally lead to deaths of less common animals, for example, babirusa killed in snares set for wild pig in Sulawesi (Clayton and Milner-Gulland 2000). Poisons set for pests may get into the food chain and affect predator populations, leading either to mortality or reproductive failure, for example of raptors.

The complexities of hunting in tropical forests

Throughout the world, wildlife populations and the forests which they inhabit are being reduced. Efforts to arrest such biodiversity loss are now integral to the policies and programs of governments, aid agencies and conservation organizations. Yet we are becoming increasingly aware that there is often a basic conflict between conservation and development objectives. Development programs often allow hunting to supply the economic and nutritional needs of rural people, yet it is hunting itself that is frequently the major factor extirpating wildlife populations.

Humans have lived in tropical forests for at least 40,000 years, and throughout that time,

they have undoubtedly hunted. Historically, extinctions of certain large animals have correlated with the presence of humans, and were almost certainly due to hunting (Olson and James 1982, Lewin 1983, Holdaway and Jancomb 2000). The expansion of humans into Latin America probably led to the extinction of giant sloths; human migration into Hawaii, Madagascar and New Zealand led to the extinction of many island birds and giant lemurs. Similarly orang-utans became extinct in all of their former wide range throughout continental Asia due to human hunting.

Nevertheless, there is good evidence that tropical forest peoples have depended on wild meat and fish to meet their animal protein requirements for many thousands of years. For species which were hunted and have survived, harvesting in the past must have been sustainable. Recent field studies show that current levels of hunting are now having dramatic impacts on wildlife in many tropical forests worldwide, frequently diminishing wildlife populations and sometimes driving species to local extinction. Clearly the context and impact of hunting have changed.

Nowadays, hunting is often done to meet the short-term economic needs of tropical forest peoples in a rapidly changing world. Balancing those short-term economic needs with long-term developmental and conservation needs can be evaluated by considering the *sustainability* of resource use. The following questions must therefore be addressed:

- Are current hunting rates of rural peoples sustainable?
- If not, what are the biological, social and cultural implications of current harvesting rates?
- What are the biological, social, and economic factors that influence the sustainability of hunting?
- By identifying those factors, can the sustainability of hunting be improved?

Answering these questions is ever more relevant as national and international agencies seek strategies and solutions to integrate short-term economic needs with long-term development needs, through the conservation of forest ecosystems and species,

This paper explores the issues surrounding the sustainability of hunting as currently practiced by rural peoples in tropical forests. It discusses the main threats to such sustainability, and how to counter them. Achieving ecological sustainability is crucial if the long-term goal of

conserving tropical forest systems and biodiversity is to be attained. It is also vital from a social perspective, given the central role of hunting and wildlife for human nutrition, health and welfare of rain forest peoples. Either we manage the resource now, while wild species still exist, or we shall be forced to address the nutritional needs of people when the wildlife resources are no longer available. By then, the wider implications for both humans and tropical forest biodiversity will be much more serious and much less manageable.

2 The Sustainability of Hunting in Tropical Forests

Defining sustainable hunting

No matter how important wild species are to people, if hunting is not sustainable the resource is depleted. Hunters are then forced to spend more time and energy seeking an ever diminishing source of protein. At the same time, wildlife populations dwindle to such levels that they may become locally extinct.

In the original formulation on sustainability, outlined in 1980 in the World Conservation Strategy, natural resource use was defined as sustainable when it did not significantly affect the wild population. This assumed that there are conditions under which the use of a resource has minimal impact on the resource itself. By analogy to savings accounts, natural populations could be described as capital, and the harvest as taking the interest. It was initially assumed that resource users could harvest the interest without touching the capital. This formulation however is flawed: biological systems do not work like economic ones. Density-dependent effects mean that the "interest" is not always proportional to the "capital." Under certain circumstances, a smaller population for instance might generate greater production than a larger population. In addition, any harvest decreases population numbers, thus affecting the "capital."

So when is hunting sustainable? A simple answer is when harvest does not exceed production. The harvest rate is driven by the demands of consumers on the one hand, and is controlled by taboos, rules, regulations,

enforcement and incentives on the other. The production rate is determined by the density or numbers of animals, and the reproductive rate of the average individual animal. When the two sides of the equation are balanced, when production balances harvest, then sustainability is possible. This answer is incomplete, however. Harvest can equal production at many different population densities, even when population levels have been reduced to much below carrying capacity. If a population is reduced to such a low level that it is in danger of extinction, or to where the offtake no longer meets the social and economic needs of the people who are harvesting it, the harvest cannot be considered sustainable.

Moreover, wildlife populations comprise living individuals which are part of dynamic and complex systems. They live in social groups which are disrupted by the loss of individual members. Loss of significant numbers of individuals will have wider repercussions throughout the ecosystem (Box 2.1). The inter-relationships between animals and plants are complex. Studies in Central America have shown that plant reproduction is very sensitive to changes in the animal community. The plant species which can reproduce in the absence of large animal pollinators, dispersers and browsers increase at the expense of the many which cannot. This results in a gradual but profound shift in the character of the plant community, accompanied by major loss of species diversity. As plant species disappear, so too do animal species which depend on them,

Box 2.1

Changes in a biological community caused by hunting

Hunters concentrate initially on large animals, many of which play keystone roles in forest ecology, as well as comprising the majority of the vertebrate biomass. Reduction or extirpation of populations of such species can result in:

- Loss of seed predators (such as agoutis, peccaries, pigs, large squirrels). With reduced seed predation, trees with large seeds are at a competitive advantage over trees with small seeds. In one study in Panama, such trees dominated small forest patches after less than 75 years in the absence of seed-eating animals.
- Loss of seed dispersers. Human hunters concentrate most of their hunting on frugivores and granivores (primates, bats, frugivorous birds, forest ungulates), which perform a primary role in seed dispersal. Loss of such species will reduce seed dispersal which, in the long term, will affect forest composition.
- Loss of predators, (large cats, raptors). This can cause unusual and uneven densities of different prey species. In turn, increases in certain prey species can lead to decreases and local extinctions of their animal or plant food species, which changes forest composition and decreases overall biodiversity. In Barro Colorado Island, Panama, absence of large predators led to an increase in coati populations. The coaties' predation on eggs and fledglings in nests then caused declines and extinctions of many species of low-nesting birds.
- Loss of food for predators. Hunting of ungulates can reduce the populations of predators that depend on them for prey. In India, human hunting can result in reductions of more than 90 percent of the ungulate prey normally eaten by tigers. This both reduces the densities of tigers and results in their hunting smaller prey, thereby causing further detrimental impacts on the biological community.

Even if hunted species still persist in an area, their numbers might be reduced to such low levels that they are "ecologically extinct" that is, no longer fulfilling their ecological role in the forest. Thus over-hunting just a few species has far wider repercussions on the long-term diversity and health of tropical forests.

Sources: Redford 1992, Terborgh 1999, Madhusudan and Karanth 2000.

generating an extinction spiral, and resulting eventually in a greatly impoverished plant and animal community. Similarly, disrupting predator-prey relationships can impact on both animal and plant communities. In other words, levels of harvest must be both sustainable, and consistent with the wider management goals for the resource, users of that resource, and the habitat in which it occurs.

If the core goal of management (be it of a country's wildlife program, protected area system, logging concession, community based conservation program, or integrated conservation and development program) is conservation of natural systems, then the following criteria for sustainability can be defined:

- 1) Harvested populations should not show a consistent decline in numbers. Many species have populations which fluctuate in

numbers over time. Following the onset of harvesting, population densities almost always decline but if these declines persist then this indicates that the annual harvest is greater than annual production, and that harvesting is not sustainable.

- 2) Harvested populations should not be reduced to densities where they are vulnerable to local extinction. If populations are reduced to low densities, or low population numbers, they might be unable to recover, and are in danger of extirpation.

Taken together, these criteria establish the lower limits on the density of harvested populations. They define the ecologically sustainable levels of harvest, but do not establish the socio-economically sustainable levels. Therefore other criteria must also be included. Harvested populations cannot be reduced to densities where they cease to be a significant resource for human users. The term "significant" is not

precise, but broadly means that the resource no longer fulfils its important nutritional, economic and cultural roles in local societies. The population density of a harvested species required for socio-economic sustainability will sometimes be higher than that required for ecological sustainability.

For hunting to be sustainable, it must be both ecologically and socially sustainable. In the real world, this is extremely complex, given all the political, biological, social and practical constraints.

Is hunting in tropical forests sustainable today?

For many species, and in most areas, hunting in tropical forests today is not sustainable. This is true across Latin America, Africa and Asia (see case studies in Robinson and Bennett 2000a). It is true not only for people living in degraded forests and those in market economies, but also includes many indigenous societies that hunt

solely for subsistence (Table 2.1). In the few cases where hunting is sustainable, conditions apply like those found among the Aché in Paraguay: The Aché are largely outside a market economy, exclude other hunters from their hunting areas and occur at especially low densities of only 0.18 people per km² (Hill and Padwe 2000).

Impacts of hunting on wildlife

Even when hunting is for subsistence alone, large numbers of animals are extracted per year from many tropical forests (Table 2.2). These not only comprise the "game animals" generally considered to be important for human nutrition, but include a wide range of other species (Box 2.2). Such hunting has significant effects on wildlife populations:

- For tropical forest species, hunting is largely additive to natural mortality and reduces population densities of hunted species (Table 2.3). On average, neotropical

Table 2.1 Percentage of hunted species for which hunting rates are unsustainable (that is, population densities show that offtake consistently exceeds production). All hunters comprise members of local forest communities. (*Figures in parentheses = number of species analyzed*)

<i>Ethnic group</i>	<i>Country</i>	<i>Reason for hunting</i>	<i>Percent of species hunted unsustainably</i>	<i>Reference</i>
Huaorani	Ecuador	Subsistence	30 (10)	Mena et al, 2000
Aché	Paraguay	Subsistence	0 (7)	Hill and Padwe, 2000
Sirionó	Bolivia	Subsistence	50 (10)	Townsend, 2000
Sanya, Mijikenda	Kenya	Subsistence; some trade	42.9 (7)	FitzGibbon et al., 2000
Bubis, Fang	Bioko	Subsistence and trade	30.7 (16)	Fa, 2000
Various	Equatorial Guinea			
	Central African Republic	Subsistence and trade	100 (4)	Noss, 2000
Bangando, Baka	Cameroon	Subsistence and trade	100 (2)	Fimbel et al., 2000
Various	Sulawesi, Indonesia	Subsistence and trade	66.7 (6)	O'Brien and Kinnaird, 2000
Minahasans	Sulawesi, Indonesia	Subsistence and trade	75 (4)	Lee, 2000

Table 2.2 Number of mammals (> 1 kg) hunted/km²/year. All hunters comprise members of local communities in areas free from logging.

<i>Ethnic group</i>	<i>Country</i>	<i>No. of mammals hunted/km²/year</i>	<i>Reference</i>
Huaorani	Ecuador	10.1	Mena and others 2000
Aché	Paraguay	14.9	Hill and Padwe 2000
Sirionó	Bolivia	14.3	Townsend 2000
Maya	Mexico	0.49	Jorgenson 2000
Xavante	Brazil	0.77	Leeuwenberg and Robinson, 2000
Sanya, Mijikenda	Kenya	8.0	FitzGibbon et al., 2000
Various	Central African Republic	26.9	Noss, 2000
Various at Manembonembo	Sulawesi, Indonesia	7.39	Lee, 2000
Various at Gunung Ambang	Sulawesi, Indonesia	4.52	Lee, 2000

Box 2.2**What are the “game animals” in tropical forests?**

In most tropical forests, a major proportion of the meat harvested by forest hunters comes from a relatively small number of large-bodied species. These are normally the larger ungulates and primates. For example, 44 percent of the biomass harvested by the Huaorani in Ecuador comprises just two species (common woolly monkey and collared peccary). Similarly three species of ungulates comprise 80 percent of the biomass harvested by rural hunters in Sarawak, Malaysia (bearded pig and two barking deer). These animals, important for human nutrition, are often described as “wild game” or “bushmeat”. Species which are commonly hunted, or even raised to be hunted, are described as “game species”.

This terminology implies that hunters rely on relatively few species, the game animals, while other species are infrequently hunted. This is not the case; hunters in tropical forests take a wide range of species. For example, the common woolly monkey and collared peccary only make up 27 percent of the number of animals killed by the Huaorani, and the three ungulates only 22 percent of the animals hunted in Sarawak. Forest hunters often take a wide range of species. The Maracá Indians of Colombia kill at least 51 species of birds, including 10 hummingbirds; the Huaorani of Ecuador take about 25 species of mammals, 11 birds and five reptiles; and the Sirionó Indians of Bolivia hunt 23 species of mammals, 33 birds and nine reptiles. A similar picture is seen in Africa. In south-west Central African Republic, hunters using snares capture 33 species of mammals, seven reptiles and three birds, and in the Lobéké region of Cameroon, hunters take at least 36 animal species. In Asia the picture is comparable, with at least 26 species of mammals, 12 birds and five reptiles regularly eaten by rural hunters in Sarawak. In Laos hunters kill and eat almost any species of mammal, bird and reptile from small birds to large ungulates.

Worldwide, hunting studies show that while a few species provide most of the diet they are not the only ones significantly affected by hunting. Indeed, to most tropical forest hunters, “game” is any animal encountered, ranging from small rodent or bird to large ungulates, and almost anything else in between.

Sources: Ruddle 1970, Vickers 1991, Bennett and others 2000, Fimbel and others 2000, Mena and others 2000, Noss 2000, Townsend 2000.

Table 2.3 Percentage by which the density of mammals is lower in moderately and heavily hunted forests compared to lightly or unhunted tropical forests. None of the forests were subject to any form of commercial logging or other habitat disturbance.

<i>Location</i>	<i>Country</i>	<i>Percent by which mammal densities lower in moderately and heavily hunted forest</i>	<i>Reference</i>
23 Amazonian sites	Brazil	80.8	Peres 2000
Quehueiri-ono	Ecuador	35.3	Mena and others 2000
Mbaracayu	Paraguay	53.0	Hill and Padwe 2000
Ituri I	D.R. of Congo	42.1*	Hart 2000
Ituri II	D.R. of Congo	12.9*	Hart 2000
Mossapoula	Central African Republic	43.9*	Noss 2000
7 sites in Sarawak and Sabah	Malaysia	62.4	ELB, unpublished data
Nagarahole	India	75.0	Mahusudan and Karanth 2000

- mammal populations are reduced by 80 percent under moderate hunting, and can be reduced by more than 90 percent under heavy hunting (Redford, 1992).
- Hunting can lead to reduced average body size of hunted species over time. By selecting for large-bodied animals, hunting removes larger animals from the population and can lead to evolution of smaller average body mass; this has apparently happened through historical time in the case of orang-utans (Bennett 1998).
 - Hunting can change population demography and reduces the proportion of animals in older age classes of the population. For example, in heavily hunted parts of the Ituri forest, only 56 percent of the duiker population are adults compared to 64 percent in nearby lightly hunted areas (Hart 2000). The mechanisms generating this shift in age structure vary and are still poorly understood.
 - Hunting can lead to lowered average age of first reproduction. Thus one-third of female blue duikers with two erupted molars are sexually mature in hunted areas of the Ituri Forest in Central Africa, compared to only 5 percent of the same age class in non-hunted areas (Hart 2000).
 - In theory, hunting could lead to an increase in average female fecundity, although this has not yet been demonstrated for any tropical forest species.
 - Hunting can lead to a decrease in annual production of hunted populations. Despite possible lowering of the age of sexual maturity and increases in fecundity, species populations often decrease dramatically following hunting, and the proportion of breeding adults is often also greatly reduced. This leads to lower annual production which limits the potential for harvest (Robinson and Redford 1991).
 - Hunting can lead to local extinction of certain vulnerable species, especially large-bodied species with low intrinsic rates of natural increase. Thus in Ecuador, seven mammal species (30 percent of all large mammals) are not present in areas heavily hunted by the Huorani (Mena and others 2000). Similarly in Sarawak all diurnal primates have become extinct in three out of four heavily hunted sites surveyed, and in Sulawesi babirusa and anoa are both

suffering range reductions due to hunting (Bennett and others 2000, O'Brien and Kinnaird 2000).

- Hunting changes the composition of the biological community. The representation of different guilds and trophic levels in a community changes through the preference of hunters for certain classes of animals, and these changes can have wide repercussions throughout the forest ecosystem (Box 2.1).
- Hunting leads to a significant decrease in the annual biomass production of the

biological community. Reductions in the representation of large-bodied species in the community, and in the production of individual species, contribute to the lower production of the community as a whole (Puri 1992, Hart 2000). As a result hunters, such as the Yuquí Indians in the Amazon, are forced to harvest larger numbers of smaller species for food as the larger animals are depleted (Stearman 2000).

3 Factors Affecting the Sustainability of Hunting

Many factors affect the sustainability of hunting in an area; these factors can act both independently and together. Based on results from recent studies in tropical forests, the main factors affecting sustainability can be attributed to five main categories: physical and geographical; biological; social (including patterns of human settlement and immigration); cultural and religious; and economic (Robinson and Bennett 2000a).

Physical factors

The physical configuration of human uses across the landscape influences the extent to which wildlife populations are affected by hunting pressures.

Distance from "source" areas

Some areas of land act as "sources" for populations of animals, others are referred to as

"sinks" (Box 3.1). "Sources" are areas considered as net producers of animals—contributing more animals through births than are lost through deaths. "Sinks" are the opposite. The greater the distance of a hunted area or "sink" from a "source," the less sustainable the hunting. This is because with distance from a source, populations are not easily replenished by animals moving in from outside through immigration, seasonal movements or dispersal.

Accessibility

Ease of access to, or within, a hunted area reduces the sustainability of hunting in that area. Physical accessibility is influenced directly by factors such as distance, relief, and physical barriers, and indirectly through factors resulting from human intervention, such as roads and other transport mechanisms (Box 3.2). Easy

Box 3.1

"Sources" and "Sinks"

Wild animals move across the landscape due to daily or frequent ranging, annual migration, or dispersal. Areas which are net drains on populations are known as "sinks," and those which are net producers, and from which replenishment occurs, are known as "sources." For a sink population to be stable, annual immigration from a source is needed. To know whether a hunt is sustainable, the number of animals harvested per year over the total area of source plus sink must be known. Source areas are frequently larger than sink areas. For example, in the Mbaracayu Reserve, Paraguay, the Aché Indians hunt intensively in an area of about 57 square kilometers; this is supplied by a source area of some 394 square kilometers, a ratio of almost 1:7 sink to source. Under such conditions, the hunt is apparently sustainable. The ability to move from source areas to sinks varies between animal species. For hunting to be sustainable, sources need to be protected. Maintaining connectivity within the landscape to allow animals to move between sources and sinks is crucial. Habitat fragmentation can disrupt the system, stop migration and reduce sustainability of hunting.

Sources: Pulliam, 1988; Hart, 2000; Hill and Padwe, 2000.

Box 3.2
Impacts of roads on hunting

In general, roads are seen as being essential for development, and are usually integral to national and regional development plans. In terms of hunting, however, roads increase access. They often result in overharvesting and greatly depleted wildlife populations due to:

- Enabling increased immigration into the forest area
- Increased forest clearance along roadsides, thereby reducing and fragmenting forest habitat and increasing effective human population density in the remaining forest
- Loss of inaccessible and undisturbed "source" areas where populations are net producers of animals
- Increased access to markets. This allows local peoples to sell wild meat out, and to buy in technology (for example, shotguns, cartridges, snare wires, batteries, vehicles, fuel) which facilitates indiscriminate and excessive hunting
- Increased access by outsiders into forest areas, often from towns many tens of kilometers away. These are both hunters themselves, or traders who buy wild meat from local hunters.

The result is that roads frequently correlate with the demise of wildlife populations. In North Sulawesi, for example, the building of a new highway correlated with local loss of certain species (babirusa and anoa), and greatly reduced populations of other species. In Sarawak, ease of access is directly and inversely correlated with the densities of primates, hornbills and large ungulates in a forest. In the short term, roads often lead to increased harvest rates since hunters suddenly have rapid access to a much larger area, so an illusion of plentiful wildlife resources is created temporarily. Over the longer term, however, the overall increase in hunting pressure reduces the sustainability of the harvest, and populations are reduced over the wider area.

There are some exceptions. In Latin America, where the preference is generally for domestic meat over wild meat, roads provide access to markets and domestic meat supplies so that rural people can reduce their reliance on wild meat. Moreover, in the rare cases where wildlife protection is effective, roads can increase the effectiveness of patrolling and enforcement.

Sources: Ayres and others 1991, Bennett and others 2000, Clayton and Milner-Gulland 2000, Lee 2000, Madhusudan and Karanth 2000.

access of outsiders to an area decreases local hunting sustainability. If an area is easily accessible, outsiders can enter the area to hunt, thereby increasing pressure on the wildlife.

Proximity of hunted areas to markets and other commercial centers further decreases sustainability. As proximity to these centers increases, market hunting tends to increase. People tend to become more involved in a cash economy, and the tendency to sell wild meat to buy commodities increases. A secondary effect is that with proximity to market centers, people have easier access to hunting technologies such as cartridges, snare wire, and batteries for night hunting.

Biological factors

The biological characteristics of harvested populations limit the *supply* of wildlife products, and thus determine the extent to which wildlife species can be harvested sustainably.

Biological production

Production is the addition to the wildlife population, whether or not those additional animals survive. Production varies greatly between habitats. Hunting in areas with low production is less likely to be sustainable, since few animals are produced, and the number of animals harvested can quickly exceed the number produced.

In comparison to savannah and grassland ecosystems, tropical forests have a very low production/km² (Robinson and Bennett 2000b). The standing biomass/km² of harvestable animals in tropical forests is relatively very low, and many species in forest habitats have low intrinsic rates of population increase. Even within tropical forests, there is considerable variation in wildlife production across forest types. Thus, monodominant *mbau* forests in central Africa have much lower production than biologically diverse forests, and upland *terra firme* forests in Amazonia have lower production than *varzea* forests. Often secondary forests support higher biomass of some wildlife species than do undisturbed forests. For example, in the Ituri Forest, Democratic Republic of Congo, production in primary forests equals some 50 kg of wild meat/km²/year, while in adjoining secondary forests it equals 318 kg/km²/year, mainly duiker which thrive in such habitats (Wilkie 1989).

Moreover, in tropical forests, hunting usually reduces population densities to levels of less than maximum productivity. For many tropical forest species, population densities of 65 percent to 90 percent of carrying capacity (*K*) have been suggested as maximal for productivity, yet in tropical forests even "light" hunting reduces populations, on average to about 30 percent of carrying capacity (Table 2.3). Hence, overall production of wild meat in tropical forests is low.

Vulnerability to harvest

Some species are more vulnerable to hunting pressure than are others. Species with low intrinsic rates of population increase are less resilient to hunting (for example, primates and carnivores tend to have lower rates, while ungulates and rodents tend to have high rates). Species whose mating, nesting, predator avoidance or social behavior allow easy harvest are especially vulnerable to hunting. For example, group-living species (most primates)

are vulnerable since hunters encounter and can hunt more than one animal at one time. Animals with spectacular displays or loud calls (birds of paradise, curassows, hornbills), or which breed communally in accessible areas (turtles, maleo birds) are all likely to be more at risk. Slow-moving species, once detected, are easy to catch by hand (tortoises, bear cuscus, pangolins). Species which use regular pathways are easier to trap (four-toed elephant-shrews; porcupines), as are species which are readily attracted to baits. Many species, however, change their behavior in response to hunting which lowers the risks (by changing their calling behavior, avoiding vulnerable areas, or becoming more nocturnal).

Species which have limited distributions, favor undisturbed habitats or have a limited ability to recolonize hunted areas are often less resilient to harvest. Those which are naturally rare or have limited distributions are particularly vulnerable to hunting, especially in years of low breeding or food shortage, when they can quickly be driven to extinction locally.

Social factors

Human social patterns strongly influence the sustainability of hunting, primarily through *demand* for wildlife products, and the effects of such demand on the rates of harvest of wild species.

Human population density

Human population densities influence hunting sustainability through their impact on demand and harvest levels; the more people using the resource, the less likelihood of sustainable harvesting. Studies worldwide show that where humans depend exclusively on wildlife for meat, tropical forests cannot support much more than one person per square kilometer, even under the most productive circumstances (Box 3.3). In less productive forests (*terra firme* forests in Amazonia, monodominant *mbau*

Box 3.3

Limits to the carrying capacity of tropical forests for human hunters

The productivity of any natural system is limited. In tropical forests, the standing biomass of large, harvestable mammals is low and can be an order of magnitude lower than in more open tropical habitats. This is mainly due to the scarcity of grass and browse. Using the known densities of wildlife for Manu forest, Peru, for example, the maximum harvest of wild meat which would be theoretically sustainable in neotropical forests is only 152 kg/km²/year. This concurs with apparently sustainable harvest rates from other tropical forests generally being less than 200 kg/km²/year. Harvests above this level are clearly not sustainable.

What is the maximum number of people who can live on this amount of meat? The US Recommended Daily Amount (RDA) of protein for a 70 kg man is 0.28 kg of meat per person per day. If the sustainable harvest of wild meat from a forest is 150 kg/km²/year, and 65 percent of that is edible meat, then each square kilometer of forest sustainably produces 97 kg of edible meat per year. Hence, in tropical forests, the carrying capacity for people depending exclusively on wild meat cannot exceed one person/km²/year if the harvest is to be sustainable. Actual densities of traditional hunter-gatherers in tropical forests are generally lower than this. In most neotropical forests, people traditionally lived at a density of less than one person per 10 km². If this human carrying capacity is exceeded, unless alternative sources of protein are used (for example, domestic animals, fish), then wildlife populations will be depleted, and the people will be tied to a declining resource base.

Switching from a hunter-gatherer lifestyle to swidden or other forms of agriculture does not usually help. Agriculture increases the amount of carbohydrate and plant protein available, so human population densities increase in agricultural systems. However, for various cultural and other reasons, domestic animals rarely provide significant amounts of protein in many tropical forest swidden societies, and people still hunt. Even though secondary forests in swidden systems can be more productive than primary forests for ungulates, this is offset by the fact that agriculturalists are more likely to be involved in market economies and selling meat. Hence, due to their higher population densities, agriculturalists tend to have greater impacts on wildlife populations, and their hunting is less likely to be sustainable.

Once the biological carrying capacity of humans in tropical forests is exceeded, no amount of political empowerment or institutional strengthening will allow communities to manage and conserve their natural resources.

Source: Robinson and Bennett 2000b.

forests in central Africa, and tropical heath forests in Borneo), carrying capacities for hunting communities are even lower. Hence, even in forests where human population densities are currently less than one person per square kilometer, hunting is not necessarily sustainable. In addition, likely increases in effective human population densities over time (for example, through reproduction, or immigration) might cause carrying capacity eventually to be exceeded. Actual densities of people in tropical forests where hunting is both ecologically and socioeconomically sustainable are usually much less than one person per square kilometer, such as the Aché in Paraguay (Robinson and Bennett 2000b).

As forest area decreases, due to logging or agricultural conversion, the density of hunters using the remaining forests will increase. Effective population density also increases if people's access to forest is curtailed through the loss of land tenure, usufruct rights or other social dislocations. The problem is further compounded when new immigrants move into the area or outsiders start hunting along new access roads.

Immigration

Immigration into tropical forest areas not only increases the number of people who depend on the local wildlife resources, and decreases the probability of hunting sustainability, it can also

have significant effects on the amount of wild meat available for the original residents. For example, in Amazonia, after large-scale invasions by colonists between 1983 and 1988, the protein intake of the Yuquí Indians dropped from 88 g to 44 g per person per day (Stearman 2000).

As well as simply increasing effective hunting levels, new immigrants tend to change the pattern of wildlife harvests (Lee 2000, Stearman 2000). Immigrants often hunt a narrower range of species, resulting in depletion of populations of favored species. Secondly, immigrants do not generally observe local traditional taboos and practices for controlling hunting patterns, and often convert the forest to other land uses. Not only does this decrease forest area, but new immigrants may consider some wildlife species as "agricultural pests" to be extirpated.

Sedentarism

Increased sedentarism is frequently associated with an increase in human population, heavier use of adjacent forests, and the loss of hunting sustainability (Box 3.4). Many indigenous peoples living in tropical forests move across the landscape in response to local wildlife depletion. In modern society, these people are sedentarized and encouraged to settle in one place by governmental agencies and evangelical institutions. In permanent settlements they have greater access to schools, health care markets and jobs, but where people also hunt, it leads to local wildlife depletion. Sedentarism is almost invariably associated with people being denied access to the broader resource landscape and also with an increased reliance on agricultural practices. Greater reliance on agriculture in turn requires a larger labor force and greater market involvement, which may encourage further hunting of wildlife for consumption and sale (Box 3.4). Moreover as many traditional societies become integrated into market economies, people's desire for

Box 3.4 **"Pacification" and sedentarization of indigenous peoples**

National governments and evangelical organizations often promote programs to pacify and sedentarize indigenous peoples for practical, political or spiritual reasons. Such programs can destroy the local sustainability of hunting by:

- Increasing the reliance on agriculture, which in turn leads to increased human populations. After becoming sedentary, the Amazonian peoples the Yuquí and the Sirionó doubled their populations in 12 and 10 years respectively.
- Increasing the effective local human population density since the area of forest decreases with clearance for agriculture; and hunting becomes concentrated in a smaller area.
- Decreasing hunting zone rotation, outlier camps and trekking, all of which formerly dispersed hunting over wider areas and allowed wildlife populations to recover. This is due to communities being tied to one place because of farming cycles, wage labor, or school terms.
- Providing increased access to the community and its resources, from the outside.
- Often providing improved technologies which can be used for hunting. This can be general items such as motorbikes, outboard motors and fuel, or specific ones such as guns given to control crop pests.
- The development of trading relationships, with traders often hunting in native areas for food and sport.
- Increasing demand for consumer goods, which is frequently met by selling wildlife.
- Increasing social stratification.
- Often breaking down taboos against hunting certain species.
- Breaking down the system of traditional hunting territories.

These negative impacts of sedentarization may be reduced if the use of domestic animals is encouraged to replace wild meat. Usually, this does not occur, or not until wild species have been reduced to a point at which they no longer provide sufficient protein. By that time many former hunting communities are already showing signs of malnourishment.

Source: Stearman 2000.

material possessions increases, and they rely on sale of wildlife to generate cash to buy goods; this in turn results in increased harvest rates.

Cultural and religious factors

Religious and cultural traditions affect sustainability by controlling which species are hunted. For example, Islam, Buddhism and Hinduism, unlike Christianity, have religious laws restricting the killing and eating of wildlife. Thus, in northern Borneo, populations of many species of animals are higher in Moslem areas than in most non-Moslem areas. In India, many species of large animals, including predators, flourish even in areas of high human population densities because of Hindu tolerance for other creatures. Where societies do hunt, religious and other cultural factors act on the sustainability of hunting primarily by influencing the diversity of species harvested, and, within a species, the numbers of animals and range of age-sex classes harvested as well as the hunting technologies used.

Hunting practices

Traditional hunting practices are more likely to be sustainable than those employing new technologies, especially when the former are part of the repertoire of human groups who have lived for millennia in the same tropical forests. As hunting practices change, the probability that hunting will be sustainable decreases.

Hunting territories belonging to specific hunters or families are characteristic of many traditional groups, and serve to disperse hunting pressure and assign stewardship to a specific person or group of people. This system of traditional hunting territories is now disappearing in many areas. The loss of this system allows more open access to wildlife resources, especially to outside hunters, with concomitant declines in the probability of hunting sustainability (Bodmer 2000, Eves and Ruggiero 2000, FitzGibbon and others 2000).

Social taboos traditionally provide another safeguard against overharvesting certain species (Bennett et al and others 2000, Hill and Padwe 2000, Leeuwenberg and Robinson 2000). Thus the Ibans in parts of Sarawak will not hunt orang-utans and Muruts in Sabah will not hunt hornbills. Amongst the Xavante in Brazil, the hunting of armadillo, brocket deer and peccaries is prohibited for six months after the birth of a child, and some species are only hunted by the Paraguayan Aché for ceremonial purposes related to child naming. These taboos can be widespread across a region, or limited to a certain ethnic group, clan or family. Taboos can be formal, as in the case of many indigenous societies, or informal, as found in many other forest-dwelling peoples. As social taboos against hunting certain species break down, overhunting ensues.

Hunting technology

Advances in hunting technology generally increase overall harvests as well as the diversity of species harvested (Bennett and others 2000, Hill and Padwe 2000, Mena and others 2000, Stearman 2000). Even apparently minor changes in technology can allow increased efficiency of harvesting wildlife. The introduction of metal tips to arrows in the 1990s allowed the Aché in Paraguay to increase their hunting of tapirs. The novel use of dogs in conjunction with the traditional spears of the Huaorani in Ecuador resulted in their starting to hunt tapir, brocket deer and collared peccary. The introduction of batteries and flashlights allowed hunting of nocturnal animals by the Kelabits in Sarawak, and Yuquí and Sirionó in Amazonia. Access to bikes, motorbikes, outboard motors and gasoline all increase efficiency of hunting, the size of areas that can be hunted, and ability to “ship out” products. As a result, sustainability tends to decrease.

The need for cash to purchase new hunting technologies can increase harvesting of forest

wildlife. This affects hunting rates and sets up an increasing spiral of harvest. The use of new hunting technology increases wildlife harvests; the wildlife is sold to generate more cash which is used to buy more new hunting tools, which in turn increase wildlife harvests.

Worldwide, preferred hunting technology usually now includes the increased use of wire snares and firearms. Unlike many traditional hunting methods including traditional traps, wire snares are not selective and take a wide variety of species and sizes of animals (Lee 2000, Noss 2000). In Sulawesi, for example, snares set for Sulawesi pigs often catch the endangered babirusa and crested black macaques. If snares are not regularly checked, there is a great deal of waste. One study in the Central African Republic estimated that 27 percent of total snare captures are lost to scavengers or decomposition (Noss 2000). If hunting is purely for food, dead animals in snares are discarded. If snaring is also to obtain animal parts such as bones for the Chinese medicinal trade, even rotten animals have a value and snares are set even more indiscriminately, as occurs in Laos (Rabinowitz 1998).

Animals which escape from snares are frequently wounded, and unlikely to survive (Noss 2000). In central Africa, for example, it was estimated that for every three animals captured in snares, two escape after breaking the cable but may not survive their injuries. Snares are much less discriminating than hunting with nets and take a greater variety of species as well as more females so their overall impact on the population is greater. Moreover, because the time taken to set snares is low, and costs of obtaining them cheap, they are used even if wildlife densities are so low that other more active hunting methods are no longer cost-effective. Hence, they are a particular threat to rare species. This is a particular concern in central Africa where snares are probably now

the most widely-used hunting technique. Since snares are difficult to detect, enforcement against their illegal use is a problem.

Firearms have greatly improved the ease of wildlife harvesting in tropical forests, especially of canopy-dwelling species (Mena and others 2000, Stearman 2000). For example, among the Huaorani in Ecuador, a shift to firearms as the primary hunting method resulted in improved hunting success: a 15 percent increase in both the number of individuals and biomass harvested. Shotguns can kill over greater ranges than traditional weapons, thereby increasing the numbers and types of animals hunted. Whether this results in increased harvests, decreased time spent hunting, or a mixture of both, is debatable, but it is clear that the use of firearms increases the range of species taken. It also increases the injury rate of hunted animals. The use of .22 rifles in Amazonia causes wounding and subsequent wastage rates of about 25 percent of animals targeted (Leeuwenberg 1994, Townsend 1995). In general, therefore, the use of firearms reduces sustainability of the hunt.

Economic factors

Commercialization of the wildlife harvest

Increasingly, the harvest of wildlife in tropical forest areas is becoming commercialized. As forest areas become more accessible, and as forest people increasingly participate in a cash economy, a major commodity traded is wild meat. Other wildlife products such as skins, skulls, antlers, feathers and fur might also be sold. Indigenous communities increasingly trade wildlife for other goods, including modern medicines, school fees and books, salt and sugar, as well as consumer items such as radios and televisions. The boundary between subsistence and commercial hunting is rarely clear (Hart 2000, Stearman 2000). In almost all indigenous societies, no distinction is made between subsistence and trade hunting. The total value of the trade in wild meat from

tropical forest areas is tens of millions of dollars per year (Steel 1994, Juste and others 1995, WCS and Sarawak Forest Department 1996, Clayton and Milner-Gulland 2000).

Whatever the reasons for its occurrence, commercialization of the wildlife trade from tropical forests invariably leads to greatly reduced sustainability of hunting (Box 3.5). Commercialization increases hunting intensity by local people and can dramatically increase wildlife harvest rates. This has been shown in all tropical forest regions: Latin America, Africa, and South-east Asia. Commercialization also increases entrance of non-resident commercial hunters into a region (Marsh and Gait 1988, Auzel and Wilkie 2000, Bodmer and Puertas 2000, Griffin and Griffin 2000, Hart 2000).

Commercialization can also increase the hunting pressure on rare species and non-commercial species (Caldecott 1988, Bodmer and Puertas 2000, Bennett and Gumal, in press). Local people involved in the commerce of marketable species often turn to other non-commercial species for their own subsistence

needs. As the larger species in an area are reduced through commercial trade, subsistence hunters increasingly hunt smaller, less preferred species. For example, in Sarawak, Malaysia the trade reduced populations of large ungulates, so local people turned to primates and large birds for subsistence. Hunting of those smaller species is often not sustainable. Where wild meat is preferred, commercialization results in increased consumption by wealthy citizens, and an increased demand for wild meat. As the commercial market for wild meat develops, hunters frequently sell the preferred species, and consume the less preferred species themselves. Demand for these preferred items, frequently in urban centers, can lead to increased harvest rates.

Finally, where hunting communities have recently entered the market economy, commercialization can result in debt peonage (Hart 2000, Stearman 2000). Access to capital allows traders to supply new hunting technology (for example, guns, wire snares, flashlights) to hunters, who frequently remain in continuous debt to the traders. This debt

Box 3.5

The commercial wildlife trade

The market in fresh and dried meat is extensive in Africa and Asia, but not in Latin America, probably because of a cultural preference for wild over domestic meat in the former two continents. Conversely, the commercial trade in wildlife skins, leather, fur and feathers has a more extensive history in Latin America than in Africa or Asia. In both cases, however, the commercial trade in wildlife decreases sustainability of hunting by:

- Greatly increasing the number of consumers for the wildlife from an area of forest, thereby increasing the effective human population density so that wildlife is used by more than one person per km²;
- Increasing trends towards commercialization and cash economies. These increase social stratification among hunting communities and cause breakdowns in traditional hunting practices;
- Increasing hunting levels by local people, and by outside commercial hunters entering forest areas;
- Increasing the intensity of hunting of rare species, through accidental capture.

The trade in wildlife products is often characterized by “boom-and-bust” cycles. Increases in the commercial value of a product are followed by over-hunting. Wildlife populations then decline until hunting is no longer economically viable. The history of the commercial trade in wildlife products is a history of non-sustainability. *Arguably, there is not a single example of a commercial trade in wildlife products from tropical forests that has been sustainable over a significant period of time.*

Source: Bennett and Robinson 2000.

peonage serves to increase hunting intensity as hunters continually have to harvest and sell more wildlife to pay off debts.

Market values for wildlife

Animals with very high market value are more likely to be overhunted. These tend to be species where the whole animals, or parts of them, are valuable in international trade (elephants, tigers, rhinos, parrots) or those which have great cultural significance (birds of paradise, hornbills).

Where hunting is to procure meat, however, market value has little influence on the sustainability of hunting. There is some variation in prices of different wild meats in local markets, reflecting local preferences, but price differences between species are generally small. In Cameroon, for example, the market price is roughly the same for porcupines, pythons, giant pangolins, monkeys and even rare species such as chimpanzees, gorillas and drills (King 1994, McRae 1997). Hence, differences in market prices of wild meat probably have little effect on hunting pressure.

Income of hunters and consumers

Increases in both hunter and consumer incomes affect harvesting of wild species. Increases in hunter income, if reinvested in improving hunting technology, can increase hunting efficiency, and thus reduce hunting sustainability. Firearms, cartridges, batteries, outboard motors, motor vehicles and fuel all increase hunting efficiency, and can increase harvests. Maintaining these assets requires more cash and more wildlife hunted. Thus in Bioko, African hunters hunt to recoup the costs of gun hire, ammunition and transport (Fa 2000).

Increased hunter incomes come from a variety of sources, including temporary work outside rural communities. Many men leave their villages to work temporarily in extractive

industries such as logging and oil fields. They return with the cash to improve their hunting technology, thereby increasing hunting rates (Auzel and Wilkie 2000, Mena and others 2000). Conversely in Africa, collapsing economies and decreased income is encouraging rural people to leave towns and revert to a more subsistence economy. For example, in Cameroon and the Democratic Republic of Congo, unemployed laborers are leaving towns, and returning to their villages and a hunting life style (Fimbel and others 2000, Hart 2000).

Changes in consumer income and buying power have different effects on the consumption of wild meat, depending on the region. It is often assumed that if people have more income, their dependence on wild meat will be reduced and hunting rates will decline. In both Africa and Asia wild meat is generally preferred over domestic livestock. Accordingly, increased income of consumers at local level leads to an increased demand for wild meat, or increased ability to hire hunters (Balinga 1977, Srikosamatara and others 1992, King 1994, McRae 1997, Auzel and Wilkie 2000, Lee 2000, Eves and Ruggiero 2000). On the other hand, in many parts of Latin America increased income of consumers generally leads to decreased consumption of wild meat (Castro and others 1976, Ayres and others 1991, Bendayán 1991, TCA 1995). This is because domestic meat is generally preferred by consumers in rural areas, although there may still be a specialty market for wild meat in larger towns.

Tropical forest logging — A special case

Logging of tropical forests is one of the single biggest contributors to the decreasing sustainability of hunting in tropical forests worldwide (Robinson and others 1999). Fifty-eight percent of all forests in Asia, 19 percent in Africa, and 28 percent of the forests in Latin America have already been subject to commercial logging, an average of 31 percent of

all tropical forests worldwide. Between 50 and 59 thousand square kilometers more are opened up to logging each year (Whitmore and Sayer 1992, WRI 1994, Johns 1997).

While logging of tropical forests changes the relative abundance of individual species within the biological community, logged forests can support significant wildlife populations (Frumhoff 1995, Johns 1997). Populations of some species preferred by hunters (deer, pigs and peccary) can increase following logging, taking advantage of more open grassy areas and secondary growth. Nevertheless, activities associated with logging significantly increase harvest rates and decrease the probability that hunting is sustainable (Robinson and others 1999). This is because:

- Logging roads increase access to the forest. Logging areas contain extensive networks of

roads, usually linked into the national infrastructure.

- Logging operators themselves frequently subsist on wild meat, so their presence increases hunting pressure in the area either directly or by employment of, or purchase from, local hunters.
- Generally being outsiders to the area, the loggers often do not follow traditional hunting practices.

Research shows that wild meat consumption varies from site to site. For example, in Sarawak in 1996, the annual catch by hunters for a single logging camp of about 500 people was about 1,150 animals, or 29 tons of meat per year. A conservative estimate was that workers in such camps throughout the whole of Sarawak hunted some 55,045 animals or 1,400 tons of wild meat

Box 3.6

Effect of the logging industry on hunting rates in Congo

The impact of the logging industry on hunting rates is illustrated by data from the Ndoki area, Congo. Here, hunting rates were studied in four communities: a remote community far from the road (Toukoulaka), a community which is about 15 minutes by river to a logging road (Nganzicolo), a community beside a logging road (Ngatongo), and the workers in the logging camp itself (Ndoki).

	Toukoulaka (remote)	Nganzicolo (15 minutes to road by & river)	Ngatongo (beside logging road)	Ndoki (logging camp)
No. animals hunted/capita/yr	4.7	28.1	17.4	9.4
Biomass hunted/capita/yr	43.3 kg	114.8 kg	230.1 kg	141.3 kg
Percent of hunted biomass traded	5%	62%	75%	37%
Bushmeat eaten/capita/yr	22.6 kg	32.9 kg	32.9 kg	54.8 kg
Percent of meals containing bushmeat	39%	49%	49%	76%
Rank order of bushmeat as income source	4	2	1	3

In Ndoki, the impacts of logging activities are clear. Logging company employees hunt much more wild meat than do local villagers; and both logging company employees and villagers close to logging roads hunt more wild meat than do people in remote villages. Even though logging company employees sell less wild meat than do people in villages they are a greater drain on wildlife populations. Villages continue to consume similar amounts before and during logging operations, but hunting rates, and amount of wild meat sold, increase with increasing access to resources and markets provided by logging roads.

Source: Auzel and Wilkie 2000.

per year for their own consumption (WCS and Sarawak Forest Department, 1996). In a single logging camp of 648 people in the Republic of Congo, the annual harvest was 8,250 animals, equivalent to 123.5 tons of wild meat (Auzel and Wilkie 2000). The impact of such activities

causes considerable declines in the densities of wildlife. It also changes the hunting patterns of local communities themselves (Box 3.6). These factors combine to reduce hunting success of local people in areas affected by commercial logging.

4 Enhancing the Sustainability of Hunting

Previous chapters have outlined the main factors which individually, or in combination lead to unsustainable hunting and reduction and loss of wildlife populations. This chapter focuses on management solutions that conserve wildlife yet allow continued human access to an important resource.

Wildlife management at the national level

National governments can seek to manage the hunting of wildlife through a combination of actions: conservation of critical wildlife areas, and measures aimed specifically at regulating and controlling hunting. Nationally regulated sports hunting has been successful in encouraging sustainable use in some temperate and savannah countries (Child 1990, Geist 1994). National regulation has been less successful in promoting sustainable hunting in tropical forests, and managing subsistence or commercial hunting. In many tropical forest countries, the general approach has been to prohibit hunting in specific areas or for selected species. Potentially, national governments can enhance the sustainability of hunting through:

- Establishment of protected areas (see below)
- Controlling hunting access to key wildlife areas (by excluding outsiders from traditional hunting areas)
- Controlling or banning the commercial trade of wildlife, including its transport and sale
- Establishing and enforcing laws against hunting the species most vulnerable to hunting

- Establishing and enforcing laws on the use of different modern hunting technologies
- Reducing the need for wild meat by establishing programs to provide domestic animals or other sources of protein for rural nutritional needs.

To date, there are few examples from tropical forest countries where such approaches have been tried and implemented effectively. Enforcing such regulations requires political will, institutional capacity, adequate staffing levels and training, motivation and back-up from the judiciary or other local regulatory mechanisms. Currently, many or all of these mechanisms to support conservation are lacking in many tropical forest countries. Exceptionally, the Malaysian state of Sarawak has recently adopted a Master Plan for Wildlife which is regulating and managing hunting (Box 4.1).

Protected Areas

The establishment of totally protected areas (national parks, wildlife sanctuaries) and multiple use areas (indigenous reserves, forest reserves, wildlife reserves) allows a national government to regulate land uses and the activities permitted within those lands, even where parks contain significant human populations. All such reserves serve either to prohibit hunting, or regulate or control access to wildlife, or both. Protected areas can enhance the sustainability of hunting within and around their boundaries by:

Box 4.1

Government initiatives to enhance the sustainability of hunting in Sarawak, Malaysia

The Malaysian state of Sarawak, concerned about its rapidly-dwindling wildlife populations, prepared "A Master Plan for Wildlife" for the entire state (WCS and Sarawak Forest Department 1996). This comprehensive policy and action plan was based on many years of research into the effects of human activities on wildlife, especially hunting and logging. The state government is now taking aggressive strides to implement this plan. Measures already implemented include:

- *Not issuing any new shotgun licenses and strictly controlling the number of shotgun cartridges* which can be bought by hunters per month. Each hunter is allowed 10 cartridges, enough for subsistence hunters to procure meat for their families, but not enough for excessive hunting for sport and trade. This policy has been strictly enforced since January 1998, and is clearly working. In one sample plot where sport hunting of flying foxes was rampant, more than 600 cartridges were collected before the restriction, and a mere 13 in the same week a year later. Moreover, people in some areas are switching only to buckshot for larger animals, since they do not want to waste cartridges on smaller animals with less meat. This reduces hunting pressure on smaller, more vulnerable species such as primates and hornbills.
- *Passing of new wildlife legislation, notably the Wild Life Protection Ordinance 1998 to ban the sale of all wildlife and wildlife products taken from the wild.* This was accompanied by a major publicity and education campaign at all levels, from senior decision makers, to town consumers and rural hunters. Enforcement involves several collaborating agencies, including Forest Department staff, local councils and police, and has necessitated multi-faceted training of enforcement officers. Rural communities and their leaders have given strong support to the trade ban, because hunting for subsistence is still allowed. Monitoring systems are being put into place to evaluate the effectiveness of the trade ban in allowing wildlife populations to recover, and wildlife staff are being given extensive training to allow proper enforcement and monitoring.

The Wild Life Protection Ordinance, and the new National Parks and Nature Reserves Ordinance 1998, allow for quicker gazettelement and stronger protection of conservation areas, including the provision to involve local communities in their management. These laws will allow Sarawak's protected area system to be extended and improved. The Sarawak case shows that, given the political will, research and policy can work together to promote effective management of hunting in tropical forest countries.

- Limiting or preventing the conversion of land under tropical forests to other land uses, thereby maintaining essential habitats for wildlife.
- Acting as a "source" of wildlife for nearby hunting communities (see Box 3.1). Protected areas can serve as refuges for wildlife where populations can maintain high densities, and can replenish nearby "sink" areas which have been heavily hunted, for example, duiker replenishment of hunted forests in Congo.
- Limiting immigration into the area, and limiting hunting by outsiders by restricting hunting to traditional users, such as Penan in Mulu National Park, Sarawak.
- Limiting or prohibiting the use of new hunting technologies.

For a protected area to contribute to sustainability of hunting, it must be effective in conserving wildlife and have mechanisms in place to ensure that regulations can be enforced (van Schaik and Kramer 1997). The protected area must be large enough: 1) to allow all hunted species to maintain viable populations; and 2) to maintain sufficient productivity within the overall forest system to support the levels of hunting required to supply the subsistence needs of local communities.

Hunting is only sustainable if the effective population density of people hunting in the area is well below one person per square kilometer (see Box 3.3). Above these hunting levels, protected area regulations should actively discourage or prevent hunting. Furthermore,

where hunting is allowed, it should be restricted to the less vulnerable species (for example, those with high reproductive outputs). In protected areas, no commercial hunting can be allowed and shotguns and wire snares should not be permitted. Thus, in Sarawak traditional hunters are not allowed to use snares even in areas where they have rights to hunt (State Government of Sarawak 1998).

Protected areas are the cornerstones of any strategy for conservation and sustainable use. Because of their roles as reservoirs and "sources" for wildlife populations, protected areas are frequently the *only* way to ensure that tropical forests can continue to support hunting by neighboring local communities who depend on the wildlife resource.

Wildlife management at the local level

Devolution and decentralization of authority over wildlife resources from national governments to local community level is often proposed as an effective solution for resource management and conservation (IIED 1994, Western and Wright 1994, Lutz and Caldecott 1996). Some of this impetus derives from concerns of social justice and equity, some also stems from a recognition that local communities may be efficient managers of wildlife resources, especially as part of co-management arrangements with additional technical support (Bodmer and Puertas 2000, Leeuwenberg and Robinson 2000). In many tropical forests, the limited resources and capacity of national agencies mean that engaging local communities in management may be the best or only option for encouraging hunting sustainability.

Community-based management can enhance the sustainability of hunting by:

- Restricting access by outsiders to community resources, thereby lowering the effective human population density relying on the resource

- Strengthening traditional systems of resource exploitation
- Resisting increased commercialization
- Establishing local protected areas as "sources," and ensuring their proper protection, with the enforcing communities being the recipients of the benefits of the areas
- Dispersing the location and intensity of hunting.

For community-based conservation to be successful local managers must understand the aims and operations of the system, and have the necessary management capacity and resources to monitor impact of hunting on wildlife and to make necessary changes to management based on that monitoring. Checks and balances must be built into the system, otherwise over-exploitation will occur (Redford 1989).

Communities must have the capacity to manage their land and wildlife resources, and this depends on appropriate cultural traditions, adequate political, legal and economic power, and the presence of strong community institutions. In today's complex social, political and economic landscapes, few communities by themselves have all of these attributes (Rettig and others 1989).

An ideal solution in many cases is a system of co-management between the local communities and an outside agency, be it the relevant government agency, conservation scientists, or NGOs. This allows the community to manage the resources in their area, while maintaining checks and balances, providing the necessary legal, practical and technical support, and ensuring monitoring and feedback. One area where this approach is being implemented is the Reserva Comunal Tamshiyacu-Tahuayo in north-eastern Peru (Box 4.2). In such community-based efforts, management must be designed to be culturally appropriate and understandable. In some cases, people evince a preference to return to more traditional

Box 4.2

Community based co-management in Peru

Local communities are involved in co-management of the 322,500 ha Reserva Communal Tamshiyacu-Tahuayo in north-east Peru. The area is divided into three management zones: (a) a fully protected core of approx. 160,000 ha, far from any settlements. No hunting usually occurs here, so it acts as a refuge and "source" area for wildlife; (b) a buffer zone for subsistence use of approx. 160,000 ha. Local people but no outsiders can hunt here (including some species for trade), but no agriculture or settlements are allowed; (c) an undefined area of permanent settlement. No people live in the core area or buffer zone. Inhabitants of the settled zone are non-tribal people known as "*ribereños*."

The partners in the co-management are: (a) the local *ribereños* communities who have the responsibility for wildlife management in the areas; (b) government agencies; (c) wildlife biologists, responsible for monitoring wildlife populations and the effectiveness of management; (d) NGO extension workers, responsible for conveying this information to the local communities and working with them to decide on management strategies.

The communities hold an established game register for recording all hunts, and appoint game rangers who are responsible for making the records. Various management options have been tried, including a game tax, quota system, and male-directed hunt. There are still problems to be solved, such as continued over-hunting of lowland tapir and large primates, but for other species the system is maintaining hunting at sustainable levels. The cooperation and support within the local communities means that other problems should be soluble in the longer term.

The following factors contribute to success of co-management in the area:

- The area is not too large (a single watershed system)
- The number of community members is small enough for effective communication
- Communities already have cohesive social systems and can effectively define their boundaries and membership
- It is assumed that long-term economic benefits will be realized through management
- There is a mechanism for conserving wildlife in a manner compatible with the local cultural traditions
- Formal, legal and multi-year agreements are in place
- Technical decisions are separate from allocation decisions
- There is external support from universities, research institutions and NGOs who provide technical information.

Source: Bodmer and Puertas 2000.

practices such as hunting territories and dispersing hunting, rather than exploring alien systems such as bag limits and seasons (Leeuwenberg and Robinson 2000). Such pilot approaches could be more broadly integrated into Integrated Conservation and Development Projects (ICDPs) which are attempting to reconcile biodiversity conservation with the needs of indigenous peoples and other local communities.

Provision of alternative sources of protein and income

Current levels of hunting are not sustainable in many tropical forests, even when done by local

peoples for their own subsistence. In Bioko, Equatorial Guinea, for example, the human population requires protein equivalent to more than four million kg of meat per year, yet the maximum sustainable harvest of wild meat from the island's forests is only 23,000 kg per year—a mere 0.575 percent of that total (Fa 2000). One way to reduce dependence on wild meat is to provide alternative sources of protein and income.

Most tropical forest communities already use wild-caught fish as well as meat. There is a general tendency for wild fish consumption to

increase as wildlife populations decline (for example, Penan in Sarawak: Chin and Bennett 2000). The sustainability of this additional fish harvest has never been studied. Similarly, the spread of logging in tropical forests may lead to reductions in fish stocks due to increased sediment loads from soil erosion, and oil pollution as a result of logging activities (MacKinnon and others 1996). As hunting becomes less sustainable due to overhunting and forest loss, it is unlikely that the protein deficit can be satisfied with increased catches of wild fish, and other alternatives will be necessary.

Forest hunters often keep domestic animals, so are familiar with basic animal husbandry. However, many societies keep only a few domestic animals and reserve them for ceremonies and festivals; they rarely use them for daily subsistence (Strickland 1986, Eves and Ruggiero 2000). To facilitate larger-scale animal husbandry, government or other subsidies would be needed to provide stock and training in livestock care and provision of forage. Governments are already experimenting with options for reducing the reliance on wild meat. Options include: (1) rearing wild species in captivity (such as ostriches, crocodiles and cassowaries); (2) rearing fish in ponds or floating cages; (3) producing plant-based protein sources; and (4) rearing domestic animals (goats, chickens, pigs, cows).

The rearing of wild animals in farms and ranches is sometimes promoted as a good option, but many species are difficult to rear in captivity, wild species are almost always less productive than domesticated races and initially, at least, capture of wild species for "farming" is a drain on wild populations. Rearing wild species in captivity may also do little to reduce wild harvests since it is generally impossible for law enforcers to distinguish captive bred animals from hunted wild ones. Thus captive facilities can become a conduit for

illegal wildlife trade, can divert funds, manpower and attention away from management of animals in the wild, and can be a reservoir for diseases that spread to wild populations.

An alternative is to grow non-animal sources of protein. Humans do not need to consume animal meat for growth and health, so large-scale production of plant-based proteins would remove the need to hunt wild meat. In most tropical forest cultures, however, the desire to eat meat is strong; in many Latin American countries, for example, the term for "eat" is literally "eat meat." A rapid switch to vegetarianism is unlikely to occur in the conditions prevalent in most tropical forest countries today. As a long-term goal, with major educational campaigns, this transition might be attainable, but it is unlikely to happen in the short term.

The most realistic approach to supply people's protein needs in the immediate future is the farming of domestic livestock or fish. Given that many hunting and forest peoples are semi-migratory, however, their lifestyles do not allow for adequate care of livestock, other than easily transported species such as chickens. The Dayaks of Long Segar, Kalimantan, for instance, move from villages to their fields at planting and harvest times so that government efforts to introduce cattle into such societies have been a miserable failure (MacKinnon and others 1996).

Providing alternative sources of protein and income cannot, on its own, prevent the unsustainable harvest of wildlife (Bennett and others 2000, Lee 2000, Madhusudan and Karanth 2000). As long as there are animals left in the forests, hunting will still continue to satisfy human taste, especially since wild meat is essentially "free." In northern Sulawesi, and also in Nagarhole, India, people have adequate income and food, yet still choose to hunt and eat

wild meat. In Ulu Engkari, Sarawak, the Ibans have ample potential food and cash through government-subsidized fish culture schemes, yet they prefer to sell the fish for additional cash and continue to hunt for their own food. Hence, animal husbandry schemes may partially address the problem of unsustainable hunting, but must be seen as just one component of a much wider program of habitat protection, major education programs, and the multiple other measures needed to reduce hunting pressure more directly.

Controlling hunting in tropical forest logging areas

Controlling hunting in areas subject to tropical forest logging is especially complex because of

the many different players involved (logging employees, local people, and other hunters), and the associated social, cultural, and economic changes brought about by the logging activity. At the concession level, certain initiatives to reduce hunting have met with some success, for example, in the Kabo and Pokola logging concessions in the Republic of Congo (Box 4.3). More widely, as more concessionaires attempt to adopt sustainable forest management and timber certification, hunting could be reduced substantially if hunting controls could be incorporated fully into certification criteria (Box 4.4).

Box 4.3

Managing hunting in a forest concession in northern Congo

In northern Congo, the Kabo, Loundougou, and Pokola forestry concessions cover some 1.2 million ha and abut Nouabalé-Ndoki National Park (400,000 ha). The concessions were granted to the Congolaise Industrielle des Bois (CIB), which has worked with a government agency, the Ministry of Forestry Economy (MEF), and an international conservation organization, the Wildlife Conservation Society (WCS) since 1998 to reduce the impacts of logging on biodiversity. Regulation of logging-associated hunting and wildlife trade was of special concern.

The first step was to involve local communities and company employees living in the concessions. Efforts focused on Kabo and Pokola, with human populations of about 3,000 and 11,000 people respectively. Committees in the five major and six smaller villages proposed regulations to manage wildlife, and adopted:

- The establishment of conservation zones within the concessions where hunting was not allowed;
- A prohibition on snare hunting, which was considered to be wasteful and unselective;
- A prohibition on hunting protected species (gorilla, chimpanzee, elephant, leopard, and bongo);
- The banning of commercial hunting;
- Restrictions on the entry of commercial hunters into the concessions;
- Restrictions on the transport of hunters and wild meat on company vehicles; and
- The development of a system of official hunters for controlled legal offtake of certain species for subsistence.

The communities expected the regulations to allow for a more sustainable production of wild meat. An additional incentive is the provision of alternative animal protein: organized hunts into wildlife-rich areas, beef importation, and tilapia farming are being established.

An "ecoguard" brigade under MEF officers was recruited and trained to enforce these regulations in the concessions. They concentrated on controlling vehicular traffic on roads and manning permanent posts at key points. During 1999, this resulted in the confiscation of 9,160 snares, 14 high caliber elephant guns, 28 12-gauge shotguns, 9 ivory tusks, and 2 leopard skins. 40 legal charges were submitted to the Regional Direction of

continued

Box 4.3 (continued)**Managing hunting in a forest concession in northern Congo**

Forest Economy and the CIB administration, who are responsible for fines and sanctions. This has moderated employee perceptions and behavior. Known incidence of gorilla, chimpanzee and elephant killings were lower in 1999 than 1998, but have not been completely eliminated.

Monitoring of markets in logging camps and villages, and surveys of wildlife, indicate that efficacy of the program varies with investment made—where the project was most active, for example, the percentage of snared animals was lower. Access to alternative wildlife areas also affected hunting patterns. For instance, the percentage of snared animals in Kabo market decreased then increased, apparently reflecting a shift in hunting to areas across the Sangha River in Cameroon. Gorilla, chimpanzee and buffalo continue to be common in many parts of the concessions, and elephant have been more visible in clearings.

This project is still in progress. Hunting has been greatly reduced in Kabo, less so in Pokola with its greater human population and proximity to Ouesso, the regional capital. The conservation of great apes has been strengthened, and commercial hunting greatly reduced. Elephant hunting and the transport of ivory/meat and hunters on company trucks remain problems, as a result of the high economic incentives for elephant harvest. Progress is positively related to: local community awareness and support of wildlife management, which have waxed and waned; commitment by CIB, the logging company, to modify its internal regulations and communicate that commitment to its employees; and the involvement of government enforcement. The continued opening up of the forest to allow access to new stands of timber, however, will put additional strains on the fragile wildlife management structure.

Source: Paul Elkan, personal communication.

Box 4.4**The role of certification in reducing hunting in timber concession areas**

One mechanism to try to ensure that tropical timber harvesting is more sustainable is timber certification. Increasing numbers of international and national certification bodies now exist, and all have produced detailed principles, criteria, guidelines, and indicators. The emphasis of these has generally been on social impacts of logging rather than the impacts on the wider biological community, and the issues of hunting and wildlife trade stimulated by logging are usually poorly addressed.

Probably the highest and most widely used standards are those of the Forest Stewardship Council (FSC). FSC Principles 6.2 and 6.3 state that "Safeguards shall exist which protect rare, threatened and endangered species and their habitats (nesting and feeding areas). Conservation zones and protection areas shall be established, appropriate to the scale and intensity of forest management and the uniqueness of the affected resources. Inappropriate hunting, fishing, trapping and collecting shall be controlled. ... Ecological functions and values shall be maintained intact, enhanced, or restored, including: a) forest regeneration and succession; b) genetic, species and ecosystem diversity; c) natural cycles that affect the productivity of the forest ecosystem." Principle 7 says that the management plan shall provide "plans for the identification and protection of rare, threatened and endangered species." These principles address the issue of refuges for those few species that decline due to the direct effects of timber felling. But they barely raise the issue of hunting and wild meat trade, nor the effects which loss of pollinators and dispersers to hunting have on the ability of the forest to regenerate after logging. They are ill-defined, so are difficult to apply in practice. Loss of wildlife on which local people depend is hardly addressed either. FSC Principle 3.2 states that "Forest management shall not threaten or diminish, either directly or indirectly, the resources or tenure rights of indigenous peoples," but the meaning is general, and it is unlikely that "resources" is being read to mean major loss of wild meat. These vague principles are not in line with the well-defined criteria for other issues such as sustainability of timber production and workers' rights.

continued

Box 4.4 *(continued)*

The role of certification in reducing hunting in timber concession areas

Other certification systems are no better in this regard. None take full account of the widespread effects of hunting stimulated by logging. Some certification bodies are using the principles to draw up more specific criteria, but this is rare. To protect wildlife over large parts of the landscape, and the food supplies of local peoples, certification must recognize that hunting should be controlled in the production forest itself, not just in small pockets within a sea of logging. Basic criteria to include are:

- Logging roads must be closed when no longer essential for access
- Logging company vehicles and roads must not be used to transport hunters and wild meat
- Logging company employees should not hunt while in the employ of the company, and should not buy and consume wild meat
- Logging companies should ensure that readily-accessible, affordable supplies of fresh protein are available for all employees so that they do not need to rely on wild meat.

Source: Bennett 2000.

5 Conclusions and Recommendations

Hunting in many tropical forest areas today is not sustainable. There are numerous reasons for this.

First, the intrinsically low rate of production of wild animals in tropical forests (compared to more open savannah habitats) places strict biological limits to the amount of hunting that can be done sustainably.

Secondly, increasing access to forest areas, which allows outsiders to come into the area, promotes loss of forest. It also increases access to markets for sale of wild meat, and to buy new and improved hunting technologies, as well as causing numerous economic changes within the communities.

Thirdly, increasing effective human population density in forest areas, due to intrinsic increase, immigration, or the increasing sedentarism of forest peoples, causes increased hunting per unit area.

Fourthly, changes in hunting practices, including loss of traditional practices and increasing use of modern technologies, make hunting more efficient and less discriminating.

Finally, the increasing commercialization of hunting, the advent of the wildlife trade, and commercial logging of many forest areas precipitate many or all of the above changes.

There is no one simple answer to solve the problem of unsustainable hunting. Solutions must be area specific and should:

- 1) Be based on detailed knowledge of hunting patterns, ecology of the hunted species, and consider local cultural, economic and political conditions
- 2) Incorporate a monitoring and feedback mechanism, using an iterative process that ensures that adaptive management occurs, and that management is truly achieving its goals of promoting sustainability.

Unless governments, aid agencies, rural planners and conservation organizations working in tropical forest areas recognize that current hunting levels are unsustainable, the situation will continue to deteriorate. The implications are manifold, both for biodiversity conservation, and for the well-being of rural communities and economies. The following recommendations are therefore targeted at national governments, local communities, timber companies, NGOs and academic institutions, and international institutions.

Recommendations applicable to national governments

1. Establish a system of land use comprising a network of protected areas and contiguous extractive reserves, including totally protected areas where hunting is not allowed, or is very strictly limited. Two main types of protected area are needed:
 - a) Large areas, big enough to protect viable populations of all game species, and act as “sources” to replenish surrounding “sinks” where people hunt

- b) Smaller or connecting areas to protect places where species are especially vulnerable, (such as communal nesting areas, salt licks, corridors, areas rich in keystone plant sources, or known breeding areas).

Protected areas are crucial to ensure sustainability of hunting across the wider landscape. Hunting is far more likely to be sustainable if there is an adjacent protected area which acts as a wildlife “source”. Protected areas are also easier to understand and manage in the conditions prevalent in most tropical forest countries than are many other methods of potentially enhancing hunting sustainability (for example, bag limits, closed seasons).

2. Additionally, beyond the protected area network, maintain a permanent forest estate for extractive uses, including hunting. Wherever possible, this should be contiguous with the strictly protected area(s) to allow animals to move freely between the two. This will ensure protection of all species, and a sustainable food supply for rural hunters who depend on wild protein. Such areas can include production and protection forests, managed to maintain forest cover and biodiversity as well as their production objectives.

3. Ensure that the legal, technical and administrative mechanisms and trained personnel are in place for conservation regulations to be enforced, both inside and outside the protected area system. This can be done through either national or local institutions, but it is the role of government to ensure that they do indeed exist and function properly.

4. Ensure that the legal and practical mechanisms are in place for local communities to be involved in decision making and management regarding wildlife resources and hunting in their area. This must be done so that the necessary checks and balances are in place

to prevent over-exploitation. Co-management partnerships between local communities and technical/scientific advisors (government or non-government) may ensure this.

5. Establish laws to protect the more vulnerable species from all hunting. These are generally species with low natural densities, low intrinsic rates of population increase, loud or eye-catching displays, species which roost or nest communally, or are especially sought for their high economic or cultural value.

6. Ensure that laws exist to prevent, or strictly control, commercial wildlife trade, and that mechanisms are established so that laws are enforced.

7. Ensure that laws exist to prevent, or strictly control, the sale of modern hunting technologies, especially shotguns, cartridges and wire snares.

8. Ensure that laws exist to minimize the building of roads through protected areas. Where such roads are built, establish mechanisms so that hunting along such roads can be controlled (by manned gates or night curfews).

9. Establish and enforce laws and/or regulations to make logging companies operating in the country responsible for preventing hunting by their staff, for providing them with fresh domestic protein sources, and for preventing their vehicles being used to transport hunters and wild meat. Such measures must be accompanied by a major education program aimed at loggers and local communities, explaining why timber companies can no longer carry wildlife for villagers. The laws/regulations should be tied to measures to ensure compliance by companies; ideally, the penalty for non-compliance would be revocation of the timber license. Logging companies should be required to pay for

wildlife enforcement (whether done by logging, government, or other agency staff) in their concession.

10. Establish, subsidize or otherwise promote programs to ensure production of domestic animals, reared fish or plant products to supply rural protein needs. This must be done as part of overall land use planning. On its own, provision of alternative sources of protein will not prevent over-hunting, but should be part of an holistic approach if other hunting control systems are to work.

11. Ensure that monitoring and feedback mechanisms are in place so that management of hunting can be adaptive, realistic, and is known to be having the effect of enhancing sustainability.

12. Promote research into the effects of hunting at both national and local levels to assist in good management. This involves studying all factors relevant to hunting management: biological, social, cultural and legal.

13. Create mechanisms and an atmosphere to promote education and awareness programs on conservation of wildlife, and the need to reduce hunting, at all levels: decision makers, general public, schools, and local communities.

Recommendations applicable at the local community level

1. Establish a system of land use that supports establishment and management of local protected areas and contiguous extractive reserves.

2. Establish or support local mechanisms to ensure that these areas are protected effectively, including local participation in co-management where appropriate.

3. Promote education and awareness programs among all community members, so that they are aware of the problems, potential solutions, and the long-term benefits.

4. Ensure that mechanisms exist so that community members are closely involved in monitoring, management and decision making regarding hunting.

5. Encourage practices to increase the sustainability of hunting. This will depend on local circumstance and acceptability, but will often involve reverting to traditional practices (hunting territories, outlier camps, trekking, traditional technologies, food sharing) rather than practices imported from elsewhere (bag limits, closed seasons) which are difficult to understand and often locally inappropriate.

6. Encourage practices to reduce uses of harmful technologies, (by limiting use of snares, and limiting use of guns to outside core protected areas).

7. Establish mechanisms to prevent hunting of especially vulnerable species. This might involve invoking traditional taboos, restricting use of certain hunting technologies, and promoting local agreements.

8. Establish registers of local residents allowed to hunt in the extractive reserves, and mechanisms to ensure that unregistered outsiders cannot hunt there.

9. Establish mechanisms to reduce or stop sales of wildlife from local hunting areas. Education programs can help local people to understand the long-term consequences to their own future food supply if they sell meat to outsiders. Extension programs are also crucial to provide locally-appropriate production of alternative sources of protein (domestic livestock, fish farming) and cash (agricultural crops, cottage industries, ecotourism).

Recommendations applicable to timber companies

1. Enact or comply with regulations to prevent logging company workers from hunting, and establish mechanisms to ensure that they are enforced.
2. Enact or comply with regulations to prevent logging company staff, workers and canteens buying wild meat from local people, and establish mechanisms to ensure enforcement.
3. Ensure that adequate fresh protein supplies are available to all staff and workers, thereby removing the need for them to hunt.
4. Prevent logging company vehicles from carrying wildlife, thereby ensuring that they cannot be used for the wild meat trade. Security checks at concession entry / exit points can enforce this measure as well as increasing security and preventing log theft.
5. Close all non-essential roads as soon as an area has been logged. This prevents hunters in vehicles using those roads. (It also reduces the opportunities for illegal re-entry logging.)
6. Protect key areas for wildlife within logging concessions, leaving them as primary forest. These include salt licks, areas known to be important for breeding, and riverine reserves.
7. Create a system of unlogged blocks within logging concessions which act as refuges for animals which are less tolerant of logging disturbance, and from which they can recolonize logged areas. These should comprise at least 20 percent of the total area of the logging concession and be based on prior field surveys.

Recommendations applicable to NGOs and academic institutions

1. Act as intermediaries between government and international agencies, local communities

and logging companies to ensure that proper systems of hunting management can be put into effect which are enforceable, locally acceptable, and achieve the desired results of attaining conservation of biodiversity and a sustainable supply of wild meat to local communities.

2. Promote and conduct research on ecological and social topics relevant to hunting, for example, the biology and ecology of hunted species; effects of difference types, intensities and locations of hunting on wildlife species; nutritional, cultural and social needs of local hunting communities; optimal locations and sizes of totally protected and extractive reserves.
3. Promote and conduct long-term monitoring of target wildlife populations and their habitats so that management can be adaptive. Monitoring systems should be established which can be assisted or conducted by local communities and protected area staff, so that they assume "ownership" and responsibility for management recommendations.
4. Disseminate results of research and monitoring widely, especially to resource users and decisions makers.
5. Promote and conduct major education and awareness programs aimed at all levels of resource users.
6. Promote and conduct extension programs in local hunting communities, with the aim of developing alternative livelihoods and / or sources of protein to reduce the dependence on wild meat.
7. Provide training to professional field staff who are skilled both in managing biological resource use and addressing local development needs.

Recommendations applicable to international donors

1. Ensure that the issue of hunting is addressed in all development programs for tropical forest areas. This includes all environmental impact assessments (EIAs) for, and implementation of, any projects within, or adjacent to, areas of tropical forest (including all development programs, conservation programs, Integrated Conservation and Development Programs (ICDPs), and construction of roads or other infrastructure). Particular attention should be paid to the effects of projects and programs which might change human population densities and distributions across the landscape, increase access to and from tropical forest areas, and alter the economic and social systems in such areas.

2. Ensure that ICDPs and rural development programs are based on solid research into what is biologically realistic and locally appropriate. Promote long-term monitoring of hunted wildlife populations as an integral part of all programs in tropical forest areas and as an indicator of environmental impact.

3. Promote conservation education and extension programs to ensure that hunting levels are reduced, and that alternative sources of protein and/or income are developed. This could include establishment of agricultural programs for local production of domestic animals and/or fish, and extension programs to develop the necessary husbandry expertise.

This should not lead to extensive forest clearance, especially of areas of particular importance to wildlife.

4. Promote the establishment and proper management of a system of totally protected (non-hunting) areas and complementary extractive reserves as reservoirs and "source" areas for wildlife.

5. Distil lessons learned from ongoing pilot projects and adopt best practices in future biodiversity and natural resource management projects, including projects that promote sustainable forestry.

Conclusion

The questions posed at the beginning of this paper were: "Are hunting rates as practiced by rural people sustainable? If not, what are the biological, social and cultural implications of this?" Worldwide in tropical forests, studies show that hunting rates for many species are clearly not sustainable. Unless governments, aid agencies, rural planners, and conservation organizations working in tropical forest areas, as well as the communities themselves, recognize this fact, the situation will continue to deteriorate, leading to loss of biodiversity and rural well-being. It is imperative that we act now to ensure future sustainability of hunting in tropical forests if we are to address social needs, poverty alleviation, and conservation of the forests and their wildlife.

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