DEFINING FOREST PROTECTED AREA NETWORKS -- A HANDBOOK FOR DELINEATING FOREST PROTECTED AREAS IN MANAGED FORESTS OF LOWLAND BOLIVIA

28 July 1998

BRUCE G. MARCOT, Ph.D. Research Wildlife Ecologist
USDA Forest Service, Pacific Northwest Research Station
Portland Forestry Sciences Lab
1221 SW Yamhill, Suite 200
POB 3890
Portland OR 97208-3890 USA
Phone: 503/808-2010
FAX: 503/808-2020
E-mail: brucem@SpiritOne.com

DAMIAN I. RUMIZ, Ph.D. Wildlife Specialist
Proyecto BOLFOR
4to. Anillo esq. Av. 2 de Agosto
Casilla 6204
Santa Cruz, Bolivia
Telefonos : 591-3-480766, 591-3-480767
Fax : 591-3-480854
E-mail : bolfor@bibosi.scz.entelnet.bo

TODD S. FREDERICKSEN, Ph.D. Forest Ecologist
Proyecto BOLFOR
4to. Anillo esq. Av. 2 de Agosto
Casilla 6204
Santa Cruz, Bolivia
Telefonos : 591-3-480766, 591-3-480767
Fax : 591-3-480854
nelltodd@bibosi.scz.entelnet.bo

for: Conservation International, Washington, D.C., USA
Bolfor, Santa Cruz, Bolivia

INTRODUCTION

The purpose of this handbook is to provide a set of criteria that can be used to identify and delineate protected area networks of forest environments for wildlife conservation, within

managed forests of lowland Bolivia. The audience for this handbook includes forest managers and planners of timber concessions.

The guidelines provide two complementary ways to manage forest environments for wildlife: (1) identifying local patches or areas of forest conditions important as wildlife habitats and resources, which could then be delineated on maps as protected area networks; and (2) identifying individual elements or substrates within the managed forest matrix, which could then be conserved during regular forest management activities. Protected area networks, and key elements and substrates, are both vital for conserving wildlife and biodiversity.

WHY A HANDBOOK FOR PROTECTED AREAS?

Why is this handbook needed? Increasing amounts of forests being entered for commercial timber harvesting in lowland Bolivia has led to concern that wildlife sensitive to habitat disruption may reduce or disappear from the forest landscape. This handbook identifies opportunities and priorities for conservation of habitats important to conservation of wildlife species. The approach presented here helps provide not only for the continued existence of wildlife but also for functional ecosystems so important to growth and production of commercial forest products.

Existing regulations (such as Normas tecnicas para la preparacion de planes de manejo forestal en areas mayores a 200 ha., Ley 1700...) guide the protection of biodiversity and wildlife within managed forests. As well, the Standards for Voluntary Forest Certification in Bolivia call for protection of forests important to biodiversity conservation objectives [Consejo Boliviano para la Certificacion Forestal Voluntaria, 1996, Estandares para la Certificacion Forestal Voluntaria en Bolivia, Santa Cruz, Bolivia, Editora El Pais, 17 p.].

Also included with this handbook is an Annex that lists some additional, key considerations for wildlife conservation within Taruma Timber Concession of Santa Cruz. This provides an example of how additional, and more site-specific conditions, can help to complement the general guidelines.

BACKGROUND

This document was developed as Part IV, Reserve Design, of the project "1997 Bolfor Workplan: Conservation International Policy Component," of Conservation International, Washington, D.C., USA, and Bolfor, Santa Cruz, Bolivia.

ACKNOWLEDGMENTS

Sources of information for this handbook included key staff members of Bolfor, Santa Cruz, Bolivia; Timothy Killeen, Assistant Curator, Museo de Historia Natural, Noel Kempff Mercado, Bolivia; Lilian Painter and Rob Wallace, Department of Biologist, University of Liverpool, U.K.; and Betty Flores, Ornithologist, Proyecto Bolfor, Bolvia. We also thank Dr. R. E. Gullison, _____, Canada for his technical review of this document. This project was supported by Conservation International, Washington, D.C., and Bolfor, Santa Cruz, Bolivia. We especially thank Dick Rice of Conservation International for instituting this work.

GUIDELINES FOR DELINEATING FOREST PROTECTED AREA NETWORKS:
A HANDBOOK FOR MANAGED FORESTS OF LOWLAND BOLIVIA

Note: In these guidelines, the term "wildlife" generally refers to land-dwelling vertebrates (that is, mammals, birds, reptiles, and amphibians) but also can refer to plants and invertebrates.

I. UNIVERSAL CONSIDERATIONS FOR PROTECTED AREAS

A. Preserve Habitat for Priority Wildlife Species

1. Kinds of Habitats

Protect key habitats for priority species, including threatened, endangered, and Red Data Book species. Priority species also include locally and regionally endemic species (species found no where else). Their habitats can include nest or den sites, important resting sites, and important feeding sites. Presence of threatened, endangered, Red Data Book, or endemic species can be determined by biological surveys and by consulting wildlife occurrence records for the area.

Delineate the site being used as well as a buffer sufficient to shield the site from activities that could unduly disrupt vegetation conditions or create disturbance that would cause the site to be abandoned by wildlife.

2. Size of Habitats

The size of individual forest protected areas can vary according to the site-specific objective or conditions. They can vary, for example, from a tiny patch for protecting endangered or rare plants, to a broader forest area for protecting gallery forest patches for use by monkey troops. It is important to realize that there is no one single size to meet all conservation needs.

In some cases, protection would focus on "type locations" of very rare or highly endemic (range-restricted) species, that is, the few or only location in which the species is known to occur in the wild. Such areas might individually range only 0.1-0.5 ha or so in size.

At the upper end of the size spectrum, wide-ranging species that have specific forest habitat preferences, such as some primates, may require large forest areas. For example, in one study (Wallace et al., submitted), in Noel Kempff Mercado National Park, patches of gallery forest smaller than 50 ha were occupied only by night monkeys (*Aotus*) AND howler monkeys (*Alouatta*) monkeys, but not by spider monkeys (*Ateles*) and capuchin monkeys (*Cebus*) which appeared only in patches at least 1535 ha in size. (Also see section II(A) below.) Protection of forest patches for primates is more critical for species that are more prone to habitat disturbance (including logging activities), such as spider monkeys (*Ateles paniscus*) (McFarland Symington 1988).

B. Provide Buffers for Streams and Roads

Protect streamside riparian vegetation and provide a buffer along all perennial, intermittent, and ephemeral streams. Riparian buffers help lessen undue erosion and sedimentation of the stream channel from upland clearing and from adjacent road-building. Buffers also help protect vegetation cover close to water sources, which provides for some of the most important general wildlife habitat in the forest.

Riparian buffers can help provide key habitats for wide-ranging endangered species such as giant otter (*Pteronura brasiliensis*) and black caiman (*Melanosuchus niger*), recently found in healthy populations in eastern Bolivia (Taber et al. in prep., cited in Wallace et al. 1996.). Riparian buffers also can provide for some Amazonian primates, which can be limited by such habitat (Wallace et al. 1996).

Build temporary bridges when feasible, but if roads must cross streams, as far as possible cross them at right angles to the stream and provide culverts or other structures to minimize erosional damage to the stream channel.

C. Protect Scarce and Declining Habitats

These include any plant communities or wildlife habitats that are unique and that are scarce or greatly declining locally or regionally. At least representative examples of sufficient area should be conserved of each type.

D. Protect Special Wildlife Habitats

The following special wildlife habitats typically cover a small land area but are especially important to a wide variety of wildlife. Such habitats can be identified in the field or from aerial photographs, and delineated as small protected areas.

1. Riverine Gallery Forests

Forests alongside creeks, streams, and rivers often hold exceptionally high levels of biodiversity. Riverine forests and wet valley bottoms are particularly important during the dry season in seasonally dry forest types. Especially during very dry years with many fires, they may be the only green foliage and open water available as habitat and cover for wildlife.

Riverine forests also provide important sources of plants with fleshy fruits, including palms and other plant families (Moraceae, Sapotaceae, Annonaceae). Fleshy fruits are key resources for a variety of wildlife species.

2. Salt Licks and Mineral Soil

Areas of bare mineral soil, particularly where soil salts have evaporated to the surface, usually occur in wet areas near riverine forests. They are used by peccaries, tapirs, deer, cracids (guans and curassows), parrots (if on cliffs), butterflies, bees, and a variety of other wildlife.

3. Caves and Rock Outcrops

Caves are important roosting and hibernacula habitats for many bats. They also provide denning sites for carnivores (including cats, dogs, and fox), rodents, porcupines, and other medium size and large mammals. They also can be used by owls.

Rock outcrops or inselbergs (a German geological term), locally called lajas in lowland Bolivia -- often have unique and scarce plant communities, containing some plants with fleshy fruits eaten by many kinds of wildlife. After short rainfalls, rock outcrops often hold temporary ponds, which become important watering holes for wildlife, habitats for amphibian reproduction, and habitats for nightjars and other birds. Rock outcrops provide crevices for bats and specialized rodents and lizards, and seem to attract an especially high concentration of carnivores, rabbits, and other species. Rock outcrops retain heat during the evening and their warmth often attracts invertebrates, reptiles, and nocturnal birds during the cool dry season.

4. Natural Forest Openings

Natural gaps in forest cover often provide ground vegetation cover and seed-bearing herbs and shrubs which are used by a variety of wildlife. Bats feed over natural forest openings.

5. Palm Groves

Palm groves can provide special habitats for wildlife. The *Mauritia flexuosa* palm, locally known as palma real, grows large fruits that are eaten by many kinds of wildlife including tapirs and peccaries. This palm also grows large trunks. As the trunks decay, they provide cavities sites for macaws, toucans, and other species. A similar case occurs with the motacú palm (*Attalea phalerata = Scheelea princeps*) which provides food and shelter, and the asaí palm (*Euterpe precatoria*) which has highly priced fruits.

6. Lagoons and Other Water Sources

Especially in seasonally dry forests, lagoons and other water sources such as springs provide critical sources of water during the dry season for a wide variety of wildlife. Gallery forests often contain pools well into the dry season; these are important wildlife habitats needing protection.

7. Sabana (Savannas)

Savannas may look "poorer" than forest environments but some plant species found only in savannas, such as the totai palm (*Acrocomia aculeata*), are important as food for large mammals. Savannas may also provide unique habitat for reptiles and other species. Large savannas in northern Santa Cruz harbor endangered mammals such as marsh deer (*Blastocerus dichotomus*), pampas deer (*Ozotoceros bezoarticus*), and mane wolf (*Chrysocyon brachyurus*), and birds such as rheas (*Rhea americana*).

Since savannas may burn during the dry season, providing some adjacent forest cover, especially riverine forests, for wildlife is an important conservation measure.

II. OTHER CONSIDERATIONS AND DESIGN CRITERIA FOR PROTECTED AREAS

A. Consider Optimal Size, Shape, and Spacing of Forest Protected Areas

All else equal, and depending on the kind of site or habitat, protected areas should be: larger than smaller, so as to encompass more resources and cover; more round than more linear (except for gallery type forests in riparian buffers), so as to reduce adverse edge effects; and closer together rather than spread apart, so as to increase opportunities for wildlife to move among areas.

That is, a protected area that provides greater food resources, cover, less edge (is rounder or blockier in shape), and closer to other similar protected areas, provides substantially greater per-hectare conservation value than does a protected area of the same size but that has fewer food resources, less cover, greater edge (less round or blockier), and further from other similar protected areas.

B. Provide for Habitat Corridors and Connectors

Protected areas can also be delineated as wildlife corridors or connectors between other important wildlife sites. In many cases, streamside riparian buffers can help serve as corridors and connectors.

It is important to protect mosaics of contiguous, different habitats. One example is that of spider monkeys which use rocky outcrops and contiguous forest slopes down to riverine and flooded forests (Wallace et al. 1996).

C. Provide Habitats for Species Critical to Forest Productivity

Identify the following kinds of key habitats and sites for groups of species which play critical roles in maintaining the productivity and biological diversity of forest ecosystems:

1. Habitat for Essential Plant Pollinators

    a. Habitats for nectar-feeding or long-tongued bats.

    These species pollinate nectar-producing plants on whose nectar they feed: plants with large, pale flowers that open at night, and with musky odors. Such plants include balsa trees, ceiba (silk-cotton) trees, jicaro (calabash), night-flowering cacti, and others. Key habitats for these species especially include areas with caves, high ground, and rock outcrops, and includes tree hollows and patches of dense old primary forest and deciduous forest.

    b. Other essential plant pollinators.

    Other wildlife species, including most hummingbirds, orioles, and others, serve as important pollinators for other plant species not served by bats. Individual nest sites, breeding sites, and feeding sites can be protected during forest management operations.

2. Habitat for Essential Seed Dispersers

a. Habitats for short-tailed fruit bats (genus *Carollia*)

These species feed on fruits of shrubs and small trees, especially Piper species; they are one of the most important seed dispersers for many plants with small or large fruits. They carry fruits into cleared areas, stimulating forest regeneration after a small clearcut. They do well in disturbed habitats but need tree hollows, caves, overhanging banks, tunnels, culverts, or abandoned buildings for roosting, as well as understory forest vegetation for cover and feeding. Maintain such elements within mature or disturbed forests, gardens and plantations, deciduous forests, and gallery forests.

b. Habitats for Neotropical fruit bats (family Phyllostomidae, subfamily Stenodermatinae).

These species all feed on fruit, supplemented by flower nectar in the dry season when fruit is scarce. They are the main dispersers of seeds for many plants. They carry seeds for early secondary or early successional growth into forest gaps caused by natural disturbances or cutting, thus restoring new forests and maintaining plant species richness of the forest. Together, Neotropical fruit bats, of many species, require tree hollows and caves.

c. Habitats for primates and tapirs.

Most species of monkeys disperse seeds for hundreds of plant species, especially canopy trees and lianas. Tapirs, because or their large size, fruit-eating behavior, and extended ranging behavior, are the best seed dispersers. They can transport large numbers of seeds, including the the largest ones which can not be swallowed by other animals. Protect sites known to be used heavily by monkey troops and tapirs.

d. Habitat for other seed dispersers.

In many forests, birds including toucans, aracaries, trogons, cotingas and oil birds serve as seed dispersers for many canopy plant species. Caves with oil birds should be protected in reserves, and individual nests of the other species, often in tree cavities and hollows, can be protected during forest management operations.

3. Habitat for Fungal Spore Dispersers

Spiny rats consume, and are likely to be important dispersers of, underground fungi, including mychorrizal fungi which is critical to the growth, productivity, and health of many forest trees. Spiny rats also are important prey for small carnivores, including large snakes and birds of prey. Spiny rats also depend on fruits, seeds, and insects. Maintain den sites and ground cover for spiny rats. Spiny rats seem to do well in disturbed habitats, such as in plantations of bananas and other crops.

Brocket deer feed on fungi on decaying logs; they might also feed on and serve to disperse underground fungi, including mychorrizal fungi. Protect bedding, birthing, and other key forest sites for brocket deer.

4. Habitat for Predators of Seeds, Seedlings, and Animals

Peccaries have an important influence on the spatial distribution of plants, including palms. Peccaries can decline from hunting and from habitat destruction. Pacas and agoutis eat large seeds of trees and aid their dispersal by caching (burying and storing) seeds; buried seeds sometimes germinate. Large carnivores, including jaguar and puma, can serve to control the herbivory impacts of their prey species; their absence can signal potentially undesirable changes in plant communities and plant diversity.

Maintain key feeding, denning, and resting sites for all these species.

5. Habitat for Nutrient Cyclers and Insectivore Prey

Termites and ants play major roles in transferring organic material, altering vegetation structure and composition, and cycling nutrients throughout forest ecosystems. They include leaf-cutter ants (local name, sepes) which can survive after selective timber harvesting. Termites serve to break down dead forest wood and thereby recycle organic matter back into the soil.

Termites and ants also serve as key prey for Edentate mammals, including the threatened giant anteater and the vulnerable giant armadillo. Termites are also eaten by smaller armadillos, birds, and many other species. Termite nests are often used by birds, such as trogons, for nest holes.

D. Provide Habitats for Important Game Animals

Forest game species are declining in most of the areas where hunting occurs. Managed forests may become important reservoirs for them and, with appropriate monitoring and legal framework,
could provide a sustainable and legally used resource to complement those of timber products. Species such as tapirs, peccaries, deer, pacas, agoutis, and armadillos among the mammals, and cracids among the birds, are preferred game species but have been also considered above under other ecological roles. General guidelines such as protecting gallery forests, salt licks, palm groves, water and fruit sources, nesting cavities, etc. will all benefit game species. Controlling hunting, however, may be the most effective measure to protect the most vulnerable species (tapirs, spider monkeys, giant armadillos) while populations of others (deer, rodents, common armadillos) could be maintained or increased by protecting or improving habitats and eventually hunted under more sustainable rates.

E. Consider Natural Disturbances

Delineating protected areas should account for major natural disturbances, even if intermittent or periodic such as drought or innundation. In such circumstances, the distribution and abundance of habitats, resources, and wildlife populations maybe vastly different, possibly confined to more important refugia, than in normal years.

F. Allowable Activities Within Protected Areas

Protected areas and habitats, as described in the above guidelines, can be vulnerable to some human activities but compatible with others. Activities that may be compatible with habitat and wildlife conservation objectives, and could be allowed to some degree within protected areas and habitats, might include minimized transit and camping, research, seed collection, and other uses for scientific study. Logging, palm heart extraction, and other major human disturbances are incompatible and should be avoided.

III. KEY HABITAT ELEMENTS IN THE GENERAL FOREST MATRIX

This section lists key habitat elements that can be protected during timber harvest and other activities in the general forest matrix outside protected areas. Although some of these elements are not currently being specifically managed, existing forest management direction and operations can nonetheless affect their presence and distribution.

A. Protect Snags and Down Logs

Snags (standing dead trees) and down logs provide critical habitats for many species of plants, invertebrates, lizards, snakes, cavity-using birds, and many other kinds of wildlife. In turn, many of these organisms aid in breaking down the wood and eventually returning it to productive soil. Such organisms, including ants and termites, also serve as a major prey source and base for food chains in the forest. Primary cavity-excavating birds such as woodpeckers, trogons, and toucans often provide tree hollows in snags which are used in turn by a variety of secondary-cavity using species such as swallows and small owls. Where possible, snags and down logs should be left in the forest to provide these services.

B. Protect Trees Prone to Hollowing

Trees prone to hollowing provide cavities for a wide variety of wildlife. Such trees include figs and palms, which also provide important fruit food sources.

C. Protect Bromeliad patches

In drier forests occur patches of terrestrial or epiphytic bromeliads. These patches might provide important food sources (fruits) for wildlife including tapirs, deer, monkeys, and peccaries. The patches also provide shelter for seed predators. Bromeliad patches also may serve as a critical link in tree regeneration, but study is needed on this.

D. Protect Large Seed- and Fruit-Bearing Trees

Large seed- and fruit-bearing trees provide important food sources for toucans, birds of the family Cracidae, spider monkeys, and many other fruit-eating wildlife species.

E. Protect Large Overstory/Emergent Trees

Where possible, protection of large overstory or emergent trees can greatly add to the overall vertical structure of forest vegetation. They likely provide feeding, resting, cover, and nesting habitats for very wide variety of birds, monkeys, invertebrates, plants, sloths, and many other species. Large overstory trees -- even just a few per hectare -- can help serve as wildlife habitat connectors linking protected areas of primary forests.

IV. Consider Economic Tradeoffs

All else being equal, to optimize both ecological and economic value of a forest, protected areas and key habitat elements in the general forest matrix can be conserved for those areas and elements with lower economic value.

In some cases, it is advantageous economically and culturally to maintain some vegetation elements for long-term sustained production of non-timber forest products. In some cases, this would also help maintain important habitats and resources for wildlife.

V. USING AND CONDUCTING WILDLIFE AND HABITAT SURVEYS

If possible, results of existing surveys of wildlife species and habitats should be used to help delineate the kinds and locations of conditions for developing a forest protected area network -- both for delineating protected areas and for describing the kinds of conditions to protect during forest management operations in the general forest matrix between protected areas. Survey results can be matched with the categories of habitats and conditions described in this handbook, and delineated on maps and on the ground.

Where surveys do not exist, it may be of great conservation benefit to conduct at least rapid surveys of wildlife species and habitats. One type of survey -- very cost-effective and that provides quick results -- is the rapid assessment procedure. Rapid assessments can be used to describe diversity of fungi (Cannon 1997), invertebrates (Oliver and Beattie 1996), or overall biodiversity (Oliver and Beattie 1993). A good example of a rapid assessment for biodiversity can be found in the Plan de manejo, Reserva de Vida Silvestre de Rios Blanco y Negro (FAN/PL480/WCS 1994).

Where wildlife species and habitat surveys do not exist and cannot be conducted, the general guidelines presented in this handbook can still be followed and matched to conditions in the field.

LITERATURE CITED

Cannon, P. F. 1997. Strategies for rapid assessment of fungal diversity. Biodiversity and Conservation 6:669-680.

FAN/PL480/WCS. 1994. Plan de manejo. Reserva de Vida Silvestre de Rios Blanco y Negro. Santa Cruz, Bolivia.

McFarland-Symington, M. 1988. Environmental determinants of population densities in *Ateles*. Primate Conservation 9:74-79.

Oliver, I., and A. J. Beattie. 1993. A possible method for the rapid assessment of biodiversity. Cons. Biol. 7(3):562-568.

Oliver, I., and A. J. Beattie. 1996. Designing a cost-effective invertebrate survey: a test of methods for rapid assessment of biodiversity. Ecological Applications 6(2):594-607.

Wallace, R. B., R. L. E. Painter, A. B. Taber, and J. M. Ayres. 1996. Notes on a distributional river boundary and southern range extension for two species of Amazonian primates. Neotropical Primates 4(4):149-151.

Wallace, R. B., R. L. E. Painter, and A. B. Taber. Submitted. Primate diversity, habitat preferences and population density estimates in Noel Kempff Mercado National Park, Departmenta Santa Cruz, Bolivia. American Journal of Primatology.

ANNEX -- ADDITIONAL, SPECIAL WILDLIFE CONSERVATION CONSIDERATIONS FOR TARUMA TIMBER CONCESSION

This annex lists some additional, key considerations for wildlife conservation within Taruma Timber Concession of Santa Cruz, Bolivia. This provides an example of how additional, and more site-specific conditions, can help to complement the general guidelines.

LOCAL WILDLIFE ISSUES FOR TARUMA TIMBER CONCESSION

Spider monkeys deserve conservation attention in Taruma. They are hunted in the region by many local people or forest workers if nothing else is available. They may also decline if management significantly reduces fruit trees including figs (*Ficus* spp.), azucaro (*Spondias mombin*), and other species. To the extent compatible with management activities, protection of these trees can do much to provide for important wildlife food resources.

Other large game species are relatively scarce in Taruma, including tapirs, large Cracid birds, and others. Protecting known den, feeding, or resting sites of these species can aid in their conservation.

Small marsupials -- some species of *Marmosops* and others -- seem to disappear after selective logging. They are not common to begin with. This may be a seasonal effect, though, so more study is indicated.

Cercropia and Piper trees are often pioneer plants invading after cutting. They provide new food sources for foraging fruit-eating bats. Although these plants do not seem economically valuable, they are important wildlife food resources and favor forest regeneration.

The value to wildlife of individual or clumps of patuju (*Heliconia* spp.) and giant patuju (*Phenakospermum guianensis*) is poorly known and needs study. Some observations indicate that flowers of patuju may be pollinated largely by hermit hummingbirds and provide these birds with critical nectar sources for their survival; the flowers may also be eaten by some species of manikins. Fruits of patuju are animal-dispersed, indicating their importance as a wildlife food.

RESEARCH NEEDS

Research is needed in the Taruma area on the following topics:

- species ecology of selected obligate frugivores

- specific roles of large seed- and fruit-bearing trees that provide fruit food sources for toucans, crassid birds, spider monkeys, and many other fruit-eating wildlife species

- effects of selective logging on small marsupials such as *Marmosops*

- status of howler monkeys in Taruma and nearby areas to determine why they are mostly absent in Taruma

- the importance of asai palm and fig trees for frugivores and the impacts of palm heart and fig timber exploitation on wildlife

Also needed are field studies on the effectiveness of applying guidelines for protected areas or reserves for conserving biodiversity and wildlife habitats and populations.