Merging Science and Policy:

The Ecological Impacts of Logging in Central Africa

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TABLE OF CONTENTS

Acknowledgements

Executive Summary

Chapter I: Introduction. 1
Problem statement
Approach and Methodology

Chapter 2 Science and Ecological Impact 3
Problem statement
What is known and what is unknown about the ecological impact of logging?
Criteria for priority areas of ecological research
Recommended areas of research Protected areas
Does ecological research really matter for logging policy?

Chapter 3 Policy..... 14
Problem statement
The problem of merging science and policy
Policy recommendations

Chapter 4· Conclusion. 30
Recommendations
Conclusions

Appendices
Appendix I World Resources Institute and CARPE 33
Appendix II Literature Review of the Ecological Impacts of Logging 34
Appendix III Survey of the Ecological Impacts of Logging 44

List of interviewees 56

References 57

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EXECUTIVE SUMMARY

This report was prepared to help World Resources Institute (WRI) and the Central African Regional Program for the Environment (CARPE) assess and reduce the ecological impacts of logging in the Central African Congo Basin The problem WRI and CARPE face is that there is limited information on the ecological impacts of logging and existing logging policies are not effectively reducing impact Thus, this report seeks to analyze the ecological impacts of logging and, based on that information, propose recommendations to a) help minimize the ecological impacts of logging in Central Africa and b) set priorities for the next phase of the CARPE project The methodology used included a literature review, personal interviews, and a survey of nearly thirty policy makers, scientists, and non-profit managers

MAJOR FINDINGS

What information exists on the ecological impacts of logging in Central Africa?

This report concludes that there is a high level agreement that logging increases hunting and decreases species richness (the number of living organisms) There is some agreement among scientists and policy makers that logging decreases genetic diversity (the variety of living organisms), that there is a quantifiable threshold of impact beyond which the ecological impacts become increasingly pronounced, and that there is a need for more protected areas There is very little agreement or certainty about the tradeoffs between protected area size and species diversity and the applicability of scientific findings from other tropical forests

How important is that information in policy making?

Survey results indicate that most scientists, policy makers and non-profit managers believe that more information about a variety of ecological functions would be helpful for guiding policy, but that overall the ecological impacts of logging are already clear enough to send policies in the right direction Ecologists, economists, and social scientists alike agree that there should be less, rather than more, logging in Central Africa They agree that there should be more, rather than fewer, protected areas And they agree that logging fees should be higher, rather than lower While the research and analysis employed to reach these conclusions may vary, the conclusions are the same, and the policy implications go in a single direction This is what it means to say that there is sufficient scientific information for "directionally correct" logging policies in the Congo Basin

Further, interviews and survey results suggest that scientific information is a necessary, but not sufficient, condition for logging policy reform in Central Africa In other words, even if scientific findings on the ecological impacts of logging *should* matter to Central African policy makers, most experts agree that they are not very important in practice Weak political commitment and poor administrative capacity, rather than scientific information,

pose the greatest problem to effective policy implementation Until there are improvements in Central Africa's political commitment and administrative capacity, scientific information will not play a prominent role in logging policy

Given that information does not play a prominent role in policy creation and implementation in Central Africa, what should WRI and CARPE do?

WRI and CARPE have four options for dealing with the role of scientific information in policy making

1 First, they could continue to focus on increasing the wealth of scientific information on the ecological impact of logging, so that when the Central African political commitment and administrative capacity improve the information will be available

2 Second, WRI and CARPE could focus on boosting political commitment and administrative capacity in Central Africa, since commitment and capacity are the main challenges to effective policy implementation

3 Third, they could focus simultaneously on information, commitment and capacity, but run the risk of spreading their efforts too thin

4 Fourth, WRI and CARPE could try to alter the type of information being produced to make it more relevant and credible to Central African policy makers so that information will play a larger role in policy formulation in the future One way of doing this would be to "coproduce" scientific information on the ecological impacts of logging, such that the African "users" of information worked collaboratively with the Western "producers" of information in defining and carrying out scientific research on the impacts of logging

RECOMMENDATIONS

1. Focus on boosting capacity and building political commitment

Until more scientific, ecological information is incorporated into logging policy in Central Africa, this report recommends that WRI and CARPE primarily focus on building administrative capacity and political commitment for logging reform in Central Africa, rather than building the wealth of scientific information Given scarce time and financial resources, building capacity and political commitment are likely to have a higher payoff in the next 5-10 years, in terms of actually decreasing the ecological impacts of logging, than more general ecological information

2 Complement efforts with high-priority ecological research

If WRI and CARPE decide to complement capacity building and commitment generating efforts with scientific information, it should be "coproduced" way that simultaneously boosts capacity (by training host country nationals) and political commitment (by encouraging involvement from host country leaders from the start) WRI and CARPE should also focus on scientific, ecological research that is high priority, long-term, low cost, relatively easy-to-implement, and relevant to policy Based on these criteria, this report suggests that protected areas (the optimal number and size required to maintain ecological functions) be the focus of future ecological research

3. Encourage logging policies that maintain economic benefit and meet strict criteria

This report recommends that WRI and CARPE focus on policies that

- Address the underlying causes of logging impacts (strong tropical timber market, inefficient host country government regulations, weak international lending organization policy, failure to internalize costs associated with forest damage, and poor land use planning)
- Maintain economic benefit
- Meet basic criteria for success (strong political commitment, sufficient administrative, investor and funder support, public support, and lack of market and policy failures)

Based on these criteria and survey results, recommended policies for reducing the ecological impact of logging in Central Africa, in order of decreasing feasibility, are internalizing the costs associated with externalities, increasing protected areas, increasing concession length and decreasing concession area, and timber certification This report recommends that WRI and CARPE focus on these four policies and encourage international lending organizations and Central African governments to do the same

4 Continue to act as a bridge-maker of information

Regardless of which areas CARPE focuses on in the next 5-10 years, WRI should continue to act as a bridge maker of information, gathering evidence and presenting it to interested parties in a policy-relevant format Given the fact that a) Central African governments are not willing or able to pay for many conservation projects, and b) most conservation projects benefit the global community, the financial support of Western individuals, groups, and governments will be critical to ensure the long-term preservation of Central African countries As such, Westerners will - and should - continue to be an important audience for the information WRI produces on Central African forests

CONCLUSIONS

WRI and CARPE are in a unique position They are not purely economic, policy, environmental, advocacy or research organizations, they are all of the above The diversity of expertise within WRI and CARPE is their greatest strength They are in a unique position to bridge historic gaps between scientists and policy makers, social scientists and economists, researchers and advocates , to generate creative, interdisciplinary solutions to the problem of rainforest degradation in Central Africa

At the same time, the diversity of expertise within WRI and CARPE poses a distinct challenge of choosing the best approach to reducing the ecological impacts of logging At first glance, it is tempting to suggest that WRI and CARPE pursue all angles of deforestation - economic, political, ecological - simultaneously If WRI and CARPE had more money, or the rainforests had more time, this might be an option But, given resource constraints, it is necessary to focus on the best approach, rather than all approaches This report suggests that the best approach to minimizing the ecological impacts of logging over the next 5-10 years is to focus on boosting political commitment and administrative capacity, but complement these efforts with high-priority scientific research on protected areas

CHAPTER 1: INTRODUCTION

A primary mission of the World Resources Institute (WRI) and the CARPE group (described in Appendix I) is to slow the pace of deforestation in the Central African Congo Basin [1] The goal of this report is to describe and prescribe the role of scientific information in meeting that mission

Logging is the most significant cause of deforestation in Central Africa (Bryant et al , 1997), and is the focus of this report Logging, and its effects, are not inherently a problem (Panayotou, 1993) But, excessive[2] logging and unnecessary impacts, where the long-term ecological costs exceed the market benefits, are a problem in the sense that they do not maximize social good Unfortunately, excessive logging and unnecessary impacts are the norm for the Congo Basin and most of the tropics (Barbier et al , 1994)

The mean country deforestation rate in tropical Africa in the 1980s was 2 1%, higher than in the neotropics (1 4%) and tropical Asia and Australia (0 9%, calculated by Grieser Johns, 1997, based on Whitmore and Sayer, 1992) Of the six Central African countries, one (Equatorial Guinea) has lost all of its relatively undisturbed frontier forest, one is at high risk of losing its forests in the near future (Central African Republic) and four (Cameroon, Gabon, Zaire, and Congo) do not have much time left before their frontier forests are gone (Bryant, Nielsen and Tangley, 1997)

With over 90 percent of all logging in Central Africa occurring in primary forests (FAO, 1990), understanding the ecological impacts of logging is particularly important The ecological impacts of logging result from reducing or disabling the ecological functions of tropical forests These functions are regulatory (climate, water flow regulation, watershed protection, erosion prevention, biodiversity, carbon fixation), production (timber, non-wood forest products, genetic), carrier (habitat, cultivation area, recreation, carbon storage), and informational (biological, spiritual, religious, cultural, historical, Poore and Sayer, 1991, Ruitenbeek, 1992) Ecological impacts may occur as a result of direct (removing trees) or indirect (opening up areas of the forest to hunting and agriculture) activity (Barbier et al , 1994)

Problem Statement

The challenge WRI and CARPE face is that there is limited information on the ecological impacts of logging in Central Africa and existing logging policies are not effectively reducing ecological impact Tackling this challenge poses three interrelated sub-problems a science problem, a policy problem, and the difficulty of merging science and policy The

[1] The six countries located within the Congo Basin are Cameroon, Central African Republic, Congo, Democratic Republic of Congo (formerly Zaire), Equatorial Guinea, and Gabon

[2] The term "excessive" is a subjective one Economically, it requires a value-based assessment of the costs and benefits associated with logging Ecologically, it requires a value-based assessment on the proper ratio of production to protected areas For the most part, Central African governments do not think that logging in the Congo Basin is "excessive from a national perspective On the other hand, most environmental organizations do think that logging in the Congo Basin is excessive from a global perspective The reader should be aware that the term excessive implies a value judgment about what is too much

science problem is that ecological information is contradictory or insufficient, which makes it difficult to define sustainability and make policy decisions with uncertain information The policy problem is that logging policies cannot not compromise economic well-being, policies must address the underlying factors driving logging, and they must have a host of criteria for success (including political commitment, administrative capacity, public support, well-functioning policies and markets, and investor/funder support) The problem of merging science and policy is that there is a lack of applied science and there is limited information exchange between scientists and policy makers

Approach and Methodology

In order to address these problems and make policy recommendations to WRI and CARPE, this report employed the following approach

- **A literature review** was conducted to answer the question, "What is the current state of knowledge on the ecological impacts of logging in Central Africa?" and provide insight into high priority areas of scientific information that CARPE and WRI might be able to help address For the complete literature review, see Appendix II

- **A survey on the ecological impacts of logging** was given to twenty seven policy makers, scientists, and non-profit managers from the United States, Europe and Central Africa Qualitative and quantitative survey results were analyzed to determine if there is consensus on the role of scientific information in reducing the ecological impacts of logging in Central Africa Because the response rate was very low (22%), the survey offers neither a comprehensive nor representative view of the subject Nonetheless, because survey responses demonstrated a high level of consistency, qualitative results and overall rankings are presented in this paper For details on the survey, see Appendix III

- **Personal interviews** were conducted with several policy makers, scientists, and non-profit managers to test hypotheses and gather information on the ecological impacts of logging and the importance of scientific information in policy making

CHAPTER 2: SCIENCE AND ECOLOGICAL IMPACT

This chapter has four parts First, what is the problem with scientific information on the ecological impacts of logging in Central Africa? Second, what information is known and unknown about these ecological impacts? Third, what are the priority areas of research for WRI and CARPE? And fourth, how important is scientific information for policy making?

1. Problem Statement

There are three, interrelated parts of the science problem a) scientific information about the ecological impacts of logging is contradictory or insufficient, b) lack of information leads to difficulty defining sustainability, and c) lack of information causes decision-making under uncertainty

A. Information is contradictory or insufficient

The Congo Basin of Central Africa is home to one of the most biologically diverse tropical forests in the world It is also one of the least understood ecosystems of the world Information about the forests, and the consequences of their modification, is incomplete and often contradictory (Gomez-Pompa et al , 1991, Panayotou and Ashton, 1992) For example, one study found that logging increased a monkey population in one place, but decreased the same species in another place (McNeilage, personal communication, 1998) Another study found that logging increased gorilla numbers, but decreased chimpanzee numbers (White and Tutin, in press) For some species of trees, estimates of the time it takes to reach minimum legally harvestable diameter vary widely, for Okoumé in Gabon estimates range from 40 to 160 years

Incomplete or contradictory information is thus a problem for the timber industry (wanting to maximize sustainable yields), ecologists (wanting to minimize ecological impacts), and policy makers (wanting to implement the most socially efficient policies) There is considerably more scientific information on tropical forests in other parts of the world, however, scientists are uncertain about the extent to which these findings are applicable to Central Africa (as discussed later in this chapter) Lack of transferable information from other parts of the world serves to compound the problem of insufficient information in Central Africa

B. Difficulty defining sustainability

The goal of "sustainability" can be explained as both an economic and an ecological goal for forest management In economic terms, sustainable forest management means that biological "capital" (the forest) produces sufficient "interest" (forest benefits) that countries, firms, and communities can live off the "interest" without tapping into or damaging the "capital" itself (Poore and Sayer, 1991) Or, even if communities do tap into

the capital, as long as they channel the rents back into reproducible capital, there will be a constant and non-diminishing stream of benefit from the resource (Hartwick-Solow rule)

However, if we cannot distinguish the "capital" from the "interest", it will be difficult to define sustainability In other words, if we do not have information on the economic value of the original forest (the capital), we cannot determine how much of the forests' revenues should be channeled back into reproducible capital (like replanting) and how much can be consumed as "interest"

In ecological terms, sustainable forest management means that logging does not adversely affect the natural functioning of the ecosystem Because this definition implies an understanding of how forests function in the absence of logging and the ecological changes that take place as a result of logging, if we do not have this understanding, we cannot properly define the term, and we cannot establish best practices for forest management For example, if the forests of Central Africa are disturbance-adapted ecosystems which came about and are accustomed to frequent natural changes, then logging may not be a negative force on the forests - to the extent that it mimics natural events (Struhsaker, 1997, Wilkie, personal communication, 1998)

On the other hand, if Central African forests are not disturbance-adapted and never regenerate to their original state after logging activity, then logging cannot be considered "environmentally sustainable" Currently, there is not enough information to determine which of these scenarios is more likely In sum, insufficient information is a problem, regardless of whether we attempt to employ an economic or ecological definition of sustainable forest management

C. Decision-making under uncertainty

While scientific information is a prerequisite for determining the efficient use and preservation of these forests, gathering this information will take more time and resources than the governments of Central Africa can afford and more resources than the international lending or donor organizations could commit (survey respondent) But, despite incomplete information, the Central African region still needs to implement policies and practices which will promote the rational use of its forests

This challenge raises both theoretical questions (With limited scientific information, what is the soundest way to allocate and manage forest resources in the Congo Basin? What kind of environmental information would be most useful for guiding logging policies and practices?) and empirical questions (What information exists about the ecological impacts of logging? How accurate is that information?) The following sections address these questions

2. What is known and unknown about the ecological impact of logging?

Generally, the ecological impacts of logging are a function of the type, intensity,

periodicity, and extent of logging disturbance (Waide and Lugo, 1992) More specifically, the ecological impacts of logging depend on the degree of disturbance, the number and type of tree species removed, and the type of flora and fauna present in the original forest (Struhsaker, 1997) Thus, it is difficult to say, without qualification, that the ecological impacts of logging are X or Y Even under nearly identical conditions, studies have produced conflicting results on the ecological impacts of logging

For this reason, the ecological impacts of logging are sometimes classified as "uncertain" But, certainty is not a discrete variable (Courtney et al, 1997), so it is helpful to think about the range of certainty that exists on the ecological impacts of logging which impacts are highly certain, which impacts are somewhat certain, and which impacts are still under debate? If the ecological impacts of logging were truly uncertain, then we would not know whether increased logging would be helpful or harmful to ecosystems in general However, if we can discern an overall correlation between logging and ecological impact, then - even in the absence of complete knowledge of the specific relationships between logging and each species - we have enough evidence upon which to send policies in the proper direction (e g toward more or less logging, more or less protected areas, larger or smaller concession areas, more or less replanting etc) Thus, in cases where ecological information is highly certain or somewhat certain, there is probably sufficient information for policies to be directionally correct It is only when information is truly uncertain that is not useful for policy

Below, major ecological findings are categorized by "certainty" Degree of agreement among scientists, ecologists, and policy makers is used as a proxy for certainty Some of the findings are strictly ecological (like logging leads to decreases in species diversity or richness), while others are a mixture of ecology and economics (like the optimal size of a protected areas, or the effectiveness of sustainable management systems)

A) Findings for which there is a high degree of agreement

Decreased species richness

Biodiversity is the number, variety, and abundance of living organisms (Swingland, 1993) [3] Thus, species richness (i e the number of species in a given habitat) is one part of biodiversity (Grieser Johns, 1997) Generally speaking, the number of species affected by logging increases in proportion to the amount of logging damage (Johns, 1988, Struhsaker, 1997) Johns (1988) proposes that this is a logarithmic function, such that higher disturbance levels lead to disproportionately greater effects than lower disturbance levels The extent to which population numbers decline is also widely believed to depend on how closely the forest management procedure mimics natural regeneration processes (Skorupa and Kasenene, 1984)

Changes in microclimate

[3] This definition may be deceptively simple, as it poses great measurement difficulties The author notes that "the need for an unequivocal and precise meaning of biodiversity, which is scientifically sensible, is imperative if we are to develop policy and programmes for the future, and make decisions about the present" (Swingland, 1993)

Undisturbed areas of forest are usually dark, humid, cool, and wind-free (Grieser Johns, 1997) When logging creates openings in the forest, it creates openings for sunlight, heat, and wind These changes in microclimate are associated with changes in ecosystems Sunlight can adversely affect phytophobic plants (some mosses), it can scorch bark of some trees, and it can make canopy tree seedlings more vulnerable (Brown and Whitmore, 1992, Grieser Johns, 1997) Heat can also have negative effects on many species, such as understorey birds, which avoid crossing sunlit patches to avoid heat stress (Wong, 1992, Karr and Freemark, 1983 in Grieser Johns, 1997)

Damage to soils and hydrology

Building logging roads and removing felled trees with tractors exposes between 12% to 30% of the soil surface, causing severe damage to soils (Grieser Johns, 1997) Soil damage, including compaction, damage to the root mat, and a decrease in infiltration capacity, increases soil erosion and decreases soil fertility (Gomez-Pompa et al, 1991, Grieser Johns, 1997) Soil damage is also associated with increased run off and increased river sedimentation Douglas et al (1991) found dramatic post-logging increases in sediment loads in Sabah, Malaysia, where the monthly average ratio of suspended sediment from the logged to an unlogged catchment was 1 1 before logging, 4 1 after a logging road was built, and 18 1 in the five months after logging (see Appendix II)

Increased hunting

Logging has both direct and indirect impacts Direct impacts (such as changes in species composition or diversity) occur during, or persist after, the logging process Indirect impacts are not a necessary condition of logging, but often occur as a result of logging Increased hunting is the most significant indirect environmental effect of logging, both during and after logging operations (Steel, 1995, Struhsaker, 1997, A G Johns, 1997) and may have more impact than "direct" effects (MacNeilage, 1998, personal communication, Wilkie et al , in press)

Not only do logging roads facilitate hunting in previously inaccessible tracts of forest (Gradwohl and Greenberg, 1988, McNeilage, personal communication, 1998, Auzel and Wilkie, in press), but loggers themselves are thought responsible for a high degree of hunting and poaching (World Bank, 1992) There is a plethora of anecdotal evidence on the relationship between logging and hunting, but there are also several formal studies that document the impact of logging on hunting For example, a recent report by the World Society for the Protection of Animals (1995) found that in a survey of the Leroy logging camp in Gabon's Forêt des Abeilles, 250 kilos of bushmeat - 41% of which were monkeys - was supplied every day to workers and their families (BIOFAC, 1995 in Pearce, 1995) Wilkie et al (in press) found that households within a Congo CIB logging concession consumed almost twice as much bushmeat as households located within the concession but not involved with logging activity, indicating that logging transportation greatly facilitates hunting Indeed, the authors estimate that round-trip travel time for local hunters declined from 12 hours to less than 2 hours once logging roads and vehicles were available Wilkie et al (in press) conclude "data from these studies suggest that if logging company facilitated market hunting is not curbed, the future of animal populations within concessions in central and west Africa is bleak "

It is important to note that hunting is more of a ecological problem when selective logging takes place over a large area than when clear-cutting takes place in a more concentrated area This is because selective logging requires a greater network of roads than clear-cutting, and thus opens up larger tracts of the forest Wilkie (personal communication, 1998) points out that even if it is not possible to determine whether the *direct* ecological effects are worse under a) selective logging or b) clear-cutting, it is possible to determine that the *indirect* ecological effects (hunting and increased deforestation) of selective logging are worse than the indirect ecological effects of clear-cutting

B. Findings for which there is some degree of agreement

Decreased genetic diversity

As explained above, species variety (genetic diversity) is an important part of overall biodiversity Selective logging of mature forest can lead to an increase in animal species variety, since logging creates more patches in the canopy and more microclimates than exist in unlogged forests (Goldammer, 1992, A G Johns, 1997, Struhsaker, 1997, J S Hall, personal communication, 1998) However, J S Hall, a tropical forest ecologist, notes that logging often leads to increases in species considered "generalist" Because these generalist species did not exist in the unexploited forest, it follows that they are neither rare, endangered nor critical to the system's function (personal communication, 1998)

While a low level of disturbance is natural and increases in species diversity, scientists tend to agree that large, frequent and concentrated disturbances will lead to a decrease in species diversity (Goldammer, 1992) In the case of Central Africa, some scientists think that the degree of disturbance is significant enough that logging leads to an overall decrease in species diversity (Panayotou and Ashton, 1992, McNeilage, personal communication, 1998), while others think that any increase in diversity would be of more undesirable species (J S Hall, personal communication, 1998)

This uncertainty leads Barbier (1993) to conclude "the relationship between loss of habitat and loss of biodiversity has never been satisfactorily characterized and there is no predictive model for policy-making and planning" Likewise, Grieser Johns (1997) notes " there is little field evidence for large scale extinctions brought about by deforestation and there are few data concerning the erosion of genetic diversity within species caused by habitat fragmentation"

Also, while there is agreement that the forests of Central Africa are storehouses of biodiversity, the complete extent of their biological richness remains to be discovered (Lemmens and Sosef, 1998) Scientists have not had the time or the funding to complete biological inventories of much of Central Africa In the absence of complete biological inventories, rough surveys can be used to get an estimate of the biological value of a given area, however, more information is required before Central African governments can make an informed decision about how to best manage their forests (J S Hall, personal communication, 1998)

Recommended maximum threshold of impact

There is agreement that there is a threshold amount of damage to the canopy or basal stand beyond which the ecological impacts of logging become increasingly more pronounced, however, there is disagreement as to where this threshold lies For example, Struhsaker (1997) estimates that damage levels should be reduced to 25% of the basal area to enhance natural forest regeneration, while Johns (1991) estimates that damage threshold is near 50% The establishment of a conservative benchmark damage level in Central Africa will be important step toward minimizing the ecological impacts of logging in the Congo Basin

A recent study by Wilkie et al (in press) found that, when lianas were cleared prior to tree cutting, less than 7% of the canopy was cleared during selective logging operations (SFAC concession) in the Congo The authors note that such low reductions in canopy cover "may not have major adverse impacts on forest primates and birds " Thus, further research is also needed on current levels of canopy reduction in the Congo Basin to determine if the SFAC concession is an exception or the rule in central Africa, and to determine if threshold of canopy impact is an important area of study for the region

Optimal amount of protected areas

Forest management implies values about how much of the forest should be devoted to conservation efforts, how much should be devoted to timber production, and how much should be devoted to other uses like agriculture, forest dwellers, or development (Poore and Sayer, 1991, J S Hall, personal communication, 1998) While scientists agree that there is a need to set aside areas for conservation if the integrity of the ecosystem is to be maintained (Sayer, 1992), and agree that endangered species will persist longer in one large forest reserve rather than two smaller reserves of the same total area (Swingland, 1993, Grieser Johns, 1997), they do not always agree about a) the proper ratio of protected to production areas, b) the size of protected areas required to maintain the overall health of an ecosystem, and c) the potential ecological benefits of increased protected areas This last point is particularly relevant when conducting cost-benefit or net present value assessments of protected areas Often, the costs of protected areas are certain (administrative, monitoring, and foregone production) while the benefits (carbon sequestration, biodiversity preservation, preservation of forest cultures) are uncertain or difficult to quantify (Dixon and Sherman, 1990), leading to the establishment of fewer than optimal protected areas

The precise percentage of the forest that should be preserved is also "controversial " While some scientists suggest that 5% of the total area should be a requirement for biodiversity conservation (Harris, 1984), others suggest up to 20% may be required to preserve certain species (Hunter, 1990) Grieser Johns (1997) concludes that 5-10% is probably appropriate at the level of individual concessions, while 20% should be used at the national or regional level

Feasibility of managing forests for multiple objectives

Some foresters and conservationists believe multiple use management - the successful management of a single forest for multiple purposes - to be possible, many others believe multiple use management is not possible in the near future Further research is required to determine the extent to which it is possible to manage a single forest area for multiple

objectives (agriculture, timber production, production of non-timber forest goods, provision of ecological services like biodiversity etc) versus the extent to which production and protected areas must be geographically separate to be successful (Poore and Sayer, 1991, Gomez-Pompa et al , 1991, J S Hall, 1998, personal communication)

Understanding the tradeoffs between production and conservation, whether it be on a nationwide or concession basis, requires ecological, economic, and social research (Panayotou and Ashton, 1992) For example, to answer the question "what is the optimal percentage of a logging concession that should be devoted to production at a point in time?", we would need to know what species exist on concession, how susceptible those species are to disturbance, how much those species are worth, how much the timber is worth, what are the needs and desires of local communities, what is the administrative capacity of local enforcement agencies etc Currently, there is sufficient information to say that it is important to have some protected areas geographically distinct from production areas, but there is still disagreement about how to allocate specific use categories at a national and concession level (Gomez-Pompa et al , 1991)

C) Areas of research for which there is very little of agreement

Relevance of scientific findings from other areas of the world

A great deal of information about the ecological impacts of logging originates from the Amazon and Asia Scientists are uncertain about the extent to which these findings can be used as a proxy for Africa While general scientific findings from tropical forests in Asia or Latin America may be relevant to Central Africa (Boscolo, personal communication, 1998, Grieser Johns, 1997), more specific findings may not be readily transferable because Central African forests are different in several ways (J S Hall, personal communication, 1998) For example, while Asian forests are dominated by a single family of trees (Dipterocarpaceae), Central African forests are not Also, African forests do not receive the same amount of precipitation as their Asian and Latin American counterparts, and soils in Africa are thought to be lower in nutrient status

These underlying differences in forests have lead to the development of different ecosystems in Central Africa, Asia, and Latin America, each of which will respond somewhat differently to logging Therefore, "best practice" effective timber management systems may not be easily transferred from one forest to another Grieser Johns (1997) notes that "ecological analyses of the effects of logging that are based on inter-site comparisons may indicate differences, particularly species richness and composition, that might be due more to spatial heterogeneity [basic difference between different geographic areas] than to the effects of forestry activities " In other words, there are probably more ecological differences between unlogged forests in Asia and Africa than there are between a logged and an unlogged forest in the same place Determining the extent to which findings from other tropical forests are applicable to Central Africa would reduce the time required to replicate and verify existing information from other areas of the world

3. Criteria for priority areas of ecological research

High priority areas of ecological research for WRI should be those that are 1) applicable to policy 2) cost-effective and 3) relatively easy-to-implement An interesting question is how does research priority relate to the level of scientific agreement (discussed above)? High priority research is also not likely to be ranked as having high levels of agreement above, since these areas do not require additional research to be applicable to policy But are high priority research areas are more likely to have "little agreement" or "some agreement" in scientific community? The answer to this question depends on why there is "little agreement" on some areas of research If there is little agreement because further research is not cost-effective, then they should not be high priority research areas However, if there is little agreement on issues because were only recently identified as important, then they should be high priority, since the marginal benefit of research in these areas is likely to be high Because scientists tend to believe the former, this report concludes that areas of research for which there is "little agreement" are not likely to be cost-effective Therefore, this section will describe areas of research that have "some agreement", are applicable to policy, are cost-effective, and will lead to findings that are relatively easy to implement

Application to policy

WRI and CARPE should focus on areas of research that have strong policy implications, rather than those that intend to increase the wealth of academic information Research is needed to serve as the foundation for policies that minimize the ecological impacts of logging So, research topics need to be designed with relevance to policy in mind Similarly Spruit and Bearder (1998), advise scientific researchers in the Congo Basin, to "ensure that your project brings tangible benefits " For example, specific research on the effects of logging on different species of birds will be less relevant to policy than research on the optimal size of a protected area, since a clear policy recommendation will emerge from the latter, but not form the former As Narendra et al (1994) noted "What is needed is not only more research, but more relevant research "

Cost

WRI and CARPE should focus on areas of research that are not prohibitively expensive (due to the amount of time, human capital or equipment required) in favor of lower cost, more realistic areas of research For example, conducting a complete biological inventory of the Congo Basin will be more costly, and less cost-effective in terms of marginal utility, than a basic survey complemented with a complete inventory on an as-needed basis This recommendation contrasts with the World Bank assertion that "governments need to conduct national forest inventories which will serve as a basic framework for planning, implementing, monitoring and evaluating forest sector activities" (Narendra et al, 1994) Until it is clear that the marginal benefit outweighs the marginal cost of additional biological inventories in Central Africa, this report does not recommend further inventories

Implementation

WRI and CARPE should focus on areas of scientific research that are expected to be most effective in producing real world results For example, if there is little industry expertise and support for lower impact logging techniques, and if the host country government has limited monitoring and enforcement capacity, then research on threshold of logging damage (or the type, size, and class of trees that should be left undisturbed) will probably not be effective since the scientific findings and policy recommendations of the research are not likely to be implemented successfully

Recommended area of research: Protected areas

Given the above criteria, protected areas are recommended as top-priority for scientific and inter-disciplinary research Protected areas are critical if Central Africa is to maintain the ecological value of its forests Also, most of the true protected areas that exist in Central Africa remain protected thanks to the presence of scientific researchers (J S Hall, personal communication, 1998)

Recommended questions for further study include What is the optimal strategy for creating protected areas? What is the proper ratio of protected areas to production areas? What is the minimum size required to maintain the overall health of the ecosystem? The answers to these questions would be highly applicable to policy and could be implemented most easily if the research is carried out in conjunction with Central African communities and organizations However, as mentioned previously, in order for information to be most useful and most credible to Central African policy makers, they need to play a role in research and its definition Thus, this report suggests that WRI and CARPE generally focus on protected areas, but ask the host country forest agencies which specific type of information would be most useful to them

4. Does ecological research really matter for logging policy?

This chapter has focused exclusively on the role of scientific, ecological research in logging policy As seen above, research on protected areas would be highly relevant to policy But what about scientific research in general? Virtually all survey respondents and interviewees believed that ecological research was not the most important component logging policy One scientist said

> I doubt that any additional ecological information would help improve logging policies The world price of old-growth timber is sufficiently high given the poverty of Congo Basin nations to almost ensure that all remaining stands of old-growth timber are likely to be mined Unfortunately it looks like any market instrument used to promote RIL [Reduced Impact Logging] reduces logging company profits and national revenue generation As a result it is highly unlikely that cash strapped governments will push for these measures Economics is driving old-growth logging around the world, not concerns for forest function So additional information on forest functional impacts of logging are unlikely to change policy makers opinions - at least in cash strapped nations

Another survey respondent, also a scientist, wrote "Given the existing political realities, I'm not convinced that more information would have any impact in the central African context" Likewise, a policy-maker said "the number one research priority, in my opinion, would not focus on ecological relationships but on the relationship between loggers and the incentives provided by concession agreements, logging permits, etc" Struhsaker (1997) echoes this sentiment, writing "tropical rainforests are generally not managed on the basis of ecological research" Similarly, Panayotou and Ashton (1992) note "Clearly, much more long-term natural and social science research is needed before we can develop models of sustainable forest management However, we do know enough to determine that current policies are promoting destructive and unsustainable uses of tropical forests and to recommend basic policy reforms"

Thus, the consensus among scientists, policy makers and nonprofit managers is that it is important for logging policies to be based on the underlying ecological relationships between logging and impact However, the consensus also seems to be that we have sufficient ecological information upon which to base policies, and that ecological considerations are not the most important when shaping policy creation and implementation in Central Africa

Survey results and interviews suggest that political commitment and administrative capacity are the major constraint to effective implementation of sound logging policies In other words, it does not matter how much information exists on the ecological impacts of logging if the host country lacks the commitment or administrative capacity to act on scientific findings Tropical ecologist Grieser Johns (1997) agrees, noting that "even if basic principles of biodiversity conservation are included within national forest strategies, to be applied effectively these require both research programmes to determine specifically the type and extent of any interventions required and training of forestry staff to implement them"

Given this conclusion, WRI and CARPE have four main options First, they could continue to focus on increasing the wealth of scientific information on the ecological impact of logging, so that when the political commitment and administrative capacity improve the information will be available Second, WRI and CARPE could focus on boosting political commitment and administrative capacity in Central Africa, since commitment and capacity are the main challenges to effective policy implementation, leaving scientific research to other organizations Third, WRI and CARPE could focus simultaneously on information, commitment and capacity The first option (ecological research) risks spending time and money exclusively on an activity that has not proven effective in changing policy, the second option (building capacity) is estimated to require financial aid of $300-1500 million annually (Barbier et al , 1994 in Grieser Johns, 1997), and the third option (do it all) runs the risk that CARPE and WRI will spread themselves too thin

Or fourth, WRI and CARPE could try to alter the type of information being produced to make it more relevant and credible to Central African policy makers so that information

will play a larger role in policy formulation in the future One way of doing this would be to "coproduce" scientific information on the ecological impacts of logging, such that the African "users" of information worked collaboratively with the Western "producers" of information in defining and carrying out scientific research on the impacts of logging The goal of this "coproduction" is to give Central African governments and policy makers more of a vested interest in the information Without coproduction, scientific information will be less credible to host country governments, and may be resisted as "imposed from the outside " As a result, the information is not likely to be translated into policy, or the policy is not likely to be implemented Thus, this report recommends that WRI and CARPE help to pair scientists with Central African governments to conduct research on areas that both groups deem most useful to each country or region The hope is that the role of information in policy will increase over time as Central Africans become more involved in scientific research However, until that happens, the role of information will not be as great as the role of other factors like political commitment and administrative capacity

Chapter 3 turns to policy recommendations that take ecology into account, but are mostly based on the ability of policies to overcome the most significant factors for determining policy success in Central Africa economics and politics

CHAPTER 3: POLICY

This chapter has three parts First, it defines the policy problem Second, it describes the problem of merging science and policy Third, it presents a set of policy recommendations, directly targeting the policy problems, for reducing the ecological impacts of logging in Central Africa

1. The policy problem

The policy problem has three parts policies cannot compromise economic benefit, policies must address the underlying factors that drive logging, and policies must meet a host of criteria for success Each of these problems could also be called a "challenge " However, the challenges to implementing effective policies in Central Africa are so great that they are more appropriately termed "problems "

A. Policies cannot compromise economic benefit

The problem of incomplete scientific information about Central Africa's forests is compounded by the fact that Congo Basin countries are poor[4] Alone, they cannot afford to gather more scientific information about their forests, nor can they afford to set revenue-producing forests aside for pure conservation, nor can they afford to cut back on timber exports In the absence of additional sources of funding from the international community, this means that policy options are limited to those which increase, or at least maintain, the economic benefit Congo Basin countries derive from their forests To the extent that conservation projects benefiting the global community compromise the economic benefits currently enjoyed by Africans, Western individuals, organizations and governments must be prepared to help provide funding (Wilkie, personal communication, 1998)

In Central Africa, forest product exports average about 10% of net exports, ranging from 1 7% of total exports in Zaire to 23 1% of total exports in the Central African Republic (FAO, 1992, World Bank, 1992) Not only is logging an important source of foreign exchange for Central African countries, but logging companies also provide employment benefits to local people and often provide medical, educational, and social services in remote areas where government services are limited While some believe that "the economic benefits from timber harvests to the national economies of tropical countries are substantially overstated" (Repetto and Gillis, 1988), the fact remains that Central African governments are not willing to compromise on these benefits, however large or small, so successful policy reform will need to take this constraint into account

[4] In 1993, average GNP in the six Congo Basin countries (Cameroon, Central African Republic, Congo, Democratic Republic of Congo, Equatorial Guinea and Gabon) was $4,763, or $1,302 per capita Per capita GNP figures range from $264 in DRC to $4,995 in oil rich Gabon Excluding Gabon, average per capita GNP for the five Congo Basin countries drops to $570 80 (World Resources 1996-1997)

B. Policies must address underlying causes of logging

Policies aiming to reduce the ecological impacts of logging must directly address the factors that drive[5] excessive logging and excessive environmental impact in Central Africa (Durning, 1993)

Poverty is one of the most basic drivers of forest destruction and excessive logging (Leslie, 1987, Miller and Tangley, 1991) This is both because countries are poor (and do not have sufficient monitoring and enforcement capabilities) and because people themselves are poor With few alternative sources of income, Central Africans turn to the forest for logging jobs, shelter, food products, and other daily needs (Serageldin, 1992) Reductions in poverty would reduce reliance on natural resources to meet daily needs, and would allow Central African individuals, communities, and governments to manage their resources over the long-term, rather then use them for immediate survival Although outside the scope of this paper, it is important to recognize poverty as one of the underlying factors driving logging, and to realize that excessive logging will likely persist as long as poverty persists

This section reviews the more direct factors driving logging which can be addressed in the near term Below, the factors driving logging are paired with corrective policies

TABLE 1

	What are the factors driving excessive logging?	*What policies can be put in place to target each of these factors?*
1	Strong tropical timber market	Certification (Green Labeling)
2	Inefficient host country government regulations	Longer duration of logging concessions, increased or decreased area of logging concessions, caps on rotation rates
3	Weak international lending organization policy	Stricter green conditionality of World Bank/IMF loans
4	Logging costs do not include externalities	Increased stumpage fees, area taxes, performance-based deposits, concession bidding
5	Poor land use planning	Increased scientific research on sustainable forestry, increased biological inventories, increased preservation areas

1. Tropical timber market: External market forces are considered an important factor in determining patterns of tropical rain forest exploitation (Struhsaker, 1997, Repetto and Gillis, 1988) In general, increased demand for tropical timber means higher

[5] Narendra et al (1994) distinguish between ' drivers" of deforestation (population growth poverty, international trade, accessibility and technology) and the triggers of deforestation (market policy and institutional failures Because of the ambiguous distinctions between triggers and drivers, this report addresses both categories as drivers

prices, increased harvesting rates, and higher environmental impact (A G Johns, 1998) Demand for Congo Basin wood products has increased dramatically in recent years Between 1991 and 1993, the six Congo Basin countries produced a total of 70 million cubic meters of wood products, representing an average increase of 33% over 1981-1983 production levels [6] During the same time (1981-1990), tropical Africa's total forest area was reduced by 529 million hectares, or 7% (World Resources 1996-1997)

A market-based mechanism which directly addresses the increasing market for tropical timber is timber certification, or green labeling (Orsdol and Kiekens, 1992) Timber certification, or the labeling of wood products as "sustainably produced"[7], provides a means of competitive differentiation for timber producers, furnishes additional product selection information for consumers, and creates incentives for sustainable wood production (Hazel and Magrath, 1992) If timber certification is coupled with a) consumers' willingness and ability to pay extra for environmentally friendly products and b) producers' willingness and ability to implement strict "green label" environmental criteria, then there will be an increase in demand for sustainably produced timber and a decrease in ecological impact of logging

2. Host country government regulations: Regulations governing the size and duration of timber harvesting concessions can create incentives for higher or lower intensity logging (Struhsaker, 1997, Repetto and Gillis, 1988) In most Central African countries, existing legislation provides incentives for short-term profit at the expense of long-term management An example of an inefficient government regulation is the short duration of logging concession agreements Panayotou and Ashton (1992) write that "logging companies operating under short-term concession agreements, without assurance of renewal and with constant threats of encroachment and poaching, adopt hit-and-run strategies, since they have no incentive to preserve the long-term productivity of their concessions " For example, in Gabon, legislation states that logging concessions cannot exceed 25 years, giving firms the incentive to maximize profits over a short period of time Gabonese regulations also state that a logging permit will be revoked if logging activity does not take place for two consecutive years (Article 27, Law 1/82) Thus, Gabon's timber legislation provides no encouragement for environmentally sound logging practices, and actually imposes penalties for failure to degrade the forest

Rather than encouraging profit maximization, logging policies should encourage forest management Examples of policies designed to encourage forest management, longer time horizons, and fewer environmental impacts are 1) lengthening the duration of logging permits and 2) granting smaller concession areas Longer permit durations more closely approximate property rights Secure land tenure is a fundamental condition for the efficient operation of natural resource markets, since it leads to long-term planning, rather

[6] The Central African Republic and Equatorial Guinea only experienced a 16% increase in wood production between the early 80s and the early 90s, while the Democratic Republic of Congo experienced a 48% increase in production levels in a single decade Roundwood production is responsible for the vast majority (86% in 1991-1993) of total wood production in the Congo Basin countries (World Resources 1996-1997)

[7] Alternatively, certification can label all timber from certain concessions as sustainably produced, or all timber products from a certain country (Barbier et al , 1994)

than short-term profit maximization (Struhsaker, 1997, Panayoutou, 1993, Panayotou and Ashton, 1992) Contingent upon periodic performance reviews, longer permit durations could lead to more efficient forest management (Grut et al, 1991) Performance reviews every few years would ensure that delinquent forest managers were not permitted to continue destructive practices for entire length of their concession allocation

Smaller concession areas provide more incentive for logging companies to manage their plots, since firms must be careful not to exhaust the forest's resources, and therefore the cash flow, too quickly Slower forest depletion means there will be less habitat disruption at any given time, which means there will be fewer or less severe ecological impacts of logging In sum, concession areas should small enough to encourage efficient use, but large enough to encourage competition (Grut et al , 1991) Optimal concession sizes will need to be determined by each country (based on the amount of competition and the tradeoff between higher revenues and higher administrative costs for various size concessions)

3. International lending organization policy: International lending organizations like the World Bank and International Monetary Fund (IMF) can grant loans with environmental requirements which, in turn, can minimize the ecological impacts of logging (Repetto and Gillis, 1988, Struhsaker, 1997) With development assistance loans totaling nearly 1 4 billion USD from 1991-1993, comprising 5% of the region's GNP (World Resources 1996-1997), international lending organization environmental policy has the ability to influence the ecological impacts of many projects in Central Africa

In the past, the World Bank and other international lending organizations have been criticized for funding projects that cause negative environmental impacts (Struhsaker, 1997), or simply fail to take environmental considerations into account However, if the World Bank were to require Central African countries to write *and implement* environmental policy changes (like those listed above) in order to receive loans, then Central African countries would have an economic incentive to institute policies that minimize the ecological impacts of logging and other activities The World Bank has already begun to attach environmental conditions to some of its loans[8], but the Banks' enforcement of loan "green conditions" has not been consistent

4. Logging costs do not include externalities: As logging costs increase, harvesting rates will decrease Current logging taxes and fees in Central Africa are considered underpriced because they do not account for environmental externalities, leading concessionaires to create externalities and extract beyond the socially optimal rate (Plouvier, 1998, Barbier et al , 1994, Narendra et al , 1994, Durning, 1993, Hazell and Magrath, 1992, Panayotou and Ashton, 1992, Repetto and Gillis, 1988) This underpricing problem is not limited to Central Africa, indeed, as Marchak (1995) notes "Almost everywhere natural forests grow, there is a history of systematic undervaluation of

[8] For example, in 1993, Gabon was required to produce an acceptable "environmental policy" in order to secure a 22 5 million USD loan from the World Bank Not surprisingly, Gabon's "Environmental Code" (Loi 16/93) was created on August 26, 1993, just three days after the law authorizing the government to accept the loan (loi 21/93)

the wood at its source " In order to determine the proper price of timber, concession rights, and stumpage fees[9] in Central Africa, policy makers would need to a) identify and measure the external social, environmental, and intertemporal costs (costs to future generations) of timber extraction and b) internalize these costs by increasing prices or taxes for logging companies, timber consumers (Panayotou, 1993, Ruitenbeek, 1992)

As a result of the fact that the costs of logging (environmental, social) are more difficult to measure than the benefits (logging revenue)[10], "there is a dangerous asymmetry today in the way we measure, and hence, the way we think about, the value of natural resources" (Repetto et al , 1989) For example, depreciation of physical capital (logging machinery) can be calculated with a basic formula, whereas depreciation of natural capital (soil fertility, biodiversity) is unknown and uncalculated According to Repetto et al (1989), this discrepancy is particularly important for developing countries, like those of the Congo Basin, that are depleting their stock of natural capital to fund their development If the benefits of logging are reflected on national balance sheets, but not the costs, then Congo Basin countries will have drastically overestimated both the economic desirability of logging and their long-term potential for growth

While political resistance may impede placing the true "cost" of natural resource depletion on national balance sheets (since this would reduce GNP), four policies which are designed to specifically address the problem of underpriced timber are 1) increasing stumpage fees, 2) instituting area taxes, 3) creating performance-based deposits and 4) allocating concessions though a bidding process The first and second policies, higher stumpage fees and higher area taxes (which would tax ecologically sensitive areas at higher rates to reflect the true cost of logging in those areas), are both ways of attempting to internalize the environmental externalities of logging activity, and thereby reducing the ecological impacts of logging (Narendra et al , 1994) The third policy, an environmental performance-based deposit scheme, would require logging firms to give the regulatory agency an up-front deposit, which would be refunded after the logging permit had expired if the firm had met certain environmental conditions The deposit would be a means of aligning profit and environmental incentives from the start in an effort to reduce unnecessary ecological impact (Boscolo, personal communication, 1998, A G Johns, 1997, Grut et al , 1991)

The rationale for the fourth policy, allocating logging concessions through a bidding process, is that it would 1) ensure that the concession earned the highest amount of revenue possible 2) provide an indication of the proper market rate for concessions and 3) decrease corruption, since government officials sometimes grant concessions at no or minimal charge as favors, or demand additional unofficial payments (Panayotou and Ashton, 1992, Grut, 1991, Repetto and Gillis, 1988) The bidding process should distinguish between concessions open to the international bidding and those set aside for host country nationals

[9] A stumpage fee is a fee on the value of standing timber It is often termed the "economic rent" of timber because it represents the approximate market value of the timber (Grut et al , 1991, Repetto and Gillis, 1988)

[10] A cost-benefit analysis of logging in the Korup forest of Cameroon showed that the benefits of continued harvesting were about 1 million USD, while the social and ecological costs were $25 million USD (Ruitenbeek, 1992)

and firms in order to ensure that Africans were still able to afford logging concessions (IFIA, 1996)

Timber prices and logging fees in Central Africa are considered too low not only because wood products are underpriced but also because rents collected represent a fraction of rents due (A G Johns, 1997, Repetto and Gillis, 1988, Besong and Wencelius, 1992) For example, in Congo in the late 1980s, the forest fee collection rate was estimated to be about 20% of fees charged (Barbier et al , 1994) Thus, in order to minimize excessive ecological impacts, fees would have to be both increased *and* collected

5. Land use planning: Land use planning means deciding how land is to be managed, and then managing it accordingly Deciding how a forest should be managed requires an understanding of the ecological and economic value of different areas of the forest so that the forest may be divided to maximize those values It also requires using the land for the purpose for which it is best suited (Tufor, 1992) Land use plans are important both for logging companies (on the concession level) and governments (on the national level) In both cases, failure to decide on the values for which the forest should be managed (conservation or production), and failure to adhere to an established plan, risks over-exploitation and the conversion of protected areas [11] into production areas (Dixon and Sherman, 1990) These risks are particularly high during economic recessions when countries and individuals may neglect long-term plans for short-term economic gain The policy implications of this are a) in order to develop the most effective land use plan, thorough biological inventories or surveys must first be conducted to determine the ecological and economic value of the forest and b) once there is agreement on the land use plan, it must not be changed as a result of economic conditions

In theory, many Central African countries have, or are developing, land management plans In practice, however, land management plans often fail to guide actions For example, many wildlife reserves in Central Africa are subject to encroachment and poaching (Cameroon, Congo, Zaire) while in other countries (Gabon, Cote d'Ivoire) logging is legally authorized in "wildlife reserves" (Besong and Wencelius, 1992) In sum, in order for policies to effectively reduce the ecological impacts of logging, they must address these underlying drivers of excessive logging - the tropical timber market, host country regulations, lending organization policy, costs of production, and land use planning Clearly, this is an enormous and complicated undertaking, and there are many reasons this may not be feasible The next section details the criteria affecting feasible policy implementation

C. Policies must meet a number of criteria

As seen in this chapter, successful management of Central Africa's forests will require 1) policies that maintain economic benefits of logging activity and 2) policies that address the

[11] There are a number of terms that can be used to describe an area set aside for ecological or conservation purposes, such as reserve, park, natural landmark, wildlife sanctuary, protected landscape, resource reserve, and managed resource areas (Dixon and Sherman, 1991) For the purposes of this paper, however, the general term "protected area" is used to describe land with some degree of restricted use

factors driving deforestation It will also require consideration of the other criteria required for sustainable forest management, since scientific information alone is not a sufficient condition for sustainable forest management in Central Africa Five major criteria for successful policy implementation are 1) political commitment 2) administrative capacity 3) public support 4) lack of market and policy failures and 5) investor/funder support Without these criteria, the feasibility of policy creation and implementation is greatly reduced Below, criteria are presented in order of decreasing importance

1. Political commitment means that there is top-level government support for the policy The success of any environmental policy will be closely linked to the political commitment of the policy The International Tropical Timber Organization (ITTO) recognizes the importance of political commitment, one of the ITTO's guidelines for sustainable management reads "A strong and continued political commitment at the highest level is indispensable for sustainable forest management to succeed (in Poore and Sayer, 1991) This is especially true in Central Africa, where the vast majority of forest lands are owned and managed by the central government Survey respondents judged lack of political commitment to be the single greatest obstacle to the success of effective logging policies

2. Administrative capacity means that the implementation and monitoring agency or organization has the resources (human, financial, organizational and logistical) required to ensure ongoing, effective implementation of the policy Human capacity is a key part of administrative capacity Insufficient field staff leads to inadequate protection of natural resources and poor implementation of legislation throughout Central Africa (Verdoes, 1998) In the absence of strong educational institutions to train both scientists and policy makers in Central Africa, administrative capacity becomes an even greater obstacle to success (Goldammer, 1992)

Financial and logistical capacity is also a grave problem For example, in Zaire there are 800 forest department staff and 100 million hectares of closed tropical forest, meaning that there are 125,000 hectares of forest per staff member In Cameroon, there are 50,000 hectares of forest per forest department staff member (Johnson and Cabarle, 1993) In Gabon, government regulators complain of not having transportation or telephones Clearly, without transportation to get to logging concessions, regulators cannot ensure whether or not concessionaires are abiding by environmental regulations and the effectiveness of those regulations will be drastically reduced Problems like these lead many to say "My first priority for development assistance would therefore be institutional support to the central services responsible for forest conservation and management (Sayer, 1992) Survey respondents agreed, placing administrative capacity as the second most important criteria for logging policy success in Central Africa [12]

Another important part of both administrative capacity and political commitment is

[12] Just this month (March, 1998) France granted Gabon 500 million CFA ($833,333) to support a forestry management project called "Aid and Cooperation Fund Forestry and Environmental Development" A major component of the project will be providing institutional support to the forestry department (Panafrican News Agency)

corruption While corruption is often placed in a category by itself, its result is the same as any other capacity or commitment problem a reduction in the ability of policy makers and implementers to produce and implement the most efficient policies If Central African countries were able to curb corruption in the forestry sector laws would be implemented more effectively logging, revenues would increase, and the ecological impacts of logging would likely decrease

Currently, evidence of corruption in Central African logging operations - illegal logging, timber smuggling, corrupt accounting practices, undervaluing and misclassifying timber - abounds For example, in Cameroon, a Malaysian timber firm is alleged to be illegally exporting more than 30,000 cubic meters of logs per month by using an unofficial, specially constructed harbor (Martin, in Contreras-Hermosilla, 1997) In a forestry office in Gabon, a large square was recently added to the forest concession map and labeled "Omar Bongo 200,000 ha An anonymous WF official said "That concession just appeared Someone came in one day and put it on the map We don't know anything about it It was just taken," (personal communication, 1996) Corruption is not limited to government officials who are trying to compensate for their low wages Rather, corruption often begins with well-paid, high-ranking officials, so dismantling it will be a tremendous, and ardently resisted, task

3. Public support means that there is support from the general population for the policy For example, if there is a policy which calls for limited hunting on logging concessions and the local population does not support the policy, then the policy will not effective (Narendra et al , 1994) Increasingly, there is recognition among policy makers of the importance of local participation in the decision-making process and in policy implementation Survey respondents placed public support as the third most important criteria for policy success

4. Well-functioning policies and markets means that the markets operate efficiently and reflect non-timber values of the forest, and government policies intervene when necessary, and do not intervene when unnecessary (Barbier et al , 1994, Panayotou, 1993) [13]

5. Investor/funder support means that there is support from private investors (logging companies) and funders (World Bank and IMF) to carry out the given policy For example, if the World Bank offers financial and managerial support for sustainable logging projects, the success of those projects will be increased Likewise, if logging companies themselves actively support timber certification, the probability of success for timber certification will be increased Survey respondents thought this was the least important criteria for successful policy implementation

[13] Survey respondents ranked this criteria as one of the least important for policy success However, this result should not be interpreted to mean that policy and market failures are not important Rather, respondents said that *given a list of policies that are already believed to be highly effective*, market and policy failures would not be the reason the policies would not work

2) The problem of merging science and policy

> A particular problem in finding effective solutions to environmental issues is the difficulty of incorporating scientific results into effective policy Scientists should therefore attempt to provide results in a form that is suitable for evaluating economic and social consequences While the politico-economic wrangle will inevitably continue, it is the scientists who will be wrong-footed if they cannot be clear and precise in their advice and judgment when governments ask - what should we do and how?
> -Ian Swingland (1993)

As seen, the task of minimizing the ecological impacts of logging presents both science problems and policy problems This section examines the final problem merging science and policy

A. Lack of applied science

There is scientific literature on logging, and there is policy literature on logging However, there is very little literature which links scientific findings with policy implications As Grieser Johns (1997) notes Most research [on the effects of logging on biodiversity] has been academically oriented with the implications for forest management considered only after the study has been completed " There are two primary reasons for this First, due to limited space and the desire to focus on advances in science, most scientific journals tend not to publish studies with a strong policy component Therefore, scientists seeking professional advancement may be discouraged from writing about the policy implications of their work (J S Hall, personal communication, 1998)

Second, scientific findings are often very specific, while policy recommendations must be more general For example, most studies find logging to be beneficial to certain species, but detrimental to others (Struhsaker, 1997, White, 1994, Lambert, 1991, Wilson and Wilson, 1975) Extracting a policy recommendation from individual scientific works is exceedingly difficult, since policies are too broad to address micro-problems affecting specific species, in specific areas, under specific conditions To the extent that policy does have a scientific foundation, it is based on meta-analyses and the broader state of knowledge, rather than individual studies or specific results

B. Limited information exchange

There are three major problems related to the exchange of information in Central Africa First, language barriers limit information exchange between French-speaking and English-speaking scientists and policy makers (Narendra et al, 1994) While most scientists and policy makers in the region are bilingual, the English-speaking and French-speaking research communities tend to work separately

Second, there is a rift between Africans and Westerners While Africans are the information users in Central Africa, Westerners are often the information producers When

the groups that use information are not the same as the groups that produce information, exchange is limited (Panayotou and Ashton, 1992) And, even when exchange does occur, the information risks being perceived as irrelevant or not credible

Third, as with many disciplines, foresters tend to exchange information with foresters, while policy makers tend to exchange information with policy makers As a result, there is little flow of information between the groups Institutionalizing the flow of information between scientists and policy makers will be an important step toward merging the gap between science and policy

While improvements in applied science and information exchange between scientists and policy makers will be a start toward merging the gap between science and policy, many are not optimistic about how quickly this can be done Ecologist A D Johns (1987) writes "The incorporation of information on the responses of wildlife into forest management decision-making is, in most forest regions far in the future " Similarly, a survey respondent noted that "policy is affected by specific research, but not to the extent many would like to believe" (Boscolo, 1998)

However, this raises the questions to what extent *should* policy be based on science? To what extent *can* it be based on science? Policy is affected by a host of factors other than science, such as economics, ethics, political commitment, interest groups, public perception, the media, and international pressure Thus, even if the problems merging science and policy did not exist, there would still not be a direct relationship between science and policy Science provides valuable guidelines for policies, and can be useful in sending policies in one direction or another (e g more logging or less logging, clearcutting or selective logging) However, policy creation requires integrating many factors other than science- ethics, economics, politics

3) Policy recommendations

As described above, CARPE should encourage Central African governments to pursue policies designed to

1 Address the underlying causes of logging impacts (strong tropical timber market, inefficient host country government regulations, weak international lending organization policy, failure to internalize externalities associated with forest damage, and poor land use planning)
2 Maintain economic benefit
3 Meet basic criteria for success (strong political commitment, sufficient administrative, investor and funder support, public support, and lack of market and policy failures)

Below, the top four policies that accomplish all of the above goals are recommended in order of feasibility

- **Policy 1: Increased stumpage fees, area taxes, or performance-based deposits**

Problem: Logging costs do not account for environmental externalities. As discussed in Chapter 1, current taxes and fees on logging in Central Africa are underpriced and do not account for environmental externalities, leading concessionaires to extract beyond the socially optimal rate Forest fees need to be simpler, higher, collected at higher rates, adjusted for inflation, and transparent (Grut et al, 1991)

Maintenance of economic benefits: Central African governments could suffer a loss of economic benefits by changing the fee structure if the costs of the change outweigh the benefits There are two types of costs to consider actual costs of reforming the fee structure and the cost of logging firms' potential relocation Considering the first type of cost, while changes in the fee structure (and the associated information, monitoring, and enforcement costs) would be expensive, the long-run the economic benefits of higher collection rates will likely outweigh the costs of reforming the fee structure To assess second type of cost - the economic effect of increasing stumpage fees, imposing area taxes or performance-based deposits - we would need to determine if the revenue the government would gain in increased taxes would exceed the revenue lost by firms moving elsewhere Firms require expected higher returns in Central Africa to compensate them for the higher risks of conducting business in the region To the extent that new costs would compromise these returns, firms may move elsewhere On the other hand, given the rare woods found in the Congo Basin, it is likely that logging companies have a highly inelastic demand curve for African timber, therefore, an increase in price would be associated with a smaller decrease in production Also, even if logging companies do not have a highly inelastic demand for timber, they would still remain in Central Africa if consumers have inelastic demand for timber, so that firms are able to pass higher costs onto consumers

Evidence suggests that consumer elasticity of demand is inelastic (Barbier et al , 1994), such that the percentage decrease in demand for tropical timber would be much less than the percentage increase in price, meaning that producer may be able to pass these cost onto consumers with little negative consequences on demand [14] However, this is only true for producers as a group, since the elasticity of substitution among difference sources of tropical timber is very high (Barbier et al , 1994) Central African governments could also use pricing to reduce demand for certain areas of the forest, by charging a tax rate proportional to the ecological value of the area

Criteria: Increasing production costs would meet staunch opposition from industry and would require improvements in administrative capacity (particularly with regards to corruption) However, there is sufficient information for this policy change, there is sufficient support from international lending organizations, and host country governments would support it if it were shown to maintain or increase economic benefits

[14] Compiling results from nine studies, Barbier et al , (1994) found that price elasticities of demand for timber ranged from -0 3 to -2 42 Buongiorno and Manurung (1992) found that long-term price elasticities of demand for major tropical timber importers ranged from -1 14 to -0 16

There are two caveats to internalizing the costs of forest damage First, there are few examples of where proper forest pricing has actually led to sustainable forest management (Grut et al , 1991) The reason for this is less because we do not understand the relationship between pricing and forest management and more because efficient forest pricing schemes are rarely implemented Even after government attempts at implementation, new forest pricing systems can face considerable difficulties For example, in 1995, Cameroon issued a decree advocating a new pricing system and market-based logging concession bidding system The implementation of the new forestry law has been slower than expected, met considerable resistance from the private sector (which boycotted the increase in fees and refused to submit bids in the first auction in May 1996), and sparked allegations that the government did not always award concessions to the highest-bidder (WRI, in press) Some fear that the higher prices may trigger more corruption and fraud (McNeilage, personal communication, 1998) Plouvier (1988) says "however progressive [Cameroon's] new provisions seem to be, they still don't seem to enhance sustainable logging practices in the field " Despite these difficulties, by adopting a new forest policy, the government of Cameroon made an important step toward the sustainable management of its forests (WRI, in press) Cameroon's experiences with forest pricing and bidding systems may eventually serve as a benchmark for other Congo Basin countries In the meantime, the recommendations in this section are guidelines that still need to be refined on a country-by-country, case-by-case basis

A second caveat is that the timber industry is, not surprisingly, resistant to increases in production costs, saying "any sort of tax, fee or duty is in direct relationship with the life or death of the private sector" (IFIA, 1996) The timber industry brings in significant economic benefits to most Central African countries and is an important interest group Thus, the industry's organized resistance to increases in stumpage fees, area taxes, performance-based deposits or a bidding process could challenge the political feasibility of policies that enjoy support from Western environmentalists and economists, but have been labeled as "eco-dictatorship" by African timber producers (IFIA, 1996)

• Policy 2: Increase protected areas

The preceding chapter recommended protected areas as the highest priority area of ecological and interdisciplinary research This section recommends increasing protected areas, even in the absence of further scientific information, as a high priority policy

Problem addressed: Poor land use planning. Poor land use planning in Central Africa has lead to insufficient area devoted to protected areas (Grieser Johns, 1997) The importance of protected areas is outlined by Struhsaker (1998)

> In terms of conserving biological diversity within intact and viable ecosystems, there is no substitute for large areas that are protected against invasive and destructive human activities Any form of extraction has an impact Inherent in the concept of ecological management of extractive reserves is the understanding that equally large, if not larger, areas contiguous with the exploited area will be given total protection against invasive activities This is the essence of the

biosphere concept

As seen in Chapter 2, land use planning implies values Governments must decide for what objectives they would like to manage their land before they can divide up the land to appropriate uses Thus, the first step to establishing more protected areas is to determine the objective(s) of the protected areas Examples of protected area objectives include protection of watershed areas, rare ecosystems, threatened species, economically important species, ecotourism potential, scientific and educational information, and aesthetic, cultural, historical and recreational areas (Dixon and Sherman, 1990, Gradwohl and Greenberg, 1988). After objectives have been identified, governments can then identify the areas that best suit these purposes

As a classic public good, it is difficult to gain the financial resources and political commitment to establish and enforce protected areas This is because protected areas are non-exclusive (once they are established it is difficult to keep people from enjoying their benefits, such as carbon sequestration or watershed protection) and non-rival (one person's enjoyment of these benefits does not diminish another person's enjoyment of the same benefits) Thus, there is no private incentive to commit - financially and otherwise - to the preservation of the protected area Related is the fact that the benefits of protected areas are enjoyed to a smaller extent by more people than are the benefits of timber production Many people enjoying a small benefit do not have as much political motivation as a small group of people enjoying considerable benefit As a result, timber producers will lobby harder against preservation areas than citizens will lobby for preservation areas, even if the net benefits are the same to each group

Maintenance of economic benefits: Careful selection of protected areas does not require decreasing production areas It might mean maintaining the same area of reserves and parks, but simply selecting and managing them more effectively Furthermore, to the extent that protected areas can be used for revenue-generating activity (like ecotourism and non-timber forest products), forest revenue will not necessarily decline (Gradwohl and Greenberg, 1988) However, to be realistic, while increasing protected areas may not necessitate a decline in forest revenue, it also should not be expected to increase short-term revenue unless Central African countries develop strong markets for non-timber forest products and ecotourism

Also, it should be stressed that setting aside protected areas is not enough to ensure their long-term viability In order for Central African governments to maintain protected areas, funds must be allocated to cover both the opportunity cost of the area (foregone revenue from timber production, for example) and the monitoring and enforcement costs Given the economic status of Central African governments, Western individuals, groups, and governments will need to help endow Central African protected areas This report suggests that WRI and CARPE seek to play a strong role in facilitating the endowment of more protected areas in Central Africa

Criteria: Increasing protected areas fares well for some criteria, according to survey results, there is both sufficient information on the importance of protected areas and

international public support for the policy However, there is not sufficient support from many Central African governments for protected areas (many existing parks are protected only on paper) and it is difficult to secure endowments from international investors and funders to maintain protected areas

Public support is critical for the success of protected areas (Gradwohl and Greenberg, 1988) If the people living in the vicinity of the protected area do not benefit from the protected area (either through tourism or non-timber forest products), but suffer losses as a result of the protected area (if they are not permitted to hunt, log, or farm), then the projected area will not be successful On the other hand, if local communities are involved in the design, creation, management and monitoring of the reserves, and if they enjoy a net benefit from the existence of the reserve, then the chances for the reserves' success greatly improved in the long-term (Dixon and Sherman, 1991, Poore and Sayer, 1991)

- **Policy 3: Lengthen duration of logging permits, decrease area of logging concessions**

Problem: Inefficient host country government regulations. There are two main policies which encourage inefficiently high levels of logging and impose unnecessarily severe environmental impacts short duration of logging permits (leading to limited time horizons and fast rotation rates) and large logging concessions (which do not create an incentive to manage the forest)

Maintenance of economic benefits: Shorter duration permits and larger logging concessions would have a significant impact on forest revenues if taxes and fees were calculated as a percent of logs cut However, if forest taxes and fees were calculated as a function of area logged (recommended), then these policies would have no appreciable impact on the economic benefit of logging activity

Criteria: These policies are likely to be opposed by the logging industry, and therefore Central African governments, unless logging fees are based on concession area, rather than volume of logs extracted This is a hurdle that will likely meet with considerable political resistance, and may require pressure from international lending institutions However, these policies are likely to have a significant impact on the ecological impacts of logging, and do not require any further information before implementation

- **Policy 4: Timber Certification**

Problem addressed: Strong, increasing tropical timber market. High demand for tropical timbers has increased logging pressure, and therefore logging impacts, in the Congo Basin However, creating or tapping into demand for "sustainably produced" timber would provide a) means of maintaining existing economic benefits while b) addressing one of the basic drivers of logging (demand)

Criteria: Certification fares well for some criteria, including investor and funder support and lack of market and policy failures As the broadest market-based strategy to ensure rational harvesting techniques, green labeling directly links minimal ecological impacts with profit, thereby minimizing market and policy failures (Elliott, 1996) Timber certification also enjoys support from international lending organizations like the World Bank and the majority of international environmental organizations

However, green labeling does not fare as well for other criteria Most importantly, green labeling requires a level of administrative capacity (host country monitoring, enforcement, and verification of guidelines) and cooperation (between host country governments and NGOs, particularly when defining the guidelines for timber certification) that is lacking in the Congo Basin (Barbier et al , 1994) In order for green labeling to succeed, a) the same groups that benefit from the scheme, logging companies and consumers, must be willing to pay for these increased administrative costs, and b) the benefits of labeling must exceed its costs It is fairly clear that the benefits of labeling (lower environmental impacts, more choice for consumers, more demand for producers) could exceed the costs (administrative) in theory, but in practice the information and transaction costs of organizing a certification scheme in Central Africa are likely to be prohibitively high in the short-term

It is also unclear whether public support for timber certification, as revealed by willingness to pay for sustainably produced timber, is sufficiently strong (Grieser Johns, 1997) While a study conducted in the UK in the late 1980s and early 1990s suggests that a quarter to half of all consumers would be willing more for certified timber products (Barbier et al , 1993) and a number of other studies suggest that consumers would be willing to pay more for sustainably produced timber products (London Environmental Economics Centre, 1992, WWF UK, 1991, Milland Fine Timber Ltd 1990) , surveys like this should be viewed with some skepticism, since a) willingness to pay studies frequently overestimate the amount of money customers will pay for environmentally friendly products b) willingness to pay is considerably higher in Europe than in North America (Reinhardt and Vietor, 1996) and c) the elasticity of demand for different types of tropical timber products is uncertain, so it is difficult to predict whether or not higher prices for tropical timbers will force substitution to other non-tropical wood products (Grieser Johns, 1997)

Another problem with timber certification is that it may lead to unintended inequalities, both between foreign and African timber producers within a single country (since large-scale foreign producers are more likely to have the up-front capital required to engage in a certification scheme than small-scale African operations) and between different countries If wealthier, more developed countries are more likely to be able to fund, monitor and enforce a certification system, certification could act as a barrier to trade for less developed countries (Elliott and Viana, 1996) A final problem with timber certification is that most Central African governments have not expressed widespread support for green label initiatives To make green labeling more acceptable politically, Barbier et al (1994) suggest involving producer countries in the certification scheme and in the verification process, integrating certification plans with national forest and land use plans, granting exporting countries sufficient access to international markets for sustainably produced timber, and ensuring that timber certification offers a voluntary means of facilitating trade

in sustainably produced timber, rather than a mandatory means of restricting trade of unsustainably produced timber

Green labeling has the potential to reduce the ecological impacts of logging and slow the pace of deforestation in Central Africa However, at present, "there is little practical field experience to evaluate certification" (Plouvier and Roux, 1998, Orsdol and Kiekens, 1992) Given the numerous challenges it faces, certification is not likely to be a viable solution in the short-run, but it should be explored and developed as a policy tool for the future

CHAPTER 4: CONCLUSION

RECOMMENDATIONS

1. Focus on boosting capacity and political commitment

The bottleneck for policy implementation is not information, it is political commitment and administrative capacity As such, this report concludes that WRI and CARPE should focus on political commitment and administrative capacity in future studies This report also recommends that future studies should be less theoretical and more field-based Coproduced studies based on field research and pilot projects are likely to be more expensive and more time consuming, but also more realistic and more valuable in the long-term in helping WRI and CARPE to meet their mission

2 Complement capacity and commitment building efforts with scientific research on protected areas

This report recommends that WRI and CARPE focus on ecological research that is high priority, low cost, easy-to-implement and applicable to policy Based on these criteria, protected areas are recommended as the top priority area of ecological research in the Congo Basin

3 Encourage policies that internalize the costs of logging and increase protected areas

This report recommends that WRI and CARPE focus on policies that address the factors driving logging, maintain economic benefit, and meet criteria for success (administrative capacity, political commitment, public support, information, and investor/funder support) Based on these criteria, recommended policies (in order of feasibility) increase logging fees to internalize the cost of ecological damage, increase protected areas, lengthen permit duration, and encourage timber certification (in the long-run) Thus, protected areas are a recommended focus for both science and policy

4 WRI and CARPE can play a strong role in the West as advocates and bridge-makers of information

Regardless of which areas CARPE focuses on in the next 5-10 years, WRI should continue to act as a bridge maker of information, gathering evidence and presenting it to interested parties in a policy-relevant format Given the fact that a) Central African governments are not willing or able to pay for many conservation projects and b) most conservation projects benefit the global community, the financial support of Western individuals, groups, and governments will be critical to ensure the long-term preservation

of Central African countries As such, Westerners will - and should - continue to be an important audience for the information WRI produces on Central African forests

CONCLUSIONS

- **Overall, the ecological impacts of logging are clear enough to warrant policy change**

Decades ago, Aldo Leopold articulated the "Land Ethic", which states that in the absence of environmental data, the precautionary principle is the best approach for conservation Today, many ecologists and scientists similarly subscribe to the thought that "uncertainty dictates caution" (Turner and Pearce, 1993) However, uncertainty should not dictate paralysis We do not need to have near perfect information before we can create and implement best policies, rather, we need information that sends policies in the right direction Currently, we have enough information to say, for example, that more protected areas, higher costs of production, and stronger institutions would improve forest management in Central Africa Once more information becomes available, policies can be adjusted and refined as necessary In the meantime, some degree of uncertainty should not be used as an excuse for inaction

- **Scientific information is a necessary, but not sufficient, condition for logging policy reform in Central Africa**

Even if there were perfect information about the ecological impacts of logging in Central Africa, it would not be enough to ensure sustainable forest management At present, information is not thought to be an important part of policy making in Central Africa However, the role of information in Central African policy making is expected to increase as Central Africans take on a more of vested interest in the research, and become more involved in defining and carrying out research As such, WRI and CARPE should work to facilitate "coproduction" of information on the ecological impacts of logging in Central Africa, by pairing scientists with Central African policy makers In this way, WRI and CARPE will be addressing the information problem, political commitment problem, and capacity problem at the same time

Appendix I:

World Resources Institute and CARPE

Appendix I

WORLD RESOURCES INSTITUTE AND CARPE

World Resources Institute (WRI) is an independent center for policy research and technical assistance on global environmental and development issues Created in 1982, WRI is dedicated to helping governments and private organizations of all types cope with environmental, resource, and development challenges of global significance The mission of World Resources Institute (WRI) is to move human society to live in ways that protect the Earth's environment and its capacity to provide for the needs and aspirations of current and future generations

CARPE, the Central African Regional Program for the Environment, is a five year, $15 million project funded by the United States Agency for International Development (USAID) CARPE's immediate goal is to reduce the pace of deforestation and biodiversity loss in Central Africa Its long-term goal is to avert potentially negative changes in global and regional climate

CARPE is being implemented by USAID in partnership with the following US-based organizations Biodiversity Support Program (BSP), NASA Goddard Space Flight Center, Peace Corps, PVO-NGO Natural Resources Management Support Project, US Forest Service (USFS), Wildlife Conservation Society, World Resources Institute (WRI), and World Wildlife Fund (WWF) CARPE's African partners include non-governmental organizations, universities, private sector consultants and government agencies

CARPE's major focus areas include a) the role of logging, agriculture, mining, infrastructure development and urban growth on forests b) the impact of commercial hunting and gathering on forest biodiversity and c) the promotion of sustainable forest management and conservation of biodiversity Over the course of the five year pilot program, CARPE's goal is to

1 Gather and disseminate baseline information on the status of the forest throughout Central Africa
2 Characterize and prioritize the threats to the forest in the region, and opportunities for sustainable forest management
3 Develop systems for monitoring the extent, state, and uses of the forest in the region
4 Strengthen the capacity of Central African decision makers to manage the forest and maintain the long-term ecological and economic productivity of the region

The first phase of CARPE (pilot program) will be over in 18 months Thus, the recommendations in this paper are intended to provide direction for the second phase of the CARPE project

Appendix II:

Literature Review of the Ecological Impacts of Logging

Appendix II

LITERATURE REVIEW OF THE ECOLOGICAL IMPACTS OF LOGGING

There is a considerable amount of literature of the ecological impacts of logging Below, several articles are reviewed to provide an overview of the scientific underpinnings of logging policy in Central Africa Studies have been classified by impact (on primates, birds, insects, forest structure, and hydrology) This literature review is intended to provide the reader with an overview of the type of research that exists on the ecological impacts of logging It is not intended to present an exhaustive account of all existing research Broader implications of these scientific findings are discussed in Chapter 1

Summary of literature reviewed

Author, Year	Type	Location	Severity of impact	Scale
Douglas et al, 1991	Hydrology	Malaysia	severe	local
Hall, 1992	Forest structure	Zaire	insignificant for species composition severe for species diversity	local to regional
Holloway, 1991	insects	Malaysia	severe for insects requiring floristic specificity, minor for others	local
Johns, 1986	primates	Malaysia	no change in primate numbers, significant changes in activity budgets	local
Lambert, 1991	birds	Malaysia	no significant impact, but some species (nectarivores) become more abundant in logged forests while others become more rare	Local
Meijer, 1970	forest structure and soils	Malaysia	moderate	local
Pinard, 1995	forest structure and soils	Malaysia	low (due to reduced impact techniques)	local
Redhead, 1960	forest structure	Nigeria	moderate to serious	local
Skorupa and Kasenene, 1984	Forest structure (treefall)	Uganda	insignificant in lightly logged forests, severe in heavily logged forests	local
Sunderland et al ,1997	primates	Cameroon	no significant impact on species diversity, significant impact on composition	long-term
White, 1994	chimpanzees and gorillas	Gabon	mild for chimpanzees, severe for gorillas	local
Wilson and Wilson, 1975	primates	Indonesia	none to severe different effects on different species	local
Johns, 1989	birds	Malaysia	no long-term effect for 181 out of 193 species	local

- **Johns, A D. 1981. The effects of selective logging on the social structure of resident primates Malaysian Applied Biology 10. 221-226.**

Carried out on the Sungai Tekam Forestry Concession in West Malaysia, this two year study found that while low density selective logging "initially has a severe effect on resident primates, they are quick to adjust and recover " In the study area, approximately ten trees per hectare were removed, causing a loss of 45% of the total stand Reliable data was only collected for *Hylobates lar* (Lar gibbon) and *Presbytis melalophos* (Banded langur) For both of these species, selective logging was associated with "widespread loss of infants" The sample size was small (with a total of 18 females and 10 infants observed from the two species), and the study does not report statistical significance However, all ten infants died as a result of logging activity, and birth rates were markedly lower in the year after logging activity (two babies were born where nine would have been expected statistically) Previous studies suggest that infant mortality is rare for these species

The author hypothesizes that the infant deaths are most likely due to the fact that mothers need to leap further to cross post-logging gaps in trees, and that infants may be dropped or fall as a result The author reports one observation of a mother *P melalophos* who dropped her infant, probably while fleeing logging activity, and did not return for the infant, suggesting that infant abandonment may also lead to increased infant mortality

However, Johns notes that post-logging recovery rates are high for resident primates, with all species present in comparable numbers in unlogged forests and forests logged more than 5-6 years earlier In conclusion, he writes "Generally, diversity within the primate community remains constant and stability is quickly regained following logging " It should be noted that this study analyzed results from forests that had only been logged once, and that repeated logging would be expected to lead to permanent reductions in individual densities

- **Johns, A D. 1986. Effects of selective logging on the behavioral ecology of West Malaysian primates. Ecology. 67: 684-694.**

This study documents the effect of selective logging on six primate species in West Malaysia (Sungai Tekam Forestry Concession) Logging damage in the study area had caused a total loss of 50 9% of the total trees greater than 30 cm formerly present Twelve months to six years after the onset of logging, there were no significant reductions in numbers of adult primates There were, however, significant differences in the activity budgets of *Hylobates lar* (lar gibbon) and *Presbytis melalophos* (banded leaf monkey), with the primates spending less time feeding and traveling and more time

resting after logging These species also increased their range area, since logging made it necessary to roam over a larger area to have access to the same amount of food, and spent more time in lower levels of the canopy where they would be protected from sun, rain and avian predation For the other studies primate species there were insufficient data for analysis

The change in activity budgets and range area are a result of the fact that logging affects both the abundance and the dispersion of different food types Johns hypothesizes that the shift toward lower energy activities is a result of an attempt to conserve energy in the face of reduced availability of high energy foods (like fruits and seeds) and that the continued survival of primates in a logged forest is due to this adjustment in foraging strategies and activity budgets Yet, the author does note that "these species *[H lar and P melalohos]* show a remarkable degree of flexibility that is certainly not shared by all primate species

However, how long will primates - even the most flexible species - be able to maintain their populations in logged forests? Previous studies have found that reduction of food sources to a critical point can cause mortality (Dittus 1977) Johns concludes that "longer-term data are needed before definite conclusions can be drawn" on the long-term survival of primates

- **Wilson, C and Wilson, W. 1975 The influence of selective logging on primates and some other animals in East Kalimantan Folia Primatologica 23: 245-274.**

Conducted in East Kalimantan, Indonesia, this paper documents the findings of a brief survey on the impact of logging on primates The methodology was to compare primate density in unlogged areas to that of logged areas There were three survey sites an undisturbed primary forest on a logging concession, a selectively logged forest in the same logging concession, and a mixed habitat lowland forest in a different area Limitations of this early study are that the authors did not conduct any longitudinal studies (on the same plot over time) and they report degree of logging disturbance in terms of number of trees removed rather than damage to the canopy or basal area

Despite these limitations, however, the authors come to the same conclusion as other more recent studies (Struhsaker, 1997) and write "Selective logging that causes only moderate habitat disturbance does not seem to result in a significant decrease in the densities of several primate species " The authors note that while some species (the longtailed macaque and the silvered leaf monkey) prefer disturbed habitats, other species (the white fronted leaf monkey and the pigtailed macaque) are indifferent to moderate selective logging, and still others (the orangutan and the proboscis monkey) are adversely affected by selective logging, even in low levels Thus, the impact of selective logging varies as a function of the species involved

EFFECT OF LOGGING ON BIRDS

- **Johns, A.D. 1989. Recovery of a Peninsular Malaysian rainforest avifauna following selective timber logging The first twelve years. Forktail 4: 89-105.**

The results of a research project initiated in 1979 suggest that a very high proportion of birds in a previously unlogged dipterocarp forest in West Malaysia had reappeared 12 years after logging Johns recorded 193 bird species in the unlogged forest, compared with 181 bird species in the logged-over forest Significantly, of the 22 species defined as "intolerant of logged forest", all but five were present in the forest 12 years after logging, though in lower numbers The species had not reappeared 12 years after logging were mostly terrestrial litter-gleaning and understorey flycatching species

The author notes that the ability of bird species to recolonize the forest did not appear to be influenced by the vegetational composition and food abundance of the regenerating forest Rather, physiological considerations (heat and water balance) seem to be of greatest importance In this study, recolonization was facilitated by the re-establishment of a closed lower canopy, which may occur about 10 years after tractor logging This canopy re-creates the cool, humid micro-climate of the original forest

The author also notes that forests logged with conventional tractors can support regrowth of herbs (banana/ginger understorey) faster than forests logged using overhead cable systems, since the latter cause more soil compaction and disturbance Consequently, in conventional tractor-logged forests, birds are able to re-occupy the area more quickly

Given sufficient time, vegetation and fauna of a logged-over forest could return to their original states However, with logging occurring on a 35 year cycle, the forest is not permitted to regenerate completely In conclusion, Johns writes "If long-term sustained-yield management for timber is possible, then the maintenance of rainforest animals should be also But a permanent change in the avifauna may well occur with the first logging event, the original organization of the community may never be regained"

- **Lambert, F.R. 1991 The consequences of selective logging for Bornean lowland forest birds Tropical rain forest· Disturbance and recovery Proceedings of a royal society discussion meeting held on 18 and 19 September 1991.**

This study found that eight to ten years after logging, most primary forest bird species were still present in a lowland Dipterocarp forest in Sabah, Malaysia In the area studied, logging damage was "severe", with 62% to 80% of trees greater than 30 cm lost during and subsequent to logging In general, the author reports that "more species than previously supposed survive in, or use, selectively logged forest" Indeed, 207 bird species were recorded in primary forest, compared with 199 in selectively logged forest Lambert hypothesizes that the ability of birds to survive in logged forests is due to the

mosaic of habitats Patches of unlogged forest are believed to act as centers of avian recolonization in degraded forests The implications of these findings are that bird species will be able to survive or recolonize logged forests if there is a large, unlogged tract of forest to facilitate colonization or if the logging concession is large enough that there will always be tracts of forest in advanced stages of recolonization

However, Lambert offers two caveats to the results of this study First, while some species become more abundant in logged forests (nectarivores and opportunistic frugivorous species) other species become more rare in logged forests (flycatchers, woodpeckers, trogons and wren-babblers) Second, there is some question about the applicability of these results to other geographic areas Lambert notes that "results from one area cannot necessarily be used to predict the effects of logging on the avifauna of another, even when original species composition is almost the same "

Effect of Logging on Insects

- **Holloway, J D. et al. 1991. The response of some rain forest insect groups to logging and conversion to plantation. Tropical rain forest: Disturbance and recovery Proceedings of a royal society discussion meeting held on 18 and 19 September 1991.**

With over half of global diversity numbers represented by insects, the impacts of logging on insects represents an important part of biodiversity loss This study, conducted in Sabah, East Malaysia, suggests that insects which do not require floristic specificity (like moths) show significant losses in diversity and taxonomic quality after logging activity By contrast, insects which are dependent on more uniform resources (like dung and carrion beetles) show less change in diversity and faunistic composition since their food source is more likely to be found in both primary and secondary forests However, overall numbers of dung and carrion beetles may decline after logging disturbance In conclusion, the authors write " the impact of logging and forest disturbance on the diversity of a major plant-feeding insect group [moths] is measurable and significant" More research will be required to discern the exact effect of forest disturbance on insects, since "for insects, the work has barely begun"

- **Hall, Jefferson. 1992. An Assessment of small scale "selective" logging in a mixed forest in Northeastern Zaire. Symposium on African Forests.**

The objective of this study was to assess how timber extraction changes the structure of tropical forests Specifically, it tested three hypotheses 1) intermediate aged extracted tree species replace mature trees in the canopy, thus allowing for continued extraction 2) logging creates canopy openings which permit sufficient regeneration of intermediate sized tree species and 3) low intensity logging does not appreciably alter species composition

The study was conducted in three 100 hectare logging concessions in a semi-deciduous forest south of the transafrican highway in Mungamba, Zaire To assess the effects of logging on forest structure, the author compared the logged forest to adjacent unlogged (control) forests The criteria used to evaluate and compare forest structure were size class distribution, seedling and sapling densities and species area curves

The study results suggest the following

- **Basal area** The difference between the unlogged forest and recently logged forest was a 14 6% reduction in basal area, while the difference between an unlogged forest and one 10 years post-logging was greater, at 20 7% The reason the basal area rates were even higher 10 years after logging than immediately following logging is probably due to increased treefall rates in the years following logging activity Skorupa, J and Kasenene, J describe more severe (25 to 50%) post-logging increases in treefall rates in Uganda
- **Species composition and structure:** Overall, the forest concession logged in 10 years earlier had a "very similar species composition" to the unlogged forest However, there were some species which were not as prevalent in the logged forest, including Celtis mildbraedii, Khaya anthotheca, and Entandrophragma cylindricum
- **Species diversity:** Twenty five (23 6%) fewer species (greater than 10cm) were found in the forest logged 10 years earlier than in the unlogged forest Skorupa (1986) reports similar declines in species diversity for lightly and heavily logged forests in Kibale, Uganda

In conclusion, the author notes that "this data is striking in that it suggests that even in relatively low density logging operations, a significant drop in species diversity can be observed " While the study did show the canopy dominant, Cynometra alexandri, to regenerate, Hall writes "it is unlikely that low density high quality timber species can replace themselves on a sustainable basis "

- **Pinard, M et al 1995. Creating timber harvest guidelines for a reduced-impact**

logging project in Malaysia Journal of Forestry 93: 41-45.

In general, logging in the tropics is deemed "uncontrolled", "unsustainable", and "not rapidly improving" However, this article describes a unique public-private venture in Malaysia which succeeded in implementing a Reduced-Impact Logging (RIL) project in August 1992 The project began when New England Electric System (of Massachusetts) provided funds to Innoprise Corporation Sendirian Berhad (ICSB of Malaysia) to engage in RIL techniques on 1,400 hectares of its logging concession The goal of the project was to reduce selective logging damage to the soil and residual stand by employing the following techniques directional felling, prefelling vine cutting (one year prior to harvest), harvest planning (which includes mapping skid trails and logging roads), and harvest area closure

Preliminary evidence suggests that the project's goal of 50% reduction in damage to topsoil and residual forest is being met In the first 450 hectares to be logged according to RIL guidelines, "skid trail area averaged 3 4% of the total area logged, in contrast to 12% in adjacent areas logged by conventional methods" and "the percentage of the skid trails with subsoil exposed averaged 38% in RIL areas, in contrast to 87% in conventionally logged areas " Furthermore, while an average of 41% of trees (5-60cm dbh) are killed during conventional logging, only 15% were killed during reduced impact logging Despite these apparent successes, remaining areas of concerns for the continued feasibility of RIL projects include slope and wet-weather skidding restrictions (both of which seem to reduce the profitability of logging operations), and the future of international agreements on joint implementation carbon-offset projects such as this one

- **Redhead, J F 1960 An analysis of logging damage in lowland rainforest. Nigerian forestry bulletin 10 5-16 Lagos. Federal Government Printer.**

Conducted in the Sapoba Reserve, Nigeria, this early study analyzed selective logging damage on trees Overall, the study determines that the extraction of 2 3 trees per hectare caused the destruction of 25% of stems in each acre A third (32%) of commercial tree species between ten feet high and six feet girth suffered some degree of damage For 25% of trees this damage was deemed "serious" Breaking and falling caused most damage to smaller trees, while crown and bark damage accounted for most damage to larger trees A third of the logged area was affected by felling debris only, and crawler tractors affected an additional 18 7% of the area However, Redhead notes that "the proportion of stems destroyed by crawler tractors was almost twice that destroyed by felling debris" The author recommends that logging companies give more consideration to preserving commercial trees below merchantable size, that they immediately liberate young trees bent down by felling debris, and that they give more consideration to the construction of logging haulage roads

- **Skorupa, J and Kasenene, J. Tropical forest management· Can rates of natural treefalls help guide us?. Oryx 18 96-101.**

The authors conducted studies of treefall rate in three areas of Kibale Forest, western Uganda One area was relatively undisturbed mature forest, a second area was lightly disturbed (total harvest 14 cu m/ha), and the third area was heavily disturbed (total harvest 21 cu m/ha) Treefall rates in the mature and lightly logged forests were not statistically different (at 1 4% and 1 3%, respectively) However, treefall rates in the heavily disturbed forest were significantly higher, at 6 2% Because logging had not occurred for 12 years in the heavily disturbed forest, it is unlikely that the increased rate of treefalls was due to trees weakened or damaged by logging It also does not appear that the higher rate of treefall was due to insects or differences in tree/stem size, since the three plots were similar in these respects Rather, the high incidence of treefall in the heavily disturbed plot seems to be due to lower windbreak protection and soil cohesion

While low-impact logging may be feasible in theory, Skorupa and Kasenene note that in practice there are few examples of successful attempts to control logging damage However, they also agree that "there is still almost no information on just how much damage is too much" In terms of treefall, natural forests can have treefall rates up to 2 3% and still be considered normal Using 2 3% as an upper bound, the authors determine that any disturbance greater than 35% of the original forest stand constitutes too much damage in Kibale Currently, capital-intensive mechanized timber harvesting leads to disturbance of 50% As such, the authors conclude that "our results provide evidence that mechanized timber harvesting may not be a sustainable method of exploiting Kibale Forest Our results also bring into question the wisdom of allowing mechanized selective timber harvesting as a multiple-use option in tropical rain forest conservation areas "

To the extent that treefall rates are indicative of overall ecological impacts, this study would seem to suggest that successful low impact logging is possible However, further study is required to determine how much results from Kibale Forest can be generalized to other tropical forests

- **Meijer, W. 1970. Regeneration of tropical lowland forest in Sabah, Malaysia forty years after logging. Malayan Forester. 28: 206-228.**

Because sustained timber yield depends on regeneration rates, Meijer studied the rate and nature of reforestation in two ten acre plots in Sabah, Malaysia one logged and one in an adjacent virgin forest Study conclusions are

1 Selective logging (marking trees) would be the best means of ensuring sustained yield in tropical forest soils under a 60-80 year rotation
2 Areas of intensive soil disturbance can be identified even 40-45 years after logging
3 In areas not subject to severe soil disturbance, "the normal species composition of mature forest" had returned

4 Unlogged species were not more prevalent than logged species

The implications of these findings are that Dipterocarp trees belonging to the girth classes of 4-6 feet and defective trees above 6 feet girth should be left undisturbed to facilitate post-logging forest regeneration Further, the author recommends marking trees for retention instead of girdling undergrowth

Effect of Logging on Hydrology

- **Douglas, I. et al. 1991. The impact of selective commercial logging on stream hydrology, chemistry and sediment loads in the Ulu Segma rain forest, Sabah, Malaysia Tropical rain forest Disturbance and recovery. Proceedings of a royal society discussion meeting held on 18 and 19 September 1991.**

This study documented the dramatic post-logging increase in sediment load of surrounding rivers The monthly average ratio of suspended sediment from the logged catchment to that of a nearby undisturbed catchment was 1 1 before logging, 4 1 after a logging road was built, 5 1 after logging within 37 meters of the road, and 18 1 in the five months after logging One year after logging had ended, the ratio had fallen to 3 6 1

Effect of Logging on Biodiversity

- **Sunderland, T. et al. The Vegetation of the Campo Faunal Reserve and Ejagham Forest Reserve, Cameroon Unpublished document. 1997**

A joint effort sponsored by the Smithsonian Institution/Man and the Biosphere Programme (SI/MAB) and Bioresources Development and Conservation Programme (BDCP), this study established five plots in Cameroon to monitor biodiversity Two of the plots studied had been logged 20-25 years previously and exhibited slight declines in the number of trees per hectare However, with respect to logging, the primary conclusion is that "the logging activity has not had a significant impact with regard to species diversity with all species, genera and family taxon groups being as diverse, or only slightly less so than those plots in unlogged forest" Yet, the authors note that "more research is needed to further quantify the interpretation of these data"

The authors also conclude the following

- Regeneration rates of unlogged and selectively logged forests are relatively high, even after exploitation Commercial species show particularly rapid regeneration
- Logging does affect species composition (density and dominance)
- About 30% of all taxa within standing forest have actual or potential economic value

Appendix III:

Survey of the Ecological Impacts of Logging

Appendix III

SURVEY OF THE ECOLOGICAL IMPACTS OF LOGGING

METHODOLOGY

As part of this Policy Analysis Exercise (PAE), a qualitative survey on the ecological impacts of logging was distributed during the months of January and February, 1998

Goal of the survey The survey was designed to complement the literature review (see Appendix II) While the literature review aimed to discern how much and what kind of information exists on the ecological impacts of logging, the survey was designed to discern if there is any agreement on the ecological impacts of logging and to see how respondents collect, use, and interpret existing information

Means of communication The survey was distributed over fax, email, and regular mail The survey was distributed in both French and English After the survey response was received, a phone call, email or personal visit was made to ask follow-up questions as necessary

Survey recipient selection Recipients were selected using client contacts and personal contacts They were selected to be as representative as possible with regard to nationality (Africans, Americans and Europeans), job type (scientists, foresters, policy makers), and employer (non-profit agencies/NGOs, government, and private universities and firms) In this sense, survey recipients are considered "representative" but not statistically "random" Twenty seven recipients were selected This number was chosen to provide sufficient breadth of opinion from the most interested and involved parties For a complete list of survey recipients, but

Response rate. The survey response rate was only 22% This low response rate is largely attributable to the fact that many respondents were in Africa, or were traveling frequently to Africa, making correspondence difficult, costly, and time-consuming Because of the low response rate, survey results should not be considered to represent a random or comprehensive view of logging in Central Africa However, due to the high degree of agreement in the survey responses that were received, qualitative results and general rankings are included in the report

SUMMARY OF MAIN FINDINGS

- **Administrative capacity and political commitment are the most important determinants of logging policy.**

Survey results suggest that the most important determinants of effective logging policy, in order of decreasing importance, are

1 Administrative capacity
2 Political commitment
3 Public support
4 Information
5 Investor/Funder support

In other words, the greatest obstacles to effective logging policy implementation are administrative capacity and political commitment Information was ranked second to last, meaning that it is not an important component of policy These rankings corresponded with qualitative responses as well (See "Does information really matter for policy?" in Chapter 1)

- **Increased research is the most feasible policy to reduce the ecological impacts of logging, green conditionality is the least feasible.**

Survey results suggest that the ranking of logging policies, in order of decreasing feasibility, is

1 Increasing ecological research
2 Changing the duration of logging concessions
3 Increasing protected areas
4 Instituting a performance-based deposit on logging concessions
5 Joint implementation
6 Area-based taxes
7 Replanting
8 Forest privatization
9 Eco-labeling of timber
10 Increased World Bank Green conditionality

- **Putting these two findings together, survey results indicate that while increasing information may be the most feasible strategy WRI and CARPE might pursue to reduce the ecological impacts of logging, it would also be the least effective.**

SUMMARY RANKINGS FOR LOGGING POLICIES

Conclusion Looking down the columns, we see that weak political commitment and poor administrative capacity pose the greatest problem to effective policy implementation. Looking across the rows, we see that eco-labeling and stricter green conditionality are the least feasible policies. Increased scientific research is the most feasible policy, but the least effective policy.

Criteria for effective policies

Policy	Information	Political commitment	Admin. Capacity	Investor/funder support	Public Support	Lack of market/policy failures
Increased scientific research	●	○	○	●	●	●
Increase logging fees	●	○	◒	◒	◒	●
Increase protected areas	●	○	○	◒	◒	●
Longer permit duration, smaller concessions	●	○	◒	◒	◒	◒
Eco-labeling	○	◒	○	◒	○	◒
Stricter World Bank "green conditionality"	◒	○	◒	◒	○	◒

Key

● Indicates that the policy is ranked high for this criteria, meaning it fares well

◒ Indicates that the policy is ranked "medium" for this criteria, meaning it fares somewhat well

○ Indicates that the policy is ranked "low" for this criteria, meaning it does not fare well at all

LIST OF SURVEY RECIPIENTS

	Name	Organization
1	Adeleke Wale	World Wide Fund for Nature (Cameroon)
2	Allogo, Constant	CIAJE (Gabon)
3	Boscolo, Marco	Harvard Institute of International Development
4	Bourobou Bourobou, Henri	Institut de Recherche en Ecologie Tropicale (Gabon)
5	Buccowich, Mark	Department of Agriculture (CARPE)
6	Djomo, Louis	African Forestry Action Network (Cameroon)
7	Ekobo, Atanga	World Wide Fund for Nature (Cameroon)
8	Ferrer, Vincente	World Bank (Washington, D C)
9	Fotso, Roger	World Conservation Society (Cameroon)
10	Frumhoff, Peter	Union of Concerned Scientists (United States)
11	Ilambu, Omari	World Conservation Society (Congo-Kinshasa)
12	Itoua, Illanga	World Wide Fund For Nature (Cameroon)
13	Jeanrenaud, Jean-Paul	World Wide Fund For Nature (Switzerland)
14	Kaimowitz, David	CIFOR
15	Losos, Elizabeth	Smithsonian Tropical Research Institute (US)
16	MacNeilage, Alastair	World Conservation Society (United States)
17	Makana , Jean-Remy	Oregon State (United States)
18	Memvie , Jean Boniface	Project Foret Environnement (Gabon)
19	Moad, Alex	U S Forest Service (United States)
20	Mokombo, Tony	World Wide Fund for Nature (United States)
21	Murphy, Peter	Michigan State (United States)
22	Ndinga, Assitou	IUCN Program for Central Africa (Cameroon)
23	Obme Ondo, Prosper	World Wide Fund for Nature (Gabon)
24	Rice, Dick	Conservation International (United States)
25	Rietbergen, Simon	IUCN (Switzerland)
26	Vincent, Jeff	Harvard Institute of International Development (United States)
27	Wilkie, David	Associates in Forest Research and Development (US)

SAMPLE SURVEY

Dear [survey respondent],

I received your name from [contact], who recommended you as someone who might have valuable insight into my Master's thesis, which is entitled "Merging Science and Policy The Ecological Impacts of Logging in Central Africa" I am completing the thesis under the direction of Harvard University's Kennedy School of Government and World Resources Institute (WRI)

As one part of my thesis, I am conducting a survey of scientists, academics, policymakers, and non-profit managers This survey has two main goals first, to discern if there is consensus on the ecological impacts of logging in Central Africa within the scientific, academic, non-profit and policy communities and second, to generate data upon which policy recommendations can be made The results of this survey will be presented in April 1998 to Harvard and WRI and will be available to other organizations by request The survey will complement a literature review of the ecological impacts of logging in Central Africa

I would like to invite you to participate in the survey The survey is designed to take approximately thirty minutes to one hour to complete, however many questions are open-ended so that you may elaborate on your responses as you feel necessary Please type your responses directly into the survey and forward it back to me over email by February 16, 1998 My address is simonsk@ksg harvard edu As necessary, I will follow-up with your responses (over email or phone) after I have received your completed survey

Notes about the survey

- The first part of the survey poses five questions specifically about the role of information in logging policy creation and implementation The second part of the survey is more general, and asks you to rank how effective you expect various types of logging policies to be in Central Africa
- If your response to any of the questions is shaped by your knowledge of a particular research study, article, or book, please reference the literature to the best of your ability
- There are many words and phrases in this survey that are open to interpretation, such as "sound policies" and "severe impact" Where appropriate, please provide the definition you are using to interpret the questions
- Would you like your survey results to be kept confidential? (Please type in "yes" or "no" here) If you say "yes", your basic job title (e g "scientist" or "government official") will be used to identify your comments You will not be identified by your name or your employer's name

Thank you again for your time, interest and honesty I greatly appreciate your participation in this survey

Sincerely,

Katie Simons
22 Brimmer Street, Apt 7
Boston, MA 02108 USA
(617) 367-0884 simonsk@ksg harvard edu

SURVEY OF THE ECOLOGICAL IMPACTS OF LOGGING

Katie Simons
Kennedy School of Government
January, 1997

Please fill in the following background information

Employer name
Your title
Area of expertise
Country experience/interest
Contact information (email, phone, fax, address)

PART I INFORMATION

1 Do you think there is sufficient information on the ecological impacts of logging in Central Africa?

2 If you answered "no" to question 1, how much and which type of information do you think we would need before we would be able to create sound forest management/logging policies?

3 For the areas you said we have insufficient information upon which to base policies, how much time and money do you think would be required before sufficient information were available?

4 How would forest management/logging policy change if we had more information about the ecological impacts of logging?

PART II LOGGING POLICY

There are a number of policies which aim to reduce the ecological impacts of logging However, for a policy to be implemented successfully, a number of criteria must be satisfied These criteria include sufficient information, political commitment, administrative capacity, investor/funder support, public support, and lack of policy and market failures

QUESTIONS

1 Looking at the table below, to what extent are the criteria in place for the following polices? (Criteria are listed across the top of the table, policies are listed on the left-hand side)

If you think the policy has sufficient amounts of the criteria, write 1
If you think the policy has some degree of the criteria, write 2
If you think the policy lack the criteria, write 3

For example, if you think there is ample administrative capacity to support increased scientific research on the effects of logging in Central Africa, you would write "1" under "administrative capacity" and across from "increased scientific research" If you think there is some, but not enough, administrative capacity, you would write "2" and if you think there is not enough administrative capacity to support increased scientific research, you would write "3"

Criteria for effective policy implementation

Policy	*Information*	*Political commitment*	*Admin Capacity*	*Investor/funder support*	*Public Support*	*Lack of market/policy failures*
Increase scientific research						
Stricter World Bank "green conditionality"						
Eco-labeling						
Increase protected areas						
Joint implementation						
Increase concession duration						
Increase/decrease concession area						
Performance-based deposit						
Replanting						
Forest privatization						
Other _____ _____						

2) Which of the criteria presented do you think are/will be most influential in determining the success or failure of logging/forest management policy in Central Africa?

3) Which of these policies (or combination thereof) do you think has the greatest chance of success?

BASIC DEFINITIONS

Criteria

- "Sufficient information" means that there is enough centralized high-quality information upon which to base a given policy
- "Political commitment" means that there is government support for the policy
- "Administrative capacity" means that the implementation and monitoring agency or organization has the resources (human, financial, organizational and logistical) required to ensure ongoing, effective implementation of the policy
- "Investor/funder support" means that there is support from private investors (logging companies) and funders (World Bank and IMF) to carry out the given policy
- "Public support" means that there is support from the general population for the policy
- "Lack of policy and market failures" means that the policy fosters efficient use of resources

Policies

- "Increase scientific research" means increasing the amount, improving the quality and centralizing scientific information on the ecological effects of logging
- Stricter World Bank "green conditionality" means having more stringent environmental requirements for World Bank loans to Central African countries
- "Eco-labeling", or timber certification, means putting a label on Central African timber exports to certify that they are from "sustainably managed" forests
- "Increase protected areas" means increasing the amount of land set aside as protected from logging, and improving the selection of future protected areas
- "Joint implementation" means developed countries will finance rainforest conservation in exchange for carbon emissions allocations
- "Increase concession duration" means increasing the number of years for which a logging concession is allocated (from 25 years to 50 years, for example)
- "Increase/decrease concession area" means mandating smaller or larger logging concessions
- "Performance-based deposit" means requiring logging companies to pay a deposit before beginning logging operations The deposit would be refunded after logging operations ceased if ecological guidelines were followed
- "Replanting" means requiring logging companies or local/federal governments to replant a given number of trees after logging
- "Privatization" means selling forest land to logging companies or private individuals (grating secure land tenure) and permitting them to manage the forest themselves

SAMPLE FRENCH SURVEY

Cher Monsieur/Madame,

Deanna Madvin Wolfire à WRI m'a suggéré de vous contacter pour avoir votre opinion sur ma thèse, qui s'intitule "Fusion entre science et politiques l'impact écologique de la déforestation en Afrique Centrale " J'écris ma these sous les hospices du World Resources Institute (WRI) de la Kennedy School of Government de l'Université de Harvard

Pour ma thèse, je dois faire un questionnaire de scientifiques, de professeurs, de législateurs et de directeurs d'organisations à but non-lucratif Ce questionnaire a deux objectifs d'une part, discerner l'existence ou non d'un consensus sur l'impact écologique de la déforestation en Afrique Centrale au sein des communautés scientifiques, académiques, politiques ainsi que les organismes à but non-lucratif et d'autre part, de générer des données sur lesquelles pourront s'appuyer les recommendations politiques Les resultats de ce questionnaire seront présentés en avril 1998 à Harvard et au WRI et seront disponible aux autres organisations par demande Ce questionnaire sera un complément pour la literature existante sur l'impact ecologique de la déforestation en Afrique Centrale

Je voudrais vous inviter à participer à ce questionnaire Ce questionnaire dure 15-30 minutes Cependant plusieurs des questions sont ouvertes pour que les participants puissent élaborer leurs réponses sans contraintes Veuillez ecrire vos réponses directement sur le formulaire et me le renvoyer par email (si possible) ou par fax **avant le 23 Fevrier** Mon adresse, adresse email, et numéro de fax sont en haut Si nécessaire, je vous contacterai une fois que j'aurai recu vos réponses pour obtenir quelques clarifications

Notes sur le questionnaire

- La première partie du questionnaire pose quatre questions sur le role que l'information joue dans la création et l'implémentation de la politique de deforestation La seconde partie du questionnaire est plus génerale et demande de classer par ordre d'efficacité les differents types de politiques de "déforestation" en Afrique Centrale
- Si votre réponse à l'une des questions s'appuie sur une étude, un article ou livre sur le sujet, veuillez le mentionner
- Plusieurs mots dans le questionnaire sont ouverts à interprétation, tel que "politique saine" et "impact sévère " Veuillez, autant que possible, être explicite sur la définition que vous entendez lorsque vous utilisez ces mots
- Si vous voulez que votre questionnaire reste confidentiel, veuillez ecrire "oui" lorsque cette question vous sera posée Dans ce cas, nous referrerons vos commentaires par votre titre ("scientifique" ou "officiel gouvernemental") et non par votre nom, ou votre organisation

Nous vous remercions pour votre participation à ce questionnaire et pour votre intéret et votre honnêteté

Veuillez agréer, Monsieur, l'expression de mes sentiments les plus distingués

Katie Simons

QUESTIONNAIRE SUR L'IMPACT ECOLOGIQUE DE L'EXPLOITATION FORESTIERE

Veuillez remplir ce questionnaire sur votre profil

Nom de l'employeur

Votre position

Spécialisation

Pays

Email, telephone, fax, adresse

Voulez-vous que votre questionnaire reste confidentiel?

Partie I Information

1 Pensez-vous qu'il y ait assez d'information sur l'impact écologique de l'éxploitation forestière en Afrique Centrale?

2 Si vous avez répondu "non" à la première question, quelles quantités et types d'information seraient nécessaires pour créer de bonnes politiques de gestion des ressources forrestières?

3 Pour les domaines dans lesquelles nous n'avons pas assez d'information pour developper de bonnes politiques, combien de temps et d'argent seraient necessaires pour qu'assez d'information soit disponible ?

4 Comment seraient changées les politiques de l'éxploitation forestière de gestion des ressources forestières si nous avions assez d'information sur l'impact écologique de l'éxploitation forestière en Afrique Centrale?

Partie II. Politique de l'exploitation forestière

Il existe plusieurs politiques qui tentent de réduire l'impact écologique de l'exploitation forestière Cependant, pour que ces politiques soient efficaces, certains critères doivent être satisfaits Ces critères comprennent une information suffisante, un soutien public, et une réussite des politiques et des marchés Les définitions de ces critères sont inclus à la fin de ce questionnaire

1 En vous appuyant sur le tableau ci-dessous, à quel niveau les criteres pour les politiques citée sont-ils mis en oeuvre ? (Les criteres sont cités horizontalement en haut du tableau, les politiques sont sur le côté gauche)

- Si vous pensez que la politique menée a atteint un bon niveau d'efficacité du point de vue du critère décrit, écrivez 1 Si vous pensez que la politique menée a atteint un niveau d'efficacité moyen du point de vue du critère décrit, écrivez 2 Si vous pensez que la politique menée n'a pas atteint un bon niveau d'efficacité du point de vue du critère décrit, écrivez 3

Par exemple, si vous pensez qu'il y a assez de capacité administrative pour soutenir la recherche scientifique sur les effets de l'exploitation forestière en Afrique Centrale, écrivez "1" sous "capacite administrative" en face de "augmentation de la recherche scientifique " Si vous pensez qu'il y a un peu, mais pas assez de capacité administrative, écrivez "2" et si vous pensez qu'il n'y a vraiment pas assez de soutien pour l'augmentation de la recherche scientifique, écrivez "3 "

Critères pour une implémentation de politique efficace

Politique	*Information*	*Volonté politique*	*Capacité Admin*	*Soutien des investisseurs et des donateurs*	*Soutien public*	*Absence de marches et échec des politiques*
Augmenter la recherche scientifique						
"Conditionalite Verte" de la Banque Mondiale plus stricte						
Eco-labels						
Augmenter les zones protégées						
Implémentation Conjointe						
Augmenter durée de la concession						
Augmenter ou diminuer la zone de concession						
Depôts s'appuyant sur la performance						
Replantation						
Privatisation des forêts						
Autres _____						

DEFINITIONS DE BASE

Critères

- « Informations suffisantes » signifie qu'il y a assez d'informations de bonnes qualités et centralisées pour mettre en place une bonne politique
- « Volonté politique » signifie que le gouvernement soutient la politique
- « Capacité administrative » signifie que l'agence d'implémentation et de contrôle a les resources (humaines, financières, organisationelles et logistiques) requises pour assurer une implementation effective de la politique
- « Soutien des investisseurs/donateurs » signifie que les investisseurs privés (Banque Mondiale et FMI) et les donateurs soutiennent la politique menée
- « Soutien Public » signifie que la population générale soutient la politique menée
- « Absence de marchés et échec des politiques menées » signifie que la politique menée encourage une utilisation efficace des resources

Politiques

- « Augmenter la recherche scientifique » signifie augmenter la quantité, améliorer la qualité et centraliser l'information scientifique sur les effets écologiques de l'éxploitation forestière
- Des « Conditionalités Vertes » plus strictes de la Banque Mondiale signifie des règles écologiques plus strictes pour l'émission de prêts de la Banque Mondiale envers les pays d'Afrique Centrale
- « Eco-label » veut dire mettre un label sur le bois exporté d'Afrique Centrale
- "Augmenter les zones protégées" signifie augmenter les surfaces de terres protégees du déboisement et améliorer la sélection des zones protégées futures
- "Implémentation conjointe" signifie que les pays dévelopés financeront la conservation des rainforest en échange d'allocation d'émission de carbone
- "Augmentation de la durée des concessions" signifie augmenter le nombre d'années durant lesquelles la concession de déboisement est allouée (de 25 à 50 années, par exemple)
- "Augmenter/diminuer la zone de concession" signifie mandater des concessions plus ou moins grandes
- "Dépots s'appuyant sur la performance" signifie exiger des compagnies de déboisement qu'ils payent un dépot avant de commencer les operations de deboisement Ce dépot leur serait remboursé après que les opérations de déboisement aient cessé, si les regles écologiques ont été suivies
- "Replantation" signifie exiger des compagnies de déboisement ou des gens particuliers de replanter un nombre spécifique d'arbres après les avoir coupés
- "Privatisation" signifie vendre des terrains de forêt aux entreprises d'éxploitation forestière ou aux personnes particulières pour leur permettre de gerer eux-mêmes la forêt

LIST OF INTERVIEWEES

Ashton, Peter Harvard Institute of International Development

Buccowich, Mark United States Forest Service

Boscolo, Marco Harvard Institute of International Development

Clark, William Kennedy School of Government

Hall, Jefferson Yale School of Forestry

Madvin Wolfire, Deanna World Resources Institute

Wilkie, David Associates in Forest Research and Development

References

REFERENCES

Anderson, A 1990 Alternatives to deforestation Steps toward sustainable use of the Amazon rain forest New York Columbia University Press

Anderson, J and Spencer, T 1991 Carbon, nutrient and water balances of tropical rain forest ecosystems subject to disturbance Management implications and research proposals MAB Digest 7

Angelsen, A and Kaimowitz, D 1 997 What can we learn from economic models of tropical deforestation? Unpublished draft

Auzel, P and Wilkie, D 1997 Wildlife use in Northern Congo Hunting in a commerical logging concession Evaluating the sustainability of hunting in tropical forests Draft

Barbier, E , Burgess, J , Bishop, J and Aylward, B 1994 The economics of the tropical timber trade London Earthscan Publications

Barbier, E 1993 Economics and Ecology London Chapman and Hall

Besong, J 1992 New Directions in national forestry policies - Cameroon Conservation of west and central African rainforests Washington DC The World Bank

Besong, J and Wencelius, F 1992 Realistic strategies for conservation of biodiversity in the tropical moist forests of Africa Regional Overview Conservation of west and central African rainforests Washington DC The World Bank

Borota, J 1991 Tropical forests Some African and Asian case studies of composition and structure Amsterdam, New York Elsevier

Brokaw, N and Scheiner, S 1989 Species composition in gaps and structure of a tropical forest Ecology 70 (3)

Brown, N D and Whitmore, T C 1991 Do dipterocarp seedlings really partition forest gaps? Tropical rainforest Disturbance and recovery Proceedings of a royal society discussion meeting held on 18 and 19 September 1991

Bryant, D , Nielsen, D and Tangley, L 1997 The last frontier forests Ecosystems and economies on the edge Washington DC World Resources Institute Forest Frontiers Initiative

Bulte, E 1995 Tropical deforestation, timber concessions, and slash-and-burn agriculture Why encroachment may promote conservation of primary forests Wagningen, The Netherlands Wageningen Agricultural University, Faculty of Economics

Catinot, R 1997 The sustainable management of tropical rainforests Paris Scytale Publishing

Charancle, J 1996 Assessment of NGOs in Central Africa Washington D C USAID

Cleaver, K et al 1992 Conservation of west and central African rainforests Washington, D C The World Conservation Union and The World Bank

Contreras-Hermosilla, A 1997 The "cut-and-run" course of corruption in the forestry sector Journal of Forestry 95 33-36

Cooke, R 1991 Experts in uncertainty Opinion and subjective probability in science Environmental ethics and science policy series New York Oxford University Press

Courtney, H, Kirkland, J and Viguerie, P 1997 Strategy under uncertainty Harvard Business Review November-December 67-78

Dawkins, H C 1958 The management of natural tropical high-forest with special reference to Uganda University of Oxford Imperial Forestry Institute

Dixon, J and Sherman, P 1990 Economics of protected areas Washington, D C Island Press

Dixon, J et al 1986 Economic analysis of environmental impacts London Earthscan Publications

Douglas, I et al 1991 The impact of selective commercial logging on stream hydrology, chemistry and sediment loads in the Ulu Segma rain forest, Sabah, Malaysia Tropical rain forest Disturbance and recovery Proceedings of a royal society discussion meeting held on 18 and 19 September 1991

Downing, T 1992 Development or destruction The conversion of tropical forest to pasture in Latin America Boulder, Colorado Westview Press

Dubois, O 1997 Getting the roles right in local forest management in sub-Saharan Africa Some current issues and a potential tool International Institute for Environment and Development (IIED) Forestry and Land Use Programme Draft

During, A T 1993 Saving the forests what will it take? Washington D C Worldwatch Institute

Eisenberg, J, Muckenhirn, A, and Rudran, R 1972 The relation between ecology and social structure in primates Science 176 863-874

Elliott, C 1996 Certification as a policy instrument Certification of forest products Issues and perspectives Washington D C Island Press

Elliott, C and Viana, V 1996 Potential inequalities and unintended effects of certification Certification of forest products Issues and perspectives Washington D C Island Press

Ewel, J and Conde, L 1980 Potential ecological impact of increased intensity of tropical forest utilization Biotrop special publication no 11

Food and Agricultural Organization of the United Nations (FAO) 1990 Forest resources

assessment 1990 Tropical countries FAO Forestry Paper 112 Rome FAO

Gartlan, S 1989 La conservation des ecosystemes forestiers du Cameroun Gland, Switzerland IUCN

Goldammer, J G 1992 Tropical forests in transition ecology of natural and anthroprogenic distrubance processes Basel Birkhauser Verlag

Gomez-Pompa, A et al 1972 The tropical rainforest A nonrenewable resource Science 177 762-765

Gomez-Pompa, A , Whitmore, T C , and Hadley, M 1991 Rain forest regeneration and management Man and the biosphere series Vol 6 Park Ridge, N J Parthenon Publishing Group

Gradwohl, J and Greenberg, R 1988 Saving the tropical forests Washington, D C Island Press

Graham-Tomasi, T D 1984 The economics of wilderness preservation and timber supply Problems in dynamic optimization and uncertainty Ph D Thesis, University of Michigan

Grieser, A J 1997 Timber production and biodiversity conservation in tropical rain forests New York Cambridge University Press

Grut, M , Gray, J , and Egli, N 1991 Forest pricing and concession policies managing the high forests of west and central Africa World Bank Technical Paper 143 Washington, DC World Bank Africa Technical Department Series

Hall, J S 1992 An Assessment of Small Scale "Selective" Logging in a Mixed Forest in Northeastern Zaire Symposium on African Forests

Hammitt, J K 1988 Outcome and value uncertainty in environmental policy Ph D Thesis, Harvard University

Hammitt, J K 1990 Probability is all we have Uncertainties, delays, and environmental policy making New York Garland Publishing

Hawthorne, W D and Abu-Juam, M 1995 Forest protection in Ghana With particular reference to vegetation and plant species Gland IUCN

Hazell, P and Magrath, W 1992 Summary of World Bank Forestry Policy In Conservation of west and central African rainforests (Ed) Cleaver et al Washington DC The World Bank

Holloway, J D et al 1991 The response of some rain forest insect groups to logging and conversion to plantation Tropical rain forest Disturbance and recovery Proceedings of a royal society discussion meeting held on 18 and 19 September 1991

Interafrican Forest Industries Association 1996 Sustainable forest management and development in sub-Saharan Africa The role of the private sector Nairobi The World Bank Forestry Forum

International Resources Group 1992 Ecotourism A viable alternative for sustainable management of natural resources in Africa

Johns, A D 1981 The effects of selective logging on the social structure of resident primates Malaysian applied biology 10 221-226

Johns, A D 1986 Effects of selective logging on the behavioral ecology of West Malaysian primates Ecology 67 684-694

Johns, A D 1989 Recovery of a peninsular Malaysian rainforest avifauna following selective timber logging The first twelve years Forktail 4 89-105

Johns, A D 1991 Vertebrate responses to selective logging Tropical rainforest Disturbance and recovery Proceedings of a royal society discussion meeting held on 18 and 19 September 1991

Johns, A D 1992 Tropical deforestation and species extinction Species conservation in managed tropical forests

Johnson, N And Cabarle, B 1993 Surviving the cut Natural Forest Management in the Humid Tropics Washington, D C World Resources Institute

Jonkers, W B J 1987 Vegetation structure, logging damage and silviculture in a tropical rainforest in Suriname Ecology and management of tropical rainforests in Suriname Wageningen, The Netherlands Agricutural University

Jonsson, T and Lindgren, P 1990 Logging technology for tropical forests For or against? Kista, Sweden The Forest Operations Institute

Jordan, C F Amazonian rain forests ecosystem disturbance and recovery Ecological Studies 60 New York Springer-Verlag

Kemp, R H 1993 Conservation of genetic resources in tropical forest management Principles and concepts FAO Forestry Paper, ISSN 0258-6150,107 Rome Food and Agricultural Organization of the United Nations

Kennedy, D N and Swaine, M D 1991 Germination and growth of colonizing species in artificial gaps of different sizes in dipterocarp rain forest Tropical rain forest Disturbance and recovery Proceedings of a royal society discussion meeting held on 18 and 19 September 1991

Klapp, M G 1992 Bargaining with uncertainty Decision-making in public health, technological safety, and environmental quality New York Auburn House

Klein, L and Klein, D 1977 Feeding behavior of the colombian spider monkey Primate ecology Studies of feeding and ranging behavior in lemurs, monkeys, and apes Ed Clutton-Brock, T London Academic Press

Kuik, O and Gupta, J Perspectives on Africa and the global debate on joint implementation Joint implementation Carbon colonies or business opportunities? Amsterdam Free University of Amsterdam Institute for Environmental Studies

Lambert, F R 1991 The consequences of selective logging for Bornean lowland forest birds Tropical rain forest Disturbance and recovery Proceedings of a royal society discussion meeting held on 18 and 19 September 1991

Laurance, W F and Bierregaard, R O 1997 Tropical forest remnants Ecology, management, and conservation of fragmented communities Chicago The University of Chicago Press

Leigh, E G et al 1996 The ecology of a tropical forest Seasonal rhythms and long-term changes Washington, D C Smithsonian Institution Press

Lemmens, R and Sosef, M 1998 The flora of the Congo Basin The Congo Basin Recent developments and alternatives for sustainable development BOS Newsletter 16 21-24

Leopold, A 1966 A sand county almanac Oxford Oxford University Press

Leslie, A 1987 A second look at the economics of natural management systems in tropical mixed forests Unasylva 39 46-58

Mabberley, D J 1991 Tropical rainforest ecology Tertiary level biology New York Chapman and Hall

Marchak, P 1995 Logging the globe Montreal McGill-Queen's University Press

Martinez-Ramos, M et al 1989 Tree demography and gap dynamics in a tropical rain forest Ecology 70 555-558

Marsh, C Johns, A D and Ayres, J M 1987 Effects of habitat disturbance on rainforest primates Primate Conservation in the Tropical Rainforest Ed Marsh, C and Mittermeier, R New York Alan Liss Inc

Maya, R and Gupta, J 1996 Joint implementation Carbon colonies or business opportunities? Amsterdam Free University of Amsterdam Institute for Environmental Studies

Meggers, B et al 1973 Tropical forest ecosystems in Africa and South America A comparative review Washington Smithsonian Institution Press

Meijer, W 1970 Regeneration of tropical lowland forest in Sabah, Malaysia forty years after logging Malayan Forester 28 206-228

Miller, K and Tangley, L 1991 Trees for life Saving tropical forests and their biological wealth Boston Beacon Press

Mohamad, B 1987 Studies on logging damage due to different methods and intensities of harvesting in a hill dipterocarp forest of peninsular Malaysia The Malaysian Forester 50 135-146

Moss, R P 1982 Reflections on the relation between forest and savanna in tropical West Africa Discussion papers in geography (23) Department of Geography University of Salford

Nicholson, D 1958 An analysis of logging damage in tropical rain forest, north Borneo

Malayan Forester 21 235-245

Nummelin, M 1990 Relative habitat use of duikers, bush pigs, and elephants in virgin and selectively logged areas of the Kibale Forest, Uganda Tropical Zoology 3 111-120

Owen, D F 1973 Man's Environmental Predicament An introduction to human ecology in tropical Africa Oxford University Press London

Oyugi, W 1986 The impact of international environment on public administration and management systems in Africa The ecology of public administration and management in Africa Vikas Publishing House New Delhi

Panaiotov, T 1992 Not by timber alone Economics and ecology for sustaining tropical forests Washington D C Island Press

Panayotou, T 1993 Green Markets the economics of sustainable development San Francisco Institute for Contemporary Studies

Panayoutou, T and Ashton, P 1992 Not by timber alone Economics and ecology for sustaining tropical forests Washington D C Island Press

Peters, C 1994 Sustainable harvest of non-timber plant resources in tropical moist forest An ecological primer Washington Biodiversity Support Program

Pinard, M et al 1995 Creating timber harvest guidelines for a reduced-impact logging project in Malaysia Journal of Forestry 93 41-45

Plouvier, D 1998 Short overview of the situation of tropical moist forests and forest managment in Central Africa and markets for African timber The Congo Basin Recent developments and alternatives for sustainable development BOS Newsletter 16 42-49

Plouvier, D and Roux, J 1998 Promotion of sustainable forest management and certification in timber producing countries of west and central Africa The Congo Basin Recent developments and alternatives for sustainable development BOS Newsletter 16 99-107

Poore, D and Sayer, J 1991 The management of tropical moist forest lands Ecological guidelines Gland, Switzerland IUCN - The World Conservation Union

Redhead, J F 1960 An analysis of logging damage in lowland rainforest Nigerian Forestry Bulletin 10 5-16 Lagos Federal Government Printer

Reinhardt, F and Vietor, R 1996 Business managment and the natural environment Cincinati, Ohio Southwestern College Publishing

Repetto, R and Gillis, M 1988 Public policies and misuse of forest resources New York Cambridge University Press

Repetto, R et al 1989 Wasting assets Natural resources in the national income accounts Washington D C World Resources Institute

Richards, P W 1996 The tropical rain forest An ecological study Cambridge Cambridge University Press

Rietbergen, S 1993 Earthscan Reader in Tropical Forestry London Earthscan Publications

Ruitenbeek, H 1992 Economic analysis of tropical forest conservation initiatives examples from West Africa In Conservation of west and central African rainforests (Ed) Cleaver et al Washington DC The World Bank

Sayer, J 1992 Development assistance strategies to conserve Africa's rainforests In Conservation of west and central African rainforests Washington DC The World Bank

Schelhas, J and Greenberg, R 1996 Forest patches in tropical landscapes Washington D C Island Press

Serageldin, I 1992 Saving Africa's rainforests Conservation of West and Central African rainforests Washington D C , World Bank

Skorupa, J and Kasenene, J 1984 Tropical forest management Can rates of natural treefalls help guide us? Oryx 18 96-101

Spruit, I and Bearder, S 1998 (Non-) human primates in the Congo Basin The Congo Basin Recent developments and alternatives for sustainable development BOS Newsletter 16 35-41

Stavins, R N 1994 Correlated environmental uncertainty and policy instrument choice Cambridge John F Kennedy School of Government Research Programs, Harvard University

Struhsaker, T 1972 Rainforest conservation in Africa Primates 13 103-109

Struhsaker, T 1975 The red colobus monkey Chicago University of Chicago Press

Struhsaker, T 1973 A Recensus of vervet monkeys in the masai-amboseli game reserve, Kenya Ecology 54 930-932

Sunderland, T et al 1997 The vegetation of the Campo Faunal Reserve and Ejagham Forest Reserve, Cameroon Unpublished

Swingland, I 1993 Tropical foersts and biodiversity conservation A new ecological imperative Economics and Ecology London Chapman and Hall

Tabor, G , Johns, A , and Kasenene, J 1990 Deciding the future of Uganda's tropical forests Oryx 24 208-214

Terborgh, J 1992 Diversity and the tropical rainforest Scientific American Library series no 38 New York Scientific American Library

Terborgh, J 1992 Maintenance of diversity in tropical forests Biotropica 24 283-292

Tufor, K 1992 Cross-country issues in forest conservation and management In Conservation of west and central African rainforests (Ed) Cleaver et al Washington DC The World Bank

Turner, R And Pearce, D 1993 Sustainable economic development Economic and ethical principles Economics and ecology London Chapman and Hall

Van Essche, K 1993 Rapport concernant la realization d'un inventaire bibliographique dans le cadre du programme de conservation et d'utilization rationelle des ecosystemes forestiers d'Afrique Centrale Universite Libre de Bruxelles Laboratoire de Botanique Unpublished document

Van Orsdol, K and Kiekens, J 1992. Environmental labeling A market-based solution for promoting sustainable forestry management in the tropics Conservation of West and Central African rainforests Washington D C World Bank

Vansina, J 1992 Habitat, economy and society in the Central African rainforest Berg Oxford

Varangis, P et al 1995 Is there a case for tropical timber certification? Washington D C World Bank

Verdoes, A 1998 Congo Basin regional profile The Congo Basin Recent developments and alternatives for sustainable development BOS Newsletter 16 5-12

Waide, R and Lugo, A 1992 A research perspective on disturbance and recovery of a tropical montane forest In Tropical forests in transition J G Goldammer (Ed) Basel Birkhauser Verlag

Whitmore, T C 1989 Canopy gaps and the two major groups of forest trees Ecology 70 536-538

Whitmore, T C and Sayer, J 1992 Tropical deforestation and species extinction New York Chapman & Hall

White, L 1994 The effects of commercial mechanized selective logging on a transect of lowland rainforest in the Lope Reserve, Gabon Journal of Tropical Ecology 10 313-322

White, L and Tutin, C (In press) Why chimpanzees and gorillas respond differently to logging A case study from Gabon that cautions against generalizations African rainforest ecology and conservation New Haven Yale University Press

White, F et al 1995 Distribution of ruffed lemurs (Varecia variegata) in Ranomafana National Park, Madagascar Folia Primatologica 64 124-131

Wilkie, D et al (In press) Defaunation not deforestation Commercial logging and market hunting in Northern Congo The impacts of commercial logging on wildlife in tropical forests Draft

Wilson, C and Wilson, W 1975 The influence of selective logging on primates and some other animals in East Kalimantan Folia primatologica 23 245-274

Wolfire, D , Brunner, J , and Sizer, N (In press) Forests and the Democratic Republic of the

Congo Opportunity in a time of crisis Washington DC World Resources Institute Draft

World Resources Institute (In press) Forest frontiers initiative Blueprint for a global forest watch Draft

World Resources Institute (In press) The evolution of Cameroon's new forestry legal, regulatory and taxation system Draft

Worrel, R 1991 Trees and the treasury Valuing forests for society Surrey, England WWF UK