Camelid introduction and substitution plan: A sustainable land use alternative for pastoralists in Sangay National Park, Ecuador

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CAMELID INTRODUCTION AND SUBSTITUTION PLAN:
A SUSTAINABLE LAND USE ALTERNATIVE
FOR PASTORALISTS IN SANGAY NATIONAL PARK, ECUADOR.

by

P. Shane McCarthy
B.A. The University of Montana, 1991
presented in partial fulfillment of the requirements
for the degree of
Master of Forestry
The University of Montana
1997

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Chairperson

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7-15-97
Date
ABSTRACT

McCarthy, Shane P., M.F., June, 1997 Forestry


Director: Steven Siebert

During the 1970's Ecuador established 13 protected areas to preserve representatives of the country's diverse ecosystems, and to protect crucial watersheds. When the boundaries of these protected areas were established, settlement patterns and the pastoral and other natural resource utilization practices of local people were prohibited, most often without consultation or compensation. The protected area agencies and managers were then faced with the complicated task of eliminating or managing this presence and use. Six of Ecuador's protected areas include substantial tracts of high altitude humid grassland, referred to as "paramo." Virtually all of these areas were historically used for the grazing of domestic livestock, primarily cattle and sheep, before being designated as protected. Fire was used extensively by pastoralists in the paramo to rejuvenate plant growth and provide livestock with access to understory herbaceous plants. Frequent burning, combined with grazing by large exotic ruminants, is contributing to the degradation of these critical watershed ecosystems. The substitution of South American camelids (llamas, alpacas and hybrid huarizos) for the exotic livestock in and around the west zone of Sangay National Park is examined as an alternative land use strategy. Camelids are thought to be less destructive to the range and local wildlife, economically viable, and culturally acceptable.
Grass roots development work in developing countries is often fraught with complications and obstacles. There is corruption, confusion, suspicion and fear, lack of political and fiscal support and infrastructure, lack of professional networking, and bureaucratic apathy. Beyond the problems associated with rural development there are specific problems associated with protected area planning and management. It is more the rule than the exception it seems, that when protected areas are created local people are adversely affected, at least in the short term (West & Brechin 1991). Sometimes the affects can be prevented or mitigated at a later date, but on occasion are drastic and permanent. Ecuador's protected area system appears to have fallen into the same pattern as many other developing countries: little or no domestic fiscal support, strong cultural and political opposition (at least on a local basis) and a shortage of trained and motivated personnel to carry out even the most basic management tasks.

In nearly every aspect of the research that I attempted in Ecuador I came up short of solid quantitative data to support the arguments that I present in this paper. The exclosures that I erected at the proposed introduction/substitution sites to monitor the effects of burning and grazing disappeared a few weeks after I placed them there. The manure samples I painstakingly collected and submitted for parasite evaluation were lost, then confused with others, etc. Also, being a Peace Corps volunteer with no personal transportation, no monetary support (a stipend of $120 month), poor Spanish and no Quechua (the indigenous language), trying to conduct a survey in remote rural sites presented
problems. Of greatest hindrance was the basic logistics of getting to the sites, connecting with people, and then allaying their suspicions and fears. To put the campesino's reactions in perspective, I always tried to envision how a small rural caucasian town in the U.S. would react if a foreigner, especially of a different race, with broken English suddenly showed up and started asking questions about their livestock and lifestyles. I was forced to abandon my initial attempt at surveying the INEFAN sponsored site of Ingesey (a full day's travel) because a burro died the very moment I arrived there. I was kindly asked to leave before anything else died.

I had hoped to generate some statistical information from the questionnaire, from which I would then be able to show quantitatively what was happening at the sites. The situation in most cases proved to be different than I had anticipated. At most sites there were no records of any facet of the livestock acquisition, husbandry or mortality. Often there would be numerous people present during the interview and I would get several disparate answers for the same question. Usually I could gain a fairly clear idea of their problems and the reasons, but no solid numbers or proof to illustrate it. The result therefore is not a series of graphs and charts proving or disproving anything, but just a few general observations.

The focal point of this paper, a 20 year dispute over land inside Sangay National Park, was a very sensitive and most often avoided subject among those who claimed rights to the land. I had to be very careful what, who and when I asked, which meant having to retreat from the subject numerous times, lacking solid answers. I arrived in the village of Alao in a wave of suspicion because of my affiliation with the
park (and its tumultuous history with the communities) and the legacy of the "gringos" that had preceded me. The villages of Alao, Candelaria and Huarillaja are 80-90% indigenous, and the people are suspicious and contemptuous of outsiders.

In the end I was heartened to see that though I did not succeed in actually seeing the CISP in Sangay Park through to fruition, I did manage to pique the interest of several local pastoralists and stimulate some action within the government and non-government agencies. Just before I left Ecuador the village of Huarllaja acquired, on their own volition, a group of llamas from INEFAN. A technical training course for INEFAN camelid reserve employees was initiated (and I heard later was indeed conducted), and a Dutch development NGO had chosen camelid production as a long term project in the Central Sierra. Amidst all of the unsuccessful development projects in the rural areas of Ecuador, I have faith that because of its economic and ecological practicality the CISP will prevail.
ACKNOWLEDGEMENTS

I'd like to thank the following people and organizations for their assistance during my field research: The U.S. Peace Corps of Ecuador and natural resources program manager Francisco Garces, Ecuador's Ministry of Forestry, Parks and Wildlife (INEFAN), Sangay National Park, SNP superintendent Vicente Alvarez, Chimborazo Camelid Reserve, Cotopaxi National Park, Fundacion Natura (Ecuadorian NGO), CARE International, CESA (Swiss NGO), CREA (German NGO), and the numerous Ecuadorian pastoralists who patiently listened to my bungling Spanish and are trying to make sustainable decisions.

Thank you to graduate committee members Drs. Dan Fletcher, Jill Belsky, Jeff Gritzner and all the staff at the University of Montana for their patience and support.

Special thanks to graduate committee head Dr. Steve Siebert for his enthusiasm, patience and the countless hours he dedicated to nursing me through this protracted and often confusing endeavor. Also, special thanks to Dr. Stewart White for his unselfish interest and devotion in seeing this project through, the future of it depends largely on people like him.
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CHAPTER I
INTRODUCTION

In the 1970's Ecuador experienced an increased environmental and conservation awareness within certain sectors of the population and government. As a result Ecuador joined the ranks of other Latin American countries setting aside large tracts of its land as protected areas and preparing ambitious management plans with budgets based on $30/barrel oil (Fundacion Natura 1983). The most renowned and publicized of those efforts is the world famous Galapagos Islands. But Ecuador has numerous other protected areas which are famous in their own right such as Podocarpus National Park with more species of birds than all of North America, Yasuni National Park with unparalleled biodiversity and indigenous culture, and Machalilla National Park, the only dry tropical coastal park in South America, to name a few.

In total, Ecuador, a tiny country with eleven million people and some of the highest biodiversity on the planet, boasts 15 protected areas covering a sum of 3,950,283 hectares. Each of the protected areas stands as a representative of a distinct ecosystem, and each of them is threatened by at least one form of human caused degradation (Fund. Nat. 1992). Examples of this include the development of oil fields in the center of Yasuni, thousands of gold miners (using mercury) in Podocarpus, over fishing in Galapagos and logging in Cotocachi-Cayapas.

Eight protected areas in Ecuador overlay one of the two mountain ranges bisecting the country, and contain large tracts of high elevation grassland called paramo. Of the many human caused threats to Ecuador's paramo the most detrimental is burning, grazing. Hundreds of
thousands of hectares of paramo are burned, overgrazed and degraded every year in Ecuador, with much of it occurring in protected areas (Rios 1991). Because these high altitude grasslands are important watersheds, for both the Interandean valleys and the Amazon basin, their degradation is now becoming of paramount concern to citizens, politicians, and scientists (Balslev 1991, White 1991).

The underlying causes of paramo degradation include: 1) Population growth. Ecuador is a small country roughly the size of Colorado, and has one of the highest population growth rates in Latin America, at over 2.3%. With the population swelling (58.7 persons/km² in the Sierra) landless and jobless surpluses are spilling over into historically uninhabited areas such as the Amazon basin, the upper reaches of the temperate cloud forest and the paramo grasslands (IEEC 1992); 2) The paramo grassland ecosystem, because of its harsh, limiting conditions, lends itself more to grazing than to other recognized forms of exploitation. 3) There is a common belief that burning is good, or at least necessary in the paramo for optimal ungulate production, so burning is often extensive (Little 1981, Balslev 1991, White 1991). Though there are laws forbidding burning anywhere in the paramo and the grazing of livestock in the protected areas, they are rarely if ever enforced.

The largest of the mountainous protected areas, Sangay National Park, is in the geographic center of Ecuador. Named for its most dramatic feature, the active Sangay volcano, the park covers 517,725 hectares in eleven Holdridge life zones, stretching from high alpine tundra to lowland tropical rain forest. The park includes more than 175,000 hectares of paramo.
Sangay National park, though topographically rugged and climatically harsh, is threatened by exploitation on nearly all of its boundaries (Fund. Nat. 1992, IUCN 1994). Researchers believe the northwest high altitude zone is the zone most threatened by colonization and deforestation (IUCN, Fundacion Natura, and biologists C. Downer and A. Castellano). Grazing, burning and hunting by indigenous communities and large haciendas in or near the park is a major source of the problem.

Like many protected areas in developing countries, Sangay National Park was demarcated by a group of planners with little knowledge or inclusion of the local people in the planning process (SNP management plan 1976). The borders were determined according to topographic features and perceived historical use (Macey et al. 1976) and any land whether used by locals or not which lay inside those borders was automatically annexed. The outcome was predictable: suspicion and contempt from the disenfranchised perimeter communities, frustration and demoralization among the administrators and park rangers, and blatant defiance expressed in an actual increase of grazing, burning, and poaching wildlife within the park (IUCN 1994).

Due to the complexity of the land tenure in the park, the history of relations between the park and the perimeter communities, and the need for sustainable land use alternatives in the zone, the substitution of South American camelids for cattle was an attractive idea. I decided, based on research and recommendations (White 1991, Stadel 1991, Guinan 1992) to conduct a study on the plausibility of a camelid substitution plan for the paramo zone of SNP, with possible applications for the rest of Ecuador. From the presentation of the camelid
substitution idea everyone, with the exception of a few vaqueros, seemed interested and supportive (this conflicts with Guinan's 1992 survey results, which indicated a total lack of interest in camelids among the community of San Antonio-Alao). The idea began as a scheme to replace the cattle in the core areas of Sangay park with llamas, primarily for meat production. It then expanded into the stocking of perimeter zones with llamas, alpacas and huarizos for meat, wool, and breeding stock. Ecotourism llama trekking, camelid wool art and clothes and other activities were considered augmentative options. The final phase was the setting up a government alpaca breeding facility to begin propagating and promoting alpacas more.

Based on White's (1991) seminal study of alpaca vs. cattle economics, and the simple fact that camelids were native to the Andes and cattle were not, the substitution of camelids for cattle seemed to make sense. It appeared ecologically sound, economically viable and harmonious with the park management objectives and plan. According to my initial assessment, all of the essential components were present and available: the land (disputed sites Culebrillas and Plazapamba), camelid seed stock (INEFAN), a sanctioned government program (The South American Camelid Repopulation Plan, in-country experts, international support (IUCN, CESA, CARE), agency support (INEFAN), and an apparent interest by the key actors - the local people.

Several issues remained unresolved however. Specifically, who would be allowed to make decisions about the use and management of the land and animals. Since the land is a national park, should cattle or any livestock be allowed, especially in light of the fact that endangered species of wildlife could be adversely affected? Are burning practices
truly destructive? How would an enforced ban on burning affect the environment and relations with the local people?

Many planners have realized the necessity of being flexible in the management of human inhabited or utilized areas within protected areas (West and Brechin 1991). Myers (1983), reflecting upon trends in the conservation movement in Africa advocates "adapting and integrating management of protected areas to the need and realities that exist beyond the boundaries of such areas" specifically, for the adoption of a multiple use approach to protected area management.

The IUCN commission on National Parks and Protected areas noted in its policy guidelines that "the role of protected areas be modified to meet the changing requirements of society and to develop responsive management techniques for them" (IUCN 1983a). Finally, the World Congress on National Parks concluded that "... protected areas must contribute to sustainable development by complementing rural development and through the rational use of marginal lands" (IUCN 1983b).

The Sangay National Park Management Plan (1982), Guinan's (1992) case study of the attitudes of local people, and numerous other general prescriptions (Strobel 1991, IUCN 1994, et. al.), advocate sustainable development practices in preserve buffer zones including alternative agriculture (organic and polycrop), agroforestry, cottage art, and ecotourism. Camelids can play an active role in all of these prescribed options. Plus their dung, because it is deposited in central locations, is easy to gather, transport, and apply, reducing the necessity of much of the expensive and potentially dangerous commercial fertilizers. Camelids have been proven adaptable, and even
complementary to agroforestry projects (Cabarle 1989). Their high quality wool and hides can be used for clothes, rugs and art. And the use of llamas as pack animals could encourage the ecotourism industry.

**Study Objectives**

1) Examine the economic and ecological conditions, opportunities and constraints for sustainable pastoralism in a paramo grassland ecosystem using domesticated South American camelids (llamas, alpacas, hybrids) instead of cattle and sheep.

2) Provide guidelines and recommendations for the introduction and subsequent management of camelids in the park and perimeter areas and to the various participants of the plan.

**Research Methods**

Beginning in February of 1993, I spent 27 months in Ecuador as a U.S. Peace Corps volunteer. My program was natural resource conservation, and my area of specialization was protected areas planning and management. My Ecuadorian counterpart agencies were the Ministry of Forestry, Parks and Wildlife and a non-government conservation organization called Fundacion Natura. The site to which I was assigned was an indigenous village in the East Central Sierra on the border of Sangay National Park. My assigned project description included development of infrastructure in the park, personnel training, environmental education and promotion of sustainable land use in the perimeter communities.

I began my research by reviewing the history of SNP's establishment, boundaries, and agreements in the management plans.
(1976, 1982) and maps. In addition, I interviewed the SNP administrators and employees, biologists, local people and hacienda owner Tom Gillespie. With this information I identified the areas and sources of conflict in the park between the local people and the administration. I then conducted a general field survey at the most contested (and proposed substitution) sites of Culebrillas, Plazapamba, Collarnes and Atillo in the park. Included in the survey was a general census of the fauna and flora, livestock numbers and locations, husbandry practices, and damage attributable to grazing and burning. Livestock manure samples were collected and tested for identification of parasites.

Next I met with the Chimborazo Camelid Reserve and Cotopoxi Camelid Reserve managers, INEFAN's Camelid Repopulation director Dr. Gonzalo Basco, and veterinarians, biologists and technicians at Polytecnica University and Catolica University. I also spent three days on the hacienda of noted camelid expert Dr. Stewart White observing his management system.

With this background I constructed a questionnaire to investigate camelid herd compositions, origins, husbandry practices, and physical site descriptions. I then administered the questionnaire in the Chimborazo and Cotopoxi reserves, Polytecnica University's camelid experiment station, White's hacienda, and five camelid sites managed by INEFAN and NGOs CARE and CESA. Based on the site survey results I developed an index of successes and failures, bloodlines, and a working list of people and places involved with camelds in Ecuador. I used this information to launch the idea of substitution of camelds for cattle to the west perimeter communities of San Antonio-Alao, Eten, Huarllaja,
Attillo, and to hacienda owner Tom Gillespie. Throughout the period of research I attended livestock auctions and visited artisans and wool brokers to determine the interest, availability and economic feasibility of camelid products in Ecuador. After the plan expanded into setting up a reproduction and research facility for alpacas, I solicited domestic and international development NGO's for possible financial and technical support.

Before leaving Ecuador and the CISP (which was still in the proposal stage) I recruited an in-coming Peace Corps volunteer to follow up on the project. The replacement volunteer was assigned directly to the Chimborazo reserve to work with the repopulation program. After my departure from Ecuador I visited national parks and camelid reserves in Peru, Bolivia and Chile. In Peru and Chile I informally interviewed the reserve managers and local people about their respective camelid conservation programs. Upon returning to the U.S. I conducted a literature review on protected areas planning and management, sustainable development, camelid ecology and paramo ecology.

Through the research I was able to assemble information in four major areas: existing land tenure and resource use conflicts within Sangay National Park, including the history, primary actors, and physical status of the sites; the current ecology and economy of domesticated camelids in Ecuador, including successful and unsuccessful efforts; a network of resources, institutions, and individuals involved in camelid production and protected areas work in Ecuador; and some of the biological, economic, political, cultural and social obstacles that may
be encountered. From this information I will attempt to provide a set of recommendations for a camelid-cattle substitution project.

Sangay National Park CISP Sites

The two sites within SNP that I investigated and recommend for the introduction of camelids are situated in the northwest zone and are named Culebrillas and Plazapamba. The sites are geographically close to one another and straddle the core of the paramo sector of the park. These areas are appropriate for the camelid substitution plan because:

1) They are included within the INEFAN SNP boundaries.
2) The local pastoralists are indigenous people that had utilized the area before it was designated as a national park, and claim historical and cultural usufruct rights.
3) The forced removal of the cattle, without a viable substitute, could be illegal (depending on interpretation of Ecuador's indigenous land rights), unethical, and detrimental to park-perimeter community relations.
4) There appears to be substantial environmental damage due to cattle grazing and burning (conducted to provide forage for the cattle), trail erosion, wallows and trampling.
5) The paramo, as a grassland ecosystem, appears well suited to managed ungulate grazing.
6) The sites are within a day’s hike from the Alao-SNP ranger station and are thus accessible for monitoring and control by park rangers, extensionists, and campasinos.

Both areas lie in some of the most scenic and floristically important portions of the park's paramo, are rugged, and due to the
loose volcanic soils and high rainfall, are relatively fragile. The areas also provide important habitat for the endangered mountain tapir *Tapirus pinchaque* (Downer, 1990), spectacled bear *Tremarctos ornatus* and red brocket deer *Mazama rufina* (Macey et al. 1976).

The area referred to as Culebrillas is a classic glacier carved valley six kilometers long and one km wide (600 hectares or 1500 acres.) Approximately 500 hectares of the adjoining mountain sides and drainages are currently utilized by cattle. The area is wet, with an annual precipitation of 2200-3000 mm/year, and peak precipitation being June-August. Due to the high elevation (average 3500 meters) the mean temperature is a semi-cool 18-22 degrees Celsius. The valley floor is flat, but the slope on the surrounding mountains is 45 degrees or greater. Water is available water year round in the Culebrillas river (10 m wide, average 30 cm deep) and in numerous feeder streams, both ephemeral and continual. The plant community consists primarily of bunch grasses, forbes, and dwarf bamboos. The ravines, and mountain slopes are covered by Gnoxys and Polylepis trees (some of the largest and last intact stands of Polylepis in Ecuador). Fauna includes mountain tapir, spectacled bear, red-backed brocket deer, whitetail deer, puma, andean fox, andean hare, condor and dozens of species of song birds and raptors (Macey et al. 1976).

The current year-round stocking rate is 150-250 head of cattle. Ten ungulate parasites have been identified (see appendix), but of most concern is a liver fluke *Fasciola hepatica*. Parties who currently have livestock in Culebrillas include Tom Gillespie (Hacienda Santa Rosa), and
an indigenous co-op of several families from San Antonio. The recommended animal for substitution is llama and huarizo neutered males. Tourism potential in the area is high. There is ample opportunity for sightseeing, wildlife viewing, fishing, climbing, and riding. Access from San Antonio-Alao is roughly four hours by foot three hours by horse.

Plazapamba is a basin containing two plateaus separated by a deep ravine and rimmed on two sides by mountains. The two exposed sides drop off into rugged volcanic folds or "badlands." The two plateaus total approximately 500 hectares. The surrounding slopes utilized by cattle is greater than 300 hectares. The climate and elevation is essentially the same as in Culebrillas. There are no major water sources (streams, springs, ponds) on the plateaus but there is a 10 meter wide stream several hundred meters below. The flora and fauna are similar to Culebrillas, although the grass appears much healthier in Plazapamba (possibly due to less frequent burning). The livestock owners at Plazapamba include an indigenous co-op from Huarllaja, and an absentee owner (an army general who at one time lived in Huarllaja and is recently deceased. It is rumored that his sons still claim their "grazing rights."). Also, the Hacienda Alao, who claim to have sold their "grazing rights" to the indigenous co-op still maintain cattle there.

The current stocking rate is 200-300 cattle. The recommended animal for substitution is neutered llama males. The potential for tourism is high. The route to the plateau, though demanding, is extremely beautiful and provides the best access to Sangay volcano. Access from Huarhualla is six hours, from Eten eight hours, and from
Alao ten hours by foot. Access by horse is possible only from Huarhualla.

Given the topography and vegetation in Culebrillas and Plazapamba, it is extremely difficult to census livestock. The Culebrillas valley is bisected by a steep banked oxbow stream, and the uplands are heavily creased by creeks and washes feeding down from the slopes. In addition, the adjoining slopes are 60-80% covered with 2-3 meter high shrubs and trees, providing excellent cover for cattle. It was obvious by the amount of manure and walls encountered that cattle spend a lot of time in the breaks and on the wooded slopes. The most cattle I was able to make a confirmed count on in Culebrillas was 80 (December 1994). The most cattle counted at Plazapamba was 120 (January 1994). These areas may be technically overstocked depending on various quantitative factors such as if cattle concentrate for long durations in the sensitive riparian areas, or on steep slopes.
CHAPTER II
PROTECTED AREAS AND LAND TENURE IN ECUADOR

Ecuador Protected Area and Sangay National Park History

In 1971 Ecuador enacted the National Parks and Reserves Law, Decree No. 1306, to initiate a framework for protected areas. This was followed in 1974 by The Preliminary Strategy for the Conservation of Outstanding Natural Areas, authored by the Ministry of Agriculture and Livestock (MAG), United Nations Environment Program (UNEP) and Food and Agriculture Organization (FAO), to provide an inventory of natural areas. By 1976 the Preliminary Strategy had outlined a very general national conservation objective, which then became the foundation for all subsequent legislation on protected area (DINAF, 1988; Putney, 1976). Cabarle et al., (1989) submitted that despite the above cited laws, decrees and strategies, no coherent national conservation policy for sound natural resource protection existed within the national legislation. By the mid-1990's there appeared to be an increased commitment by INEFAN and various private organizations to address specific management needs and problems within Ecuador's protected area system. This is illustrated by the initiation of several amendments to the original legislation and calls for more proactive policy, cooperation with local people and increased emphasis on sustainable resource use (Fund. Nat. 1994).

Sangay National Park was established as a Nature Reserve on June 16, 1975 under Interministry Agreement No. 322. In 1976 a comprehensive natural history study of the park was conducted and a plan for management alternatives written (Armstrong, et al 1976). A
boundary definition was stated in the Official Government Register No. 69 on November 20, 1979, and the status of area was subsequently changed to National Park. A management document "Proposals for Sangay National Park" was written by Armstrong and Macey in 1979. A second management plan for Sangay National Park was written in 1980 by Huber et al. The SNP management plan was updated again in 1984. Sangay was deemed a park of "significant biodiversity and natural value" and was inscribed on the World Heritage List in 1983. The area of the park was doubled to include lands extending south of the existing boundary by Official register No. 929 on May 20, 1992. Sangay, with the title of National Park, is by definition supposed to be managed strictly as a wilderness area, exclusive of any form of resource utilization. Also in 1992 IUCN declared Sangay National Park as a "World Heritage Site in Danger."

The communities of San Antonio-Alao, Huarllaja and Atillo on the northwest perimeter of SNP had historically been opposed to the park. On at least three occasions this escalated into violence against park personnel (Colonel 19930. A SNP guard station was built in Alao in 1978 and four park guards from outside of the community were hired and stationed there. Boundary signs were installed and ranger patrols were conducted. By 1985 the administration felt that the park guards should be hired locally and three young local men were hired. Though there was still an undercurrent of animosity towards the park, by the late 1980's relations were improving. In 1992 a U.S. Peace Corps volunteer developed an area at a natural hot spring in the park near Alao. In 1993 I took up residence in the town of Alao to work with the park and the community.
The land tenure history of Ecuador is similar to much of Latin America (Kolberg 1977, Lane 1995). Prior to the arrival of Europeans the land was inhabited by various tribes of Indigenous people for between ten and forty thousand years. These people had adapted to nearly all of the major geographic niches offered: jungle, mountain, coast, islands, and desert, but the largest percentage lived in the mountains.

The land use of the Indigenous people was similar to most of the world during concurrent periods: sedentary agricultural people in the fertile valleys, nomadic herders in the highlands and deserts, swidden agriculturists and hunter-gatherers in the jungle, and fishers on the coast. The most famous of the Andean civilizations, if only because of its recent and bloody history with the Spanish conquistadors, is the Inca. Besides their well documented and highly publicized government and military, the Incas developed the foremost domestic and wild camelid breeding and use system ever known in South America (Franklin 1989).

At the arrival of the Spanish in the early sixteenth century, the Incas, for the most part, ruled the central mountainous region of what is now Ecuador, and maintained domestic camelid herds there. On the western slopes, the area of discussion in this paper, were tribes of the Puruhuayes (pur-oo-why) who reportedly were never subjugated by the Inca (Perez 1970).

The next significant known date is the "possession of land by the community of Alao" in 1665-85 (Macey et al., 1976). There are several alleged archaeological sites scattered around the West zone, but none have been officially excavated or documented, so the origins and dates
are purely speculative. It is believed however, based on official archaeological sites further south, that the Puruhuayes have been in the region and have had domesticated camelids there since at least 500 A.D. (White 1991).

By the mid-nineteenth century most of the Sierra of Ecuador had been divided up into enormous "haciendas" owned by a handful of powerful families, and the local indigenous and mestizo people suffered as the typical landless, disenfranchised masses that existed throughout Latin America at that time. This system persisted until the 1960s, at which time social unrest began to churn. While many of the countries surrounding Ecuador were steeped in civil wars over land tenure and political oppression, Ecuador managed to remain comparatively stable. There was fear of revolution in the early 1960s however, and the federal government mandated land reform laws which were designed to break up the large land holdings and distribute them equitably among the landless campasinos. The system was more or less an ultimatum served to the hacienda owners whereby they were to sell or give away a large percentage of their holdings to local people. It was, unfortunately, a plan loaded with loopholes, one of which was a lack of specificity regarding which part of the hacendado's holdings were to be liquidated, so they merely sold the most marginal 50 or so percent and retained the fertile valley land. The landless got land, albeit poor land, and the government and hacendados were technically off the hook.

In the community of San Antonio-Alao the situation was, and still is to a degree, typical of that scenario. There was one family, the Merinos, who owned a hacienda of undisclosed size consisting of nearly all of the land that could be seen in a 360 degree sweep from any point
in the valley. The prime valley land was used mainly for dairy cattle, and the thousands of hectares of high paramo were grazed by beef cattle. The exact history of how and when the Merinos managed to accumulate so much land and power is unclear, but local informants stated that: Two Merino brothers acquired the majority of the titled property in the early 1900's, which they then co-owned and managed. The Merinos actually began to run cattle in the untitled paramo ranges between 1920 and 1940. Though all of the lower elevation valley land was legally owned and titled by the Merinos, much of the high paramo such as Plazapamba, Culebrillas and other interior areas of what is now Sangay park were claimed by the Merinos on the basis that they were the first people to put cattle there. The Merino family has essentially owned and controlled the land ever since.

The two Merino brothers had families and eventually divided the property in half. They split the prime valley land down the middle and divided the paramo areas into large chunks with one share encompassing Culebrillas and the other Plazapamba. A grandson of one of the founding brothers runs one half and the other half is owned and run by Tom Gillespie. Gillespie is a U.S. citizen that married the oldest Merino daughter. The other siblings were bought out by Gillespie and his wife.

When the land reform legislation took place in the 1960s, the Merinos appear to have used the loop hole formula and sold most or all of their marginal paramo land to the indigenous co-operatives from San Antonio-Alao and retained all of the prime valley land. Culebrillas and Plazapamba, though they are technically in the paramo, are flat, productive valleys so were retained within the Merino holdings.
Apparently the Merinos never acquired legal title to Culebrillas and Plazapamba but felt that they were the rightful owners by virtue of their historic use of the areas. In the government files the areas were non-titled and thus belonged to the state.

When the park planners arrived to establish Sangay National Park boundaries, none of these remote paramo areas were legally titled, so were automatically included within the park. The boundaries, according to the 1976 study and submitted management recommendations (Macey, et al.), were "based mainly on the limits of human interference." Even if the land had been titled to private ownership, according to Ley Forestal (The National Forest Protection Law, MAG 1981) Article 73:

"The land and natural resources of private property included within the boundaries of the state's heritage lands (protected areas) are expropriated or reverted back to the ownership of the state in accordance with the laws of the subject."

Followed and further supported by Article 78:

"It is prohibited to occupy the lands of the designated protected areas of the state, alter or damage the demarcation of the management units or commit acts of deterioration of the natural resources in those existing areas."

There are also subsequent Articles in the Ley Forestal which prohibit all burning, anything deemed damaging to wildlife, and hunting in state owned protected areas (Art. 82).

Land Tenure and Indigenous Rights.

The protected areas policy and legislation in Ecuador consists of a progressing series of laws and decrees beginning with the 1971 National Parks and Reserves Law, Decree No. 1306, which was the first law
providing protected area status at the national level. Under this law protected areas were determined by MAG and a rudimentary set of regulations were established.

The next significant piece was the Preliminary Strategy for the Conservation of Outstanding Natural Areas In Ecuador, written in 1976 by MAG, the United Nations Environment Program (UNEP) and the Food and Agriculture Organization (FAO). It serves mainly as an inventory of natural areas and foundation for protected area definition and establishment, and was designed to coordinate government planning. Cabarle et. al. (1989) however, state that the plan does not address protection of natural resources, but rather is oriented more towards exploitation.

The third and most important law, from 1981, is the Forests and Natural Areas and Wildlife Conservation Law, No. 74. This law defines the seven categories of protected areas (which are still current), and outlines penalties for encroachment on the state owned land, damage to ecosystems and wildlife protection. Under this law all forested land is regulated, but private ownership rights are recognized. Natural areas are defined as those with specific conservation, scientific, educational or scenic importance, are entirely state owned and to which ownership rights cannot be acquired. In the interest of this study, it is important to note that there is a clause providing for expropriation of private land for the creation of protected areas where necessary.

Several smaller scale decrees and amended versions of the previous stated laws were added in the 1980's, including Decree No. 1529, 1983, the General Regulation to the 1981 Forest and Natural Areas and Wildlife Conservation Law.
Disputed Tenure and The Sangay National Park CISP Sites

Four sites were identified in the paramo sector of SNP which have disputed land tenure and are currently being utilized for beef production by local people and haciendas. All of the studies and assessments conducted on the management problems and needs of SNP refer to the land tenure dispute and cattle presence at the areas of Culebrillas and Plazapamba. For the purpose of this paper those two areas will be examined.

Culebrillas

Tom Gillespie was the owner of the Hacienda Santa Rosa, which includes the disputed area of Culebrillas. Mr. Gillespie was in Ecuador for only six months during 1994-95, and during that time virtually never visited Culebrillas, so was detached from and ignorant of what was taking place there. He had a dedicated ranch foreman who saw to it that each year's crop of beef bulls were herded over the pass and pushed into Culebrillas. Marketable individuals were then selected from the bulls already there, herded back out, and sold. In my periodic visits to Culebrillas I began to notice a fairly constant parade of local campasinos going to, coming from, and hanging around the vaquero's huts at the far end of the valley. I recognized most of them and knew they weren't Gillespies's employees.

Gillespie's explanation (pers. comm. 1994) was that a co-operative from the community of San Antonio had apparently decided that Culebrillas was under stocked, that it wouldn't hurt Gillespie to give up a bit of grass, and that they had hungry cattle in need of feed. So, they put their cattle over in Culebrillas. The co-op member's version was that
they had "cut a deal" with Gillespie and traded labor for grazing rights. And thus the stocking rate, burning, and trails that the park employees, biologists and tourists had been alarmed about had indeed begun to increase each year.

Park superintendent Miguel Mijia had attempted to prosecute the case by officially annexing Culebrillas, and thus gaining legal title to it for the park (see legal definitions). He then planned to eject the claimant Gillespie and his cattle. The case was filed in a federal court, ignored, then refiled, then suspended, and finally culminated with Mr. Gillespie mysteriously presenting a legal title, several years later, to Culebrillas. Mijia was demoralized and humiliated, and the case was never again challenged in the courts. Even though Culebrillas fell within the designated boundaries of the park, it was undisputedly the property of Thomas Gillespie and $100,000 was his asking price to release it to the state (although, according to the law it could have been forcibly annexed).

I was never able to get a confirmed head count of the cattle in Culebrillas, but Gillespie claimed that he kept between 100 and 150 bulls there. The co-op members all gave me different numbers of their animals, ranging from 20 to 120. The variation in answers depends upon your understanding of their quantitative perceptions, such as what exactly constitutes "their" animals, the area of Culebrillas, the duration of use, as well as their personal motivations to either stretch or pare the truth. Wildlife biologist Craig Downer, the staunchest opponent of livestock presence in the park and an admitted adversary of Gillespie, graphed estimated cattle numbers starting in 1990 at about 350 head and predicted that at the current stocking rate there could be
upwards of 3500 cattle by 1996 (see appendix). Guinan estimates in her study of Culebrillas (1992) that over 1000 head were present there in 1991-92. After spending two years there I can say categorically that those numbers were largely inflated since no one, not Gillespie and certainly not the co-op, had the resources to acquire or produce even a fraction of that number of cattle. Gillespie did claim, however, that from the 1940s up until the early 1970s the Merinos kept as many as 500 head of cattle in Culebrillas. It is conceivable that 500 head could be grazed there seasonally, but a year round carrying capacity- without burning, I would estimate more in the neighborhood of 150-200 based on stocking rates in similar sites.

Plazapamba

Plazapamba had a confusing tenure status. As mentioned earlier, it was originally stocked and claimed by the Merinos. There was also an individual from the village of Huarllaja however, that maintained a cattle herd there and claimed ownership of some undefined portion. This gentleman was a prominent army general who had left Huarllaja several years past but still maintained his cattle in Plazapamba, sharecropped with local campesinos. "The General" as he was referred to, died in February of 1995 and his family's interest in Plazapamba was uncertain. The final twist in Plazapamba's tenure surfaced in March of 1995 when I was discussing the Merino's plan for the area with one of the grandsons. He claimed they had sold Plazapamba to a co-op from Huarllaja the past year. So, as of my departure date in May of 1995 the status of Plazapamba was more confused than ever.
The Paramo Ecosystem

In the past two decades the destruction of the Amazon basin has been cited for everything from potential mass extinction and destruction of native cultures to weather altering processes which could affect the entire earth. What some scientists have now begun to address, but that the media and mainstream environmental movement seem to have largely ignored, is the concurrent destruction of the mountain ecosystems which rim the Amazon basin. The high altitude cloud forests and humid grass lands of the Andes are primary engines in the Amazon hydrologic cycle, contributing trillions of gallons of water annually to the basin. The ecological integrity of the whole Amazon basin could be in jeopardy without properly functioning headland watersheds. Not only is the Amazon basin dependent upon the Andes for much of its lifeblood of water and silt, but the Interandean valleys which provide the majority of staple foods to the populace as well. If headland watersheds are damaged or destroyed, the entire northern half of the continent will suffer. There are millions of hectares of paramo in Ecuador which not only serve as grazing lands for hundreds of thousands of livestock, but more importantly as the water supply for the major cities, hydro power for the country’s electricity, and irrigation for the Interandean valleys.

Paramo is a high-altitude ecosystem found primarily in the Andes of Venezuela, Colombia and Ecuador. Floristically it is unique and extremely diverse with up to 60% of its approximately 3000-4000
species of vascular plants endemic. The paramo is a fragile system that is slow to recover after disturbance; therefore any changes have great impact. The paramo landscape has been heavily influenced by glaciation, being very rough and uneven. It has a cold and humid climate and a diurnal temperature fluctuation at the soil surface from 0-23 degrees centigrade, resulting in a freeze-thaw cycle. Yearly rainfall may vary from 500 mm to 3000 mm (Rios & Espina 1991). In general, soils are humic, black or dark brownish, acid (ranging from about pH 3.7-5.5) and to some extent fertile. Because of the altitudinal gradient plants are adapted to low atmospheric pressure, intense ultra-violet radiation, rapid changes in isolation resulting in quick absorption and loss of heat, and drying effects of winds. Consequently, growth is slow, primary productivity is low, and decomposition and natural succession of the vegetation takes a long time (Luteyn, Sturm 1978; Ferwedal1987; Sarmiento et al. 1990); therefore ecosystem recovery after disturbance is extremely slow, especially when woody species are involved (Janzen 1973; Horn 1989; Salamanca 1991).

The paramo plant communities are characterized by bunchgrasses (Calamagrostis sp and Festuca sp), dwarfed bamboos (Chusquea sp), shrubs (Asteraceae, Ericaceae, Melastomataceae, and Hypericaceae), sedges (Cyperaceae), a dense mat of small plants at ground level including bryophytes, lichens, Ericaceae, cushion plant communities, and giant rosette-plants (Asteraceae, Bromeliaceae). Cuatrecasas (1954, 1958) divided the paramo belt into three altitudinal zones: Subparamo, 3000-3500m, shrubby transitional; Grass paramo, 3500-4100m, xeromorphic, bunchgrasses and bamboos, shrubs; Superparamo, 4100-4800, scree and sandy soils between the grass paramo and snowline, a
zone of high endemism with scattered plants of *Sencio, Draba, Ephedra, and Lupinus*. Field collections indicate that the flora consists of 112 families, 479 genera, and 3000-4000 species of vascular plants. Special adaptations to the rugged paramo environment have contributed to species endemism in paramo that may be as high as 60%. There is currently no written monograph on the flora of the paramo, only scattered comparisons in herbariums (Luteyn et al. 1992).

Unlike other mountain ranges where population centers occur at the bases or foothills, the Andes have had settlements in the highlands for thousands of years (Eckholm 1975). This means that major alterations in Andean vegetation have already taken place. Paramo supported agro-pastoral economies for several millennia, although only rarely have more complex socio-political societies developed. It may be that this relatively low density of human populations has prevented the paramo from being overgrazed to the extent of the higher grasslands (altiplano or puna) to the South (Little 1981; Balslev 1991).

Anthropological (Ferweda 1987, Eglee 1991) and ecological studies (Monastario 1980; Balslev 1991) have indicated that the paramo has few resources to make settlement attractive. Archaeologists regard paramo as a passage, ritual or hunting area. Historical research has determined that paramo was utilized during the colonial era for agriculture and cattle grazing (Valazquez 1986; AH Principal Merida, 1558, 1798, 1799; Balslev 1991), farmland and crop storage in Precolombian times, and as a traditional source of medicinal plants (Eglee 1991).

Activities such as wood cutting, road building, herding of animals, burning to stimulate forage production for grazing and agriculture have
significantly altered the fragile ecosystem and have caused native paramo plants and timberline forests to disappear at an alarming rate, thereby allowing weedy species to dominate some landscapes (Ellenberg, 1979; Verweji, in press). Such activities also lead to accelerated erosion on their slopes as the soils are not able to retain moisture within their drainage basins (Eckholm 1975, Gentry and Lopez-Parodi 1980). The principal future value of paramo may be as water catchment for the cities and farmlands below (Ellenberg 1979, Balslev 1991).

The issue of burning paramo as a method of forage enhancement is a subject of growing debate between natural resource managers and livestock producers in the Northern Andes. Controlled burning is frequently used as a vegetation management tool on rangelands around the world. The objectives are to: increase herbage yields, utilization and availability, improve wildlife habitat, control undesirable shrubs, prepare a mineral seedbed for grass establishment, and control various diseases (e.g. liver fluke) (Horn 1989; Velazquez 1991). Verweji and Budde (1977), Luteyn (1992), et al., have suggested that burning in the paramo could be responsible for increased soil erosion, destruction of crucial habitat for wildlife, and reduction of species biodiversity. Ecuador has prohibited burning in its paramo since 1982, believing that the environmental costs outweigh the benefits. The law, however, is rarely if ever enforced, especially in the remote regions such as SNP and its perimeter areas.

Laegaard (1992) asserted that fire, especially anthropogenic fire, has been a constant influence in the paramo for thousands of years, and that all species belonging to the grass paramo are adapted to survive
fires. Laegaard proposed the hypothesis that all forested areas in the paramo zone are remnants of a formerly more extensive forest, and that true timberline is at about 4100m, corresponding to the present location of the highest growing patches of forests. He asserts that former forests were destroyed by man. The uniformity of the vegetation in contemporary paramo, Laegaard suggests, is due to annual burning practices.

Studies (Laegaard 1992) of recently burned paramo and paramo not burned for many years indicate that most species presently found in grass paramo are able to survive fire; if they were not, they would not be there. Most grass paramos are burned so often that no other plant species present in the region are able to invade and become established in the vegetation between the fires. Paramo plant species have distinct survival mechanisms such as by resistant seed, suckers, apical bud protection, subterranean buds and shoot systems. Ellenburg (1979) states that even though regular fires must be a very strong selection pressure against plant life in the area, it is impossible that so many species could have had enough time to respond evolutionarily to this pressure. Therefore, many of the adaptation types we find in the fire tolerance of paramo plants are most probably adaptations to other factors and only as a side effect also help plants survive fire.

The argument against burning in the paramo often centers as much on preservation of the remaining woodlands as for the herbaceous components. A general lack of firewood is a serious problem for the local farmers in many parts of the paramo region and therefore both a protection of all remaining forests and some reforestation is of utmost importance to the whole country. Also, rain that falls on paramo runs
off rapidly, and therefore may create erosion problems and a general water deficit in dry periods. A forest cover helps retain rainwater through absorption and gradual release. In this way there will be a much more even supply of water to lower regions.

Christianson et al. (1985) also defend fire as being a historic component of paramo ecology, and feel that its effects are not as destructive as is often presumed. White (1992) states that the detrimental effects of burning are not inherent to the single act of burning, but from repetition at short intervals. White observed campesinos in Ecuador burning on two year intervals, which allowed no time for complete recovery and regeneration, especially when followed by heavy grazing pressure. A minimum of five years is needed, but with ever increasing stocking rates of cattle and sheep, that may be difficult to implement.

It is the recent increase in human population, however, that currently has the most detrimental effect on this fragile habitat. Today, for example, 70% of the population of Venezuela, 50% of Ecuador, and 75% of Colombia live in the Andean highlands, and their 3% annual population growth rates are the highest in South America (Little 1981). Spanses of paramo exist primarily in Venezuela, Colombia, and Ecuador, with some in Costa Rica, Panama, and Northern Peru (Luteyn 1991).

The paramo has a tremendous, unrealized potential for beneficial, sustainable development. Biologically, paramo plants are potential contributors of important genetic factors to high-elevation crops such as potatoes or quinoa as well as new foods such as *Ullucus tuberosus*, *Oxalis tuberosa*, *Solanum spp.*, etc. (Eglee 1981) and potentially of medicines. Also, rational watershed management programs in upland
paramo could contribute greatly to hydroelectric power, irrigation schemes, and erosion control projects in the lowland. Paramo grassland ecosystems are a major contributor to the water supplies of cities like Bogota and Quito. Although the aesthetic aspects of paramo such as ecotourism and recreation have gone practically unnoticed, the potential should not be ignored.

The paramo is rapidly becoming an endangered ecosystem. Until 15 years ago very little interest or action was taken toward the preservation of the paramo ecosystem. Recently however, paramo ecosystems have been included within the boundaries of national parks and other protected areas throughout the Northern Andes. Though there is still not a significant body of scientific research on paramo ecology, sincere attempts are being made to encourage research and condense what currently exists (Black 1988, Luteyn 1992).

**Cattle in the Paramo**

Cattle were introduced to the Northern Andes by the Spanish in the late 16th century and probably reached the higher paramos during the late 19th century. Cattle populations waxed and waned from 1540 through the mid-1800's in accordance with colonial politics. Populations began a dramatic increase in the early 1800s, but few made above 3000m. It wasn't until the late 19th century that any settlement reached the high paramo, and at least another 50 years before there was any density of livestock (Perez 1992). Cattle were present in the paramo around the villages of San Antonio-Alao by the late 19th or early 20th century, but not in significant numbers. The first sizable herds of cattle were introduced into the area in the 1940's (Colonel
Cattle can now be found in even the most remote corners of the Ecuadorian paramo.

The demand for beef is growing and the price is high in Ecuador, making beef production an attractive enterprise. However, the cattle of the paramo apparently have to make a considerable effort to meet their nutritional requirements by grazing for long periods over large areas. Cows select leaf cover over stem and green over dead material, necessitating the ubiquitous burning used by the campasinos. Also, green tussock leaves have a significantly higher nitrogen content and digestibility than dead material and short grasses, forbs, and ground-covering species are preferred to bunchgrasses. Studies indicate that cattle in the paramo have less than favorable weight gains, reach maturity later (and reproduce later), have lower adult weights, and low fertility rates and calf survival in comparison to cattle at lower elevations (Schmidt and Verweji 1992).

Management of cattle in the paramo is generally very loose. In the high paramo surrounding Alao and the neighboring villages cattle herds are owned by either the two large haciendas or by family co-ops. Property boundaries are most often just topographical features such as cliffs, rivers, or ridgelines. There is very little fence, and herd ranges overlap. The haciendas brand their cattle for identification and the co-ops simply notch the animal's ears. Bulls are never castrated or separated from the cows, so breeding is uncontrolled (resulting in less than optimal genetics). The large hacienda owners vaccinate occasionally for whatever disease seems to be predominate at the time, but again, it is inconsistent. Most of the cattle in the west zone around Sangay park are infected with endoparasites, with the liver fluke being
the highest concern (Gillespie 1994). Cows calve on their own, apparently year round. The rule is that cattle are rounded up annually to be sorted, culled and sold. The exception is if the potato or onion crop fails or there is a family emergency, in which case a cow is retrieved from the paramo and sold. Cattle are the campasino's savings account.

Environmental damage from cattle in paramo is often more pronounced than in other grassland systems due to the loose volcanic soil, high precipitation and steep slopes. Cattle create depressions by kicking and breaking turf near open pans to loosen and eat plants, which above the frostline of 3600m is then further expanded by needle ice. Also their trails, wallowing, rubbing and fighting damages or destroys large amounts of area. Though cattle prefer the valley bottoms they also graze steeper paramo slopes with a dense vegetation cover produced by seepage water from blocky talus slopes above. If the grazing pressure is intense enough on these sites it can result in soil slumps or landslides (Perez 1993).

Perez (1992) concluded in his extensive study on cattle grazing impacts on specific vegetation in the paramo that the cattle do extensive damage to at least one species of Andean rosette. He also indicates numerous points of coincidence with predation by other species of animals on similar vegetation. Because these plants have evolved without pressure from large herbivores, they may be very sensitive to the relatively recent introduction of cattle.

**South American Camelids**

Interest in using native animals as a resource, as opposed to exotics, is gaining attention in many parts of the world. For example,
ranchers in the American West are beginning to realize the advantages of domesticated bison and hybrid "beefalo" over European and Asian breeds of cattle. Ranchers and biologists in Sub-Saharan Africa are experimenting with the integration of various species of native ungulates into their production. Land owners in Australia are incorporating kangaroos and wallabies more as an appropriate and valuable commodity. Domesticated reindeer, yaks, bactrian and arabian camels, just to name a few familiar species, have all proven their superiority in survival and long term production over exotic species. The basic premise is that the native animals either evolved in situ, or have been there for tens or hundreds of thousands of years, and have been genetically and behaviorally tailored for survival in that environment. Thus, South American camelids could play an important role in the sustainable rural development of the northern Andes (Sumar 1988).

South America, as compared to Africa, Eurasia, and North America has a low biodiversity of large herbivores. Less than 3% of all of South America's mammalian species are medium to large sized (>35 kg) terrestrial herbivores (Franklin 1981). The majority biomass of that 3% is comprised of two species from the family camelidae, the guanaco, (Lama guanicoe) and the vicuna, (Vicugna vicugna). Their ecological dominance, uniqueness and paramount contribution to historical and modern man are unmatched (Franklin 1981). But considering their importance, not a great deal has been written on South American camelids until relatively recently (Cardozo 1977, 1978). Misinformation, based upon inaccurate and anecdotal observations
made by 16th century Spanish chroniclers, has been perpetuated throughout the literature (for example, Gade 1969).

Camelids first appeared in the late Eocene and were one of the first modern families of artiodactyls. The origin of camels, both those of South America and Asia/Africa can be traced back to the ancestral camels of central North America. The camel family (camelidae) was entirely a North American group during most of the 40 to 45 million years of its evolution, with the critical dispersals occurring only two to three million years ago (Franklin 1981).

About three million years ago the Panamanian land bridge gradually closed the Bolivian Trough separating the North and South American continents. Subsequently one of the most spectacular and best documented faunal interchanges took place, including the invasion of the llama-like *Hemiauchenia* into the Andes and onto the Pampas of South America by the beginning of the Pleistocene. Due to an incomplete fossil record the South American camelid evolution subsequent to the arrival of *Hemiauchenia* is not fully understood, but it is believed that two lines descended, the *Paleolama* and the *Lama*. *Paleolama* apparently became extinct during the end of the Pleistocene, and *Lama*, rapidly dispersing from its Andean origin, came to inhabit most of southern South America, splitting into the two genera *Lama* (guanacos) and *Vicugna* (vicunas) that exist today (Franklin 1981).

Lamoid taxonomy and the theoretical origins of the present day domesticated llamas and alpacas are found throughout the literature (Gade 1969; Cardozo 1954, 1975). The prevailing view is that both the llama and the alpaca are the direct descendants of the guanaco, although a number of alternative possibilities exist such as the vicuna.
and or various hybrid strains (Mann 1930; Strook 1937; Fallet 1961; Jungius 1971, Franklin 1981). Four species of camelids are recognized in South America today, the wild vicuna, *Vicugna vicugna* (with two subspecies), the wild guanaco *Lama guanicoe* (with four subspecies), the domestic llama, *Llama glama* (with two breeds), and the domestic alpaca *Lama pacos* (also with two breeds). There are no known populations of "wild" or feral llamas or alpacas in their native andean homeland.

South American Camelids have a number of important diagnostic characteristics (Choque 1979):
1) Sleep and defecate in well defined areas, and they don't graze in these areas. Also have specific places where they take dust baths.
2) They have a highly defined social structure, and can be very aggressive when provoked. They attack with their feet and can inflict serious wounds. They also spit when threatened.
3) Demonstrate great curiosity for anything that is unusual and will advance fearlessly the object of their curiosity.
4) Sleep during the night, eat during the day and ruminate mostly in the afternoon and early evening.
5) Have a particular greeting call which they can change according to the reason of the call.
6) A foot in the form of a pad or cushion which enables them to travel over sandy and rough terrain, steep mountains.
7) Females give birth during daylight hours and at intense sunlight and greatest warmth. (7am - 12pm).
8) Upper lip is bifed. Lower incisors are very sharp and grow continuously enabling them to graze short, tough ligneous pastures.
9) Hair coat is thick. Fibres grow close together providing protection against the cold temperatures of high altitudes. Coat color is cryptic.
10) Number of red blood corpuscles is high which compensates for low air pressure of high altitudes.
11) Possible to cross breed, all crosses are fertile.
13) Ovulation is induced by stimulation, gestation approx. 11 months.
14) Wild species live in social communities of family groups. Male and harem. All male group is called tropilla.

Major causes of natural mortality in South American camelids include: lack of food; predation by humans, foxes, pumas or dogs; lightening; snow; accidents and unknown causes (Cajal and Lopez, 1987; Franklin, 1982; Hofmann et al., 1983; Koford, 1957; Raedeke, 1978; Wilson 1984; Yanez et al; 1986). Data from the San Guillermo Reserve in Argentina (Cajal, Lopez 1987) indicate that the puma is responsible for 0.3% of deaths in wild camels. In the same preserve during the severe snowstorms of 1984, 4.5% and 2% of the populations of vicunas and guanacos, respectively, died from freezing. According to these data, natural mortality factors do not have a critical impact upon the recuperation of the species. Only snowstorms could significantly increase the mortality of those populations that have especially restricted distributions (e.g., San Guillermo for the vicuna).

Of the three races of domestic South American camelids, the llama is larger, sturdier, and most versatile. A llama can subsist on rougher forage and can better negotiate steep and muddy topography. Llamas are generally less affected by endoparasites such as the liver fluke (in many cases llamas will survive a rather large infection which in proportion would kill an alpaca). Because of their size and more
aggressive nature llamas are also less prone to predation than alpacas. Llama wool is generally a bit finer and more marketable than sheep wool (White 1993). In addition, llamas can be used as pack animals, as well as provide tasty, high protein meat.

Alpacas are comparatively fragile animals, more susceptible to disease and parasites, and more temperamental than llamas. Alpaca produce some of the finest, most valuable and most desired wool in the world. Alpaca wool, in the case of Ecuador's domestic market, is over five times more valuable than llama wool (White 1996). The alpaca is rarely used for labor and though it is eaten in parts of Bolivia and Peru, in the case of Ecuador slaughter would be an absurdly inefficient use because of their highly valuable wool.

A huarizo ("huari", "pucullama") is a llama-alpaca hybrid. The standard cross is a male alpaca and female llama, and is fairly common in the northern Andes. As with most hybrids the huarizo possesses characteristics of both parent species. Huarizos have the overall dimensions of a llama, a longer, finer grade of wool like the alpaca, and a temperament that falls somewhere in between. The huarizo wool, though finer than pure llama wool, is considered by buyers to be closer to llama than alpaca. Nonetheless huarizo wool enjoys a higher price in most markets. Llamas and huarizos fare better in situations where forage and care are not optimal but alpacas, if cared for, will likely yield a higher profit. As a multiple purpose animal, especially for people living on marginal land the huarizo is the logical choice.
Camelid's Historical Relationship to Man

South American camelids have been a major and strategic resource to man for millennia, and though the introduction of exotic livestock has diluted their potential for economic dominance, their importance remains unchallenged. Their energy (as a pack animal) and products (meat, wool, fuel, etc.) have been an indispensable and effective form of land use and resource exploitation in a formidable environment (Browman 1974; McRae 1976; Franklin 1981).

The early preceramic societies of native americans are believed to have settled at high Andean sites where they became year-round occupants with a camelid based subsistence culture, hunting the wild vicuna, guanaco and paleollama (Rick 1980; Franklin 1981). Estimates on actual domestication of South American camelids range from 3000 to 5000 years BP (Franklin 1981). For these early cave dwellers, nearly 90% of the meat in their diet was from camelids, of which 72% was from newborn animals. Seasonal herding movements are believed to have begun in the "Puna of Junin" in southern Peru by 3000 B.C., and Browman (1974) reported semi-nomadic pastoralism (with llamas) occurred in the late Jauja-Huancayo Basin of Central Peru for nearly 2000 years up to about 500 A.D. Alpacas are believed to have been domesticated much later, around 500 B.C. camelids have historically provided humans with labor, meat, fine wool, hides, fuel (dung), medicines and religious ceremonies. Today, the woolly alpaca is replacing the llama as the most important domestic South American camelid (Franklin 1981). To many of the pre-colonial peoples such as the Qollas, Incas, and dozens of others, nearly every aspect of their lives and cultures revolved around the wild and domesticated camelids.
When Europeans first arrived on the South American continent there were tens of millions of wild vicunas and guanacos, and millions of domesticated llamas and alpacas (Franklin 1981). By the mid-20th century the wild camelids had been decimated by market hunting and exotic livestock competition and disease. Estimates range from 20-50,000 head for that period. By the 1950s and 60s strict protection was awarded the remaining herds in the form of preserves and harvest limitations. Though still considered "endangered", vicunas and guanacos have made a remarkable comeback (Franklin, Fritz 1991).

During the 1960's the Argentine Department of Agriculture began conducting experiments to domesticate the guanacos so that its hides, wool, and meat could be utilized; some felt that it was folly to substitute domestic animals for guanacos and believed guanaco wool, hides and meat were superior to those of sheep (Strook 1937). Intensive ranching of captive and tractable herds of guanacos, while feasible, has not yet been successful.

**Camelids in Ecuador**

Shortly after the Spanish and Portuguese discovered the western hemisphere in the late 15th and early 16th centuries, they proceeded to slaughter and subjugate the indigenous people, establish forts, ports, commercial and political centers. They then began to institute their culture. This included religion, architecture, language, material values, and agriculture. Because the Incas were essentially the regional power at the time (in the Sierra) and the only organized opposition to Spanish colonialism, most of what was considered Inca technology and staple
was consciously or consequently destroyed, replaced or at least discouraged (Kolberg 1977).

The land constituting what is now Central Ecuador became one of the first areas of settlement for the Spanish, and Quito was the colonial hub of the gold and silver trade in the Andean region for more than 350 years. Thus, much of the indigenous cultural technology that survived in the remote and rugged regions of Peru and Bolivia such as terracing and camelid pastoralism, all but disappeared in what is now Ecuador by the 19th century (Lane K. 1994).

In order to "reintroduce" an animal to a place, it is requisite that it was established there in the past. It is commonly assumed that there had been wild and domestic camelids in the high paramo of Ecuador prior to the invasion of the Spanish and their livestock, but that the colonists had eliminated them (Ordonez 1991, White 1991). Camelids had been the domesticated animal of the Indigenous Andeans in Peru, Bolivia, Chile and Argentina for thousands of years. Even though the paramo grasslands are more humid than the puna (altiplano), there are enough commonalities between the two ecosystems and their respective Precolombian indigenous cultures to make it seem logical for camelids to have existed there. It is reasonable that not only are camelids a superior animal for the ecology of the paramo, but that they have a historic right to be there and thus they should be reestablished.

Chronicles by Spanish conquistadors would even have led one to believe so as with this passage:
"In past times, before the Spanish won this kingdom, throughout the sierra and countryside there was a great quantity of native sheep of this land [llamas and alpacas] and an even greater number of guanacos and vicunas; but with the speed with which the Spanish have slaughtered them, there have
survived so few that now there are almost none" (Cieza de Leon 1973 [1553]: 121).

And:

"El Inca Garcilaso de la Vega estimated that two-thirds of the original camelid population had perished within a generation of the conquest. The cause of the devastation, according to Garcilaso, was a plague of mange that swept through the camelid populations in 1544-1545. Various civil wars and competition from Iberian domesticates no doubt contributed to it also".

This is fairly solid evidence for domestic camelids in the Ecuadorian Andes at the arrival of the Spanish. But since the Inca had just invaded the land a mere half a century prior it begs the question: were the camelids native to Ecuador as a wild species, and then domesticated there as it was further south? Miller and Gill (1990) discussed the Precolombian presence (or absence) of camelids in the Sierra of Ecuador, based primarily on examination of the contents of a recent archaeological dig, Pirincay cave, in south central Ecuador. Pirincay is just 175 Km south of the Sangay study area.

Pirincay is apparently an ancient campsite rich in animal bones dating as far back as 1000 B.C. Three biostratigraphic components have been identified at Pirincay, respectively listed as "early" 1000 B.C., "transition" 300 B.C. and "late" dated at approximately A.C. 100. Examination of the fossils in the three levels reveal no camelid bones until the "late" period, at which time they are suddenly present in comparatively superabundant quantities (58.92% of the total pieces, 83.4% of total weight).

It is possible domestic camelids did not exist in Precolombian Ecuador prior to A.C. 100 and that wild camelids never existed there (If true, this would totally negate INEFAN's current mandate to
"reestablish" a wild vicuna population in the country's protected areas. Such an abrupt transition from the hunting of wild game to almost complete reliance on camelids, according to Miller and Gill is unparalleled at any other site in the Andes, and may indicate the infusion of domesticated camelid cultures from the South. Both the Early and Transition levels at Pirincay as well as the faunal assemblage of the Cueva Negra de Chobshi, some 80 km to the south (Lynch and Pollock 1981, Miller and Gill 1991), suggest that camelids did not exist within the Cuenca region prior to the beginning of the 1st millennium A.D. This interpretation is corroborated by their absolute absence at all other reported sites in the northern Andes of Ecuador and Colombia dated prior to A.D. 650 (Correal and van der Hammen 1971; Wing 1986, Miller & Gill 1991). On the coast they appear to have been absent until the time of the Inca expansion during the late 15th century (Byrd 1976, Miller & Gill 1991). Although both wild and domesticated forms of the Camelidae are common at Peruvian sites above 2000 m from as early as 3000 B.C. (Wing 1977:849, Miller 1991), they are generally considered to have been introduced into Ecuador at the time of the Inca conquest (Miller 1991, White 1991).

Early European travelers to Ecuador do not mention either the guanaco or the vicuna as part of the native fauna (Vazquez de Espinosa 1942 [1629]: 361-385; Jimenez de la Espada 1965 [1582: 271-281], although, if they were in a state of rapid decline in the 1550s, as Cieza suggests, they could have disappeared entirely by the time of observations some 30 and 80 years later. Also, it seems likely that if wild camels had been endemic to the Ecuadorian highlands, they would have been hunted at least occasionally by the residents of La Cueva
Negra de Chobshi or the early occupants of Pirincay. Their total absence in these archaeofaunas as well as in all other early Ecuadorian sites studied by Elizabeth Wing (1986) corroborates the limits of their present distribution in north-central Peru, and suggests that any camelids found at Pirincay would have to have been domesticated and introduced from the South.

Miller and Gill (1990) state that if the absence of wild camels in Ecuador is confirmed by future archaeological research in the area, Cieza de Leon's anomalous 16th century account of vicunas and guanacos near Tomebamba and Loja will be rejected. It seems unlikely, without major climatic shift, that these wild animals would have been completely absent ca. A.D. 100, then present ca. A.C. 1500, and absent again in modern times. According to other historical references (Kolberg, 1977 [1871]) alpacas were present in Ecuador as late as the last century and probably had been since the Incan conquest in the fifteenth century. The Spanish introduction of European livestock and their diseases such as mange, and the disintegration of the indigenous mountain cultures resulted in the virtual disappearance of the llama and alpaca.

How this all applies to a natives vs. exotics substitution plan in a protected area can either be viewed as an academic technicality or as a worthy philosophical question (see discussion section).

**Ecuador's Camelid Repopulation Program**

The INEFAN plan, titled "Camelid Repopulation Program" (El Proyecto Fomento, Investigacion y Manejo de Camelidos Sudamericanos) is mandated to "protect camelids in Ecuador from extinction, expand the population and learn more about their biology and ecology." A
secondary goal is to reestablish domestic camelid populations in Ecuador by distributing camelids from the two government reserves to groups of campesinos, with preference given to indigenous people. The program began in 1974 with a population of 27 animals. In 1990 it had expanded to 233 llamas, 190 hybrids, and 6 pure alpacas.

The prescribed allotment of animals to campesinos is ten mature females, and one male per co-operative, although at the INEFAN sites I visited it varied, with generally more males and less females (one problem on the reserves is that there are too many males and not enough females). The allotment is not a gift. The co-op is required to provide ten offspring to INEFAN at the end of four years or sacrifice their $500 deposit. Once the ten offspring are provided all other animals become the property of the co-op. This is a fairly liberal requirement given that each female should produce one offspring annually, for a total of forty in the four year time slot. Also, the current market value of a llama in Ecuador is about $130, so $500 for twelve animals is a bargain. If everything goes according to theory, at the end of four years the co-op could be the free and clear owners of over 40 animals.

Currently there are approximately 300 wild vicunas in the Chimborazo reserve and 150 in the northwest perimeter of Sangay park in Ecuador. These animals were diplomatic "gifts" from Argentina, Bolivia, and Chile and are managed by INEFAN for a "re-establishment" plan. The numbers of domestic camelids vary depending on the source but a conservative estimate is that there are at least 5000 llamas, 1200 huarizos and 400 alpacas, over a quarter of which are on the INEFAN reserves (Paucar 1987).
There is a large and growing body of literature which addresses protected area management and politics in less developed countries (West & Brechin 1991). Nearly all of the analysis and recommendations derived from this literature in some way emphasize integrated, local people inclusive management. In 1980 the World Conservation Strategy emphasized the importance of linking protected area management with the economic activities of local communities. In 1982 the World Congress on National Parks, in Bali Indonesia addressed at great length the need for inclusion of local people in the management of protected areas. Ecuador's government and conservation NGO's are now recognizing the need of including local people in the management of it's protected areas, so the time is ripe for a project such as the Camelid Introduction Substitution Plan (CISP).

The park management/land tenure conflict in the West zone of Sangay Park could be addressed through five different, legally supported strategies:

1) Expropriation of the land and extirpation of livestock from inside park boundaries.

**Advantages:** Follows the doctrine of complete ecosystem protection recommended in the original management plan.

**Disadvantages:** Disenfranchises the local people, local economy, and indigenous rights. Further exacerbates ill feeling toward the park and government.
2) Permit the current situation to continue as is: unregulated numbers of cattle grazing in the core areas of the park and uncontrolled burning.

**Advantages:** Respect of indigenous land rights (arguable). Less federal government intervention.

**Disadvantages:** Continuing or increasing environmental degradation.

3) Permit the current situation to continue as is, but with strict monitoring and limits on livestock herd size and distribution, as well as burning. Conducted as co-management with livestock owners and a government institution.

**Advantages:** Potentially more sustainable.

Provides a basis for a co-operative system to evolve.

**Disadvantages:** Compromise is necessary on both sides.

Economy and environment may both suffer.

4) Determine and document the exact tenure status of each claimant through research, dialogue and legal channels. Then provide a sustainable development alternative to the grazing of cattle and burning, i.e. substitution of the cattle with South American camelids.

**Advantages:** Mutually beneficial if the theory of camelid ecology and economy proves correct. Enhanced economic opportunities for local people and less environmental damage. Enhancement of the repore between local people and the protected area.

**Disadvantages:** Potential failure of the plan to yield expected economic returns. Inability of agencies and institutions to sustain support or uphold promises (leading to failure, loss of confidence). Unforeseen, unpredictable catastrophe such as disease transmission to endangered species.
5) An option that is not traditional but used with growing frequency is to obtain outside funding and purchase the land outright from those who claim ownership, if it is indeed legally saleable and offered for sale. The land when purchased is then granted to the government, managed as a private protected area, or co-managed.

**Advantages:** If managed privately, there is the opportunity for more efficiency and flexibility. The conflict is shifted away from government and to a private basis.

**Disadvantages:** The "buying" of the land may infuse money into a few pockets temporarily, but provides nothing for future local economies. Eventually the land may come under pressure of invasion again. Also, if managed privately there is the continual need for financial support.

The option for discussion in this study is for the land to be retained by the Ecuadorian government under the auspices of Sangay National Park and co-managed by INEFAN and the local people claiming historic user rights. One of the contingencies would be for the cattle owners to agree to a gradual but complete substitution of South American camelids for their cattle.

The managing of livestock on private land is very different from doing so on sensitive protected area land. Private management, at least in Ecuador, is exempt from the biological, political and often legal constraints which apply to protected areas. The production of livestock may be compatible with protected areas management, but that it requires intensive planning and consideration (West & Brechin 1991). Also, though much of what White (1991) has found regarding alpacas is
applicable to llamas, their ecology and economy are different. A llama is a larger, sturdier, more versatile animal, but economically much less valuable per unit weight.

Issues intrinsic to the protected area question include: To what degree can/should infrastructure be increased or improved? In cases such as the control of liver flukes (Fasciola hepatica) that require manipulation of the environment, or the killing of a predator such as a puma, to what extent can deviation be permitted; competition with wildlife, and endangered species in particular, for resources such as forage, water and bedding areas; should the livestock owners pay for the use of the land, even if they historically used the area before its protected area designation? How much control should the individual actors have?

Wells and Brandon (1992) suggest six preconditions for successful Integrated conservation development projects (ICDPs):
1) Serious political commitments to the project (all levels of authority, local authorities, leaders, agencies, ).
2) Legislation conducive to the achievement of ICDP objectives.
3) Realistic institutional arrangements for project management; New management structures where necessary.
4) Compatibility with regional development.
5) Systematic attention to land ownership and other resource access rights of the projects intended beneficiaries.
6) Commitment to institutional reorientation (a more people centered approach).

And, local site conditions considered favorable for ICDP implementation are:
1) Relatively low or at least stable human population densities.
2) Widespread use of traditional or appropriate technologies for resource extraction.
3) Protected area where effective management is already in place.
4) Local leaders and responsible central government agencies willing to cooperate.
5) Participation of capable organizations probably in partnerships as described above.

The camelid introduction substitution plan fulfills most of the above prescribed conditions, with the possible exception of a "protected area with effective management" (SNP has a capable and sincere administration, but their field staff is understaffed and underfunded). Based on this criteria the CISP has a relatively good probability of success, which is of utmost importance given the sensitive political nature of land tenure and utilization issues.

**Camelids Verses Cattle: Comparison Analysis**

Llamas, alpacas and hybrids can be an ecological and economically viable substitute for cattle in the paramo of Ecuador. Unfortunately there has not been, to my knowledge, a conclusive study conducted on the subject which specifically and thoroughly quantifies or analyzes a comparison. However, White (1991), as well as graduate students in Ecuador and Venezuela have examined various aspects of the economics of camelids in Ecuador (Hernandez 1983; Caranza 1987; Chavez 1988; Ordonez 1991), and the ecology of cattle in Venezuelan and Colombian paramo (Perez 1992). It is these partial studies which serve as a basis for comparison. There have also been comparative foraging studies
between sheep and alpacas conducted which may be peripherally applicable.

There are very significant and distinct physical and behavioral differences between camelids and bovids. These differences are, when compared and analyzed, the basis of argument for the ecological if not economic superiority of camelids in the paramo grasslands.

In addition to the obvious physical characteristics that suggest that camelids are better adapted than bovids to the paramo, there are a number of behavioral characteristics as well. One example is that camelids nearly always bear their young in the morning, likely a behavioral adaptation to the stormy afternoons of the Andes. Baby camelids born during afternoon storms and unable to dry their soft insulating wool before entering the near freezing nights would have little chance of surviving (Franklin 1974, 78, 81).

Research by White, Choque, et al. has identified comparative production limitations between cattle and camelids in the paramo. This comparison suggests that bovids, well adapted to open-country grazing in temperate grasslands, are not well suited for steep, wet, mountainous terrain, especially in high altitude humid tropical grasslands.
Table 1

A Comparison of the physical characteristics of bovids and camelids which may determine environmental impacts in the paramo:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Bovids</th>
<th>Camelids</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Body size/weight</td>
<td>*Large, heavy (700 + lbs).</td>
<td>*Small, light (100-250 lbs.)</td>
</tr>
<tr>
<td>*Neck</td>
<td>*Short and thick. Limits access to herbage in tall grass.</td>
<td>*Long and thin. Facilitates access to herbage in tall grass.</td>
</tr>
<tr>
<td>*Lips</td>
<td>*Solid, not dexterous.</td>
<td>*Bifurcated, dexterous</td>
</tr>
<tr>
<td>*Cardio-vascular</td>
<td>*Not adapted to high altitudes and low oxygen. More time and energy required for movement.</td>
<td>*Well adapted to high altitudes. Less energy spent on metabolism. More efficient per unit of protein prod.</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>*Athletic ability</td>
<td>*Leading cause of death in the paramo is from falling.</td>
<td>*Well adapted to steep slopes.</td>
</tr>
<tr>
<td>*Temperament</td>
<td>*Aggressive and potentially dangerous</td>
<td>*Docile, not generally dangerous.</td>
</tr>
</tbody>
</table>
Despite the overwhelmingly favorable characteristics of camelids for use in the paramo there are a few characteristics that make cattle more attractive than camelids to campasinos in the paramo:

* Cattle are less susceptible to predation by pumas (puma predation has proven to be a primary concern with camelids in the paramo, see section on predation).
* Cattle are in general less drastically affected by parasites.
* Cultural tradition. Cattle are and have been a prized possession for almost two centuries.
* Demand. It is illegal to export beef because of the general lack of domestic supply, so a head of beef is nearly guaranteed to bring at least $300. This, in an area where the gross annual income of a campesino family is about $900. A head of beef to a campesino is a savings account. When the potato or onion crop fails or declines in price as they do every three years or so, a cow may be a family's only liquid asset. There is conversely, no established market for camelids, hence no guarantee of a fair price. Though I am sure Ecuadorians would readily eat llama meat if it was cheaper than beef or if there was no alternative (as they do on the Chimborazo reserve), because of cultural conditioning most would choose beef if the price was roughly equivalent. Therefore most of the campesinos, who can't generally afford to take a risk, fail to see the potential benefits of a camelid over a cow.
Table 2

*Comparison of production limitations*

between camelids and bovids in the paramo.

<table>
<thead>
<tr>
<th>Produc. limitations</th>
<th>Bovids</th>
<th>Camelids</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Nutritional deficiencies in the paramo.</em></td>
<td><em>Phosphorous, minerals, protein, total digestible nutrients.</em></td>
<td><em>Protein.</em></td>
</tr>
<tr>
<td><em>Parasites</em></td>
<td><em>Liver fluke, roundworms, lice.</em></td>
<td><em>Liver fluke, sarna, nematodes, Sarcoystosis.</em></td>
</tr>
<tr>
<td><em>Infectious diseases</em></td>
<td><em>Blackleg, malignant edema, brucelosis diarrhea, pneumonia.</em></td>
<td><em>Carbunculo, coccidiosis, hepatitis.</em></td>
</tr>
<tr>
<td><em>Accidents</em></td>
<td><em>Falling off cliffs, down steep banks and slopes, and into subterranean holes.</em></td>
<td><em>Some injuries from stepping in holes, but rare.</em></td>
</tr>
<tr>
<td><em>Climatic Conditions</em></td>
<td><em>Sometimes succumb to rain and cold (generally in combination with heavy parasitization).</em></td>
<td><em>Rarely suffer from rain and cold except when newly sheared.</em></td>
</tr>
<tr>
<td>Produc. Limitations</td>
<td>Bovids</td>
<td>Camelids</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------</td>
<td>----------</td>
</tr>
<tr>
<td>*Predation</td>
<td>*Calves, yearlings, injured or sick occasionally taken by puma.</td>
<td>*Predation by puma is not uncommon and when confined and unprotected can account for considerable loss.</td>
</tr>
<tr>
<td>*Genetics</td>
<td>*Commonly suffer from uncontrolled breeding. Males are rarely castrated or kept separate.</td>
<td>*Similar situation &quot; &quot;</td>
</tr>
<tr>
<td>*Fertility</td>
<td>Much lower in the paramo than in other grassland ecosystems.</td>
<td>*Can be low in alpacas. Normal in llamas &amp; hybrids.</td>
</tr>
</tbody>
</table>

Chavez in his study of the potential for camelid wool in Ecuador (1988) concluded that campasinos were reluctant to substitute camelids for sheep for essentially the very same reasons I encountered with cattle: Socio-cultural custom and a guaranteed market, albeit a very weak one at times. Chavez did however encounter a "large interest" in using camelid wool among the artisans and traditional clothing manufacturers. He also determined that the high costs of tanning skins ($26 each) and the lack of the ready market for the end products were also problems. The alternative of marketing the sheared wool (cited as $35 to 45/kg) from the skins instead of selling them as tanned pelts might have increased income.
According to the results of Caranza's study of llama meat marketability in Ecuador (1987) a common disease (sarcocystosis) was prevalent in the meat and produced unsightly lesions, which although not harmful for human consumption, were disagreeable to the consumer. Apparently sarcocystosis does not occur in bovids and therefore is an aberration to Ecuadorian consumers, and could be a potential obstacle to marketability.

In the attitude survey conducted by E. Guinan (1992) on the campesinos of San Antonio-Alao, several questions focused on the cattle issue. The first question asked was: "What form of feed is utilized for your cattle?" Answered, 16 of 22 cattle owners placed cattle on the paramo. Next was: "Would you like more or fewer cattle?" Nine wanted more, nine the same, four wanted less (?!), and eight had none. Then: "Would you consider keeping llamas or alpacas?" and the disappointing response of eight saying yes and twenty-two no. The reason for the majority not wanting camelids, according to Guinan, is that these animals were considered unprofitable. Yet another revealing question: "Under what terms would you reduce your cattle numbers and grow more crops?" was answered that thirteen respondents would not change, three would change and six refused to answer. Of the twenty-nine campasinos that responded to the question "Would you change to vegetarian diet?" only one said yes. When asked if they felt that it was "necessary to put cattle in the park?" only five responded yes, fourteen said no and eleven did not answer (with no explanation offered by the author). Another disturbing revelation came from the question on their opinion of burning and clearing natural vegetation. Twenty-eight considered it good practice and only two felt it was bad. Regarding
hunting: Eleven of thirteen who claimed to be hunters were cattle owners, and four of them actually admitted to hunting mountain tapirs, which are endanger of extinction and illegal to hunt.

In the "alternative enterprises" section of the questionnaire this question was posed: "Would you prefer to make a living from ecotourism or from livestock rearing?" to which seventeen answered tourism, ten answered livestock, and three chose neither. Guinan extrapolates simply that "most would prefer to make a living from ecotourism." After having lived there and worked with those very same people for over two years I would have to challenge that assertion on the grounds that the campesinos perceive tourism simply as "easy money" (which it can be comparatively) and that their stated preference is not based on an ecological ethic as Guinan implies later in her thesis. And finally, as to the campesino's opinion of Sangay National Park: Seven had a positive opinion (all of which had worked as guides or porters), fourteen had a negative opinion, and nine were indifferent. Not an encouraging statistic, but it is an attitude that can be changed with projects such as the CISP.

Though this study focuses on the comparative ecology and economy of camelids and cattle, the fact that llamas can be used as pack animals gives them a dual purpose marketability, especially in an area with ecotourism potential. There are however, characteristics that make a horse or burro more attractive as a pack animal than a camelid to campesinos and mountain guides:

* Horses and burros are less affected by mud. This is no minor consideration in a region that receives up to 3000 mm of rain per year.
Llamas, because of their small feet, cannot travel well in deep mud, especially when loaded. They just lay down and refuse to move. (It could be argued that the reason the trails in Sangay are so deep and muddy is because heavy, hard hoofed cattle and horses are using them, and that if camelids were completely substituted the trails would be much shallower and therefore passable to them).

* Horses and burros can be ridden. The campesinos, especially the guides, seemed to argue strenuously for this dual utility, not realizing that camelids are multiple utility (can also provide wool, meat and saleable manure which a horse or burro cannot. The local indigenous people don't eat horses, burros or dogs for spiritual reasons).

* Tradition. Nothing is more coveted than a horse.

**Comparative Economics**

In comparing the total economic benefits of bovids and camelids several aspects must be considered. Bovids provide strictly meat (and possibly hide) as a saleable product, but are also used as draft animals to plow fields. There is currently no economic measurement of this use. Camelids provide wool, meat, hides, manure and have tourism potential.

As of early 1996 in the province of Cañar an arroba (25 lbs.) of meat sold for 50,000 sucres ($16/25 lbs = $1.75/lb). A large paramo bull will weigh approximately 800 pounds live, and gives roughly 400 lbs. (= 16 arrobas) carcass weight, or 800,000 sucres. So, less than $300. A pound of llama meat (when available) is roughly of the same value as beef. To most people the meat of bovids and camelids is nearly indistinguishable in color and taste. The going rate for a large male llama, live is the equivalent of about $130. Given that one beef bull is
equivalent in size and forage intake as three male llamas the economics come out roughly the same.

In May of 1996 llama wool in Ecuador was worth less than $1/kilo, though the situation is improving. S. White was offered $5.50 a kilo for alpaca leg, belly and head fiber ("chaqui lanas") by a company, Hilana, in Quito. The owner, Phillipe Esquerre, also buys huarizo fiber for somewhat less (about $4.50). This sounds cheap, but in terms of the price of sheep wool, camelids already make sense: Campesinos in the province of Bolivar are getting about 800-1100 sucres per pound of sheep wool (there are currently 3000 sucres per dollar).

White believes that within the next couple of years there will be a real market for llama and alpaca wool, centered in Riobamba and Salinas (Bolivar). The "Proyecto Bolivar", with money from the European Community, is currently planning to bring alpacas to Ecuador from Peru and start a spinning/weaving industry. The Dutch development organization, SNV, is also organizing importation of alpacas. All of this camelid (esp. alpaca) activity should raise the consciousness of many fiber processors.

White (1991) compared economics of alpacas, cattle and sheep based on several years production on his ranch. He concluded that "alpaca are adaptable to the mid-elevation paramo and competitive with most existing land uses." Income from cattle was calculated to result from the sale, at local prices, of meat in the paramo, and of meat and fresh cheese at the lower elevation. Income from sheep was assumed to result from the sale of wool and meat in both environments. Cattle and sheep offspring were not considered, to permit comparison with current alpaca husbandry. Income from alpaca was calculated to
result from the sale of their wool, at a presumed price of US $8.80/kg, and from the meat of the culled individuals, and no value was attached to the offspring produced. The presumption of wool price and the absence of an offspring price is necessary because no national market for alpaca wool and young stock has yet developed. (The wool is valued at $15-$20/kg at the wholesale level in Europe and the U.S.A.) Not included in the calculations are the cost of acquisition of the cattle, sheep, and alpaca, the cost of acquiring land, and the value of taxes, losses, and interest (see table).

The comparison shows that, even without including the value of offspring sold, alpaca in the paramo would produce more income per hectare than either beef cattle or sheep, and that at an altitude of 2900 meters they would produce more than sheep but somewhat less than a meat-cheese operation. White makes a strong argument for the use of alpacas instead of llamas as a substitution for cattle in the paramo. Economically it is probable that alpacas pencil out better. But the current price and difficulty of acquisition of alpacas in Ecuador currently makes it impractical, especially considering that llamas can be acquired from INEFAN for essentially nothing.
Table 3

Economic Comparison of Alpacas, Sheep and Cattle

in the Paramo of Ecuador

<table>
<thead>
<tr>
<th></th>
<th>Altitude (meters)</th>
<th>Carrying capacity/ha</th>
<th>Produc. costs US$/ha/year</th>
<th>Gross income US$/ha/year</th>
<th>Net income US$/ha/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpacas</td>
<td>2,900</td>
<td>8.5</td>
<td>42</td>
<td>173</td>
<td>131 plus offspring</td>
</tr>
<tr>
<td></td>
<td>3,500</td>
<td>1.8</td>
<td>15</td>
<td>38</td>
<td>23 plus offspring</td>
</tr>
<tr>
<td>Sheep</td>
<td>2,900</td>
<td>10.0</td>
<td>35</td>
<td>65</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>2,900</td>
<td>2.2</td>
<td>9</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Cattle</td>
<td>2,900</td>
<td>1.5</td>
<td>36</td>
<td>190</td>
<td>154</td>
</tr>
<tr>
<td></td>
<td>3,500</td>
<td>0.2</td>
<td>6</td>
<td>23</td>
<td>17</td>
</tr>
</tbody>
</table>

Camelid manure, because of its ease of collection and handling is a product that warrants consideration as well, especially in a country where the majority of people maintain vegetable gardens. Camelids, both wild and domestic habitually defecate in the same place day to day (a territory delineation method). This creates large cone shaped concentrations of manure that can be easily collected in a bag and sold. The standard price for camelid manure in Ecuador in 1995 was about $1 per 80 lb. bag. It doesn't sound like much, and by U.S. standards it isn't, but to a family whose annual income is less than $900 it is worth their effort.
In the perimeter communities on the west border of Sangay Park the potential for tourism is being eyed and tested by the locals. The results are mostly favorable. Even given the guide's and porter's comparatively low fees of $10 per day, they are still earning three times as much as they would as a farm laborer, for less work. Several hundred climbers and back-packers come to Sangay Park each year to hike and climb the Sangay volcano. Currently, local guides are using horses and occasionally burros as pack animals to carry equipment for tourists. A horse is generally loaded with about 150 lbs. and is priced at approximately $7 per day. A decent broke, adult horse costs about $250-300. A large llama capone can carry fifty or more pounds and could be charged out at probably $5 per day. When the value of their wool is figured in, and the fact that their meat can be sold (no one in the central Sierra will buy horse meat), the economic comparison is close. In an informal survey that I conducted on the several hundred tourists that I encountered in Alao from 1993-95, most said they would prefer to see camelids over cattle in the park, and would pay extra to use them as pack animals as opposed to horses or burros.

Site Survey Results

There is a growing interest in camelids both among private hacienda owners and foreign aid agencies such as CARE International, CESA (Swiss NGO) and, CREA(German NGO) (personal experience). White (1988) estimated 10,000 domestic camelids in Ecuador, mostly llama (Llama glama). This number considerably exceeds earlier estimates of less than 1000 (Cardozo 1968, 1974: FAO, 1971) or 2500 (Sumar 1988). An accurate census would be nearly impossible. With the exception of
the INEFAN reserves and a handful of development agency sponsored herds, I found the camelid population to be scattered arbitrarily as singles, pairs or very small groups. Often I would see a single llama among a herd of sheep, or occasionally a woman walking along a remote trail with a cargo bearing llama in tow. The majority of campesinos that I queried about camelids did not own one, did not know anyone who did, knew nothing about them, and didn't seem to really care one way or another about them.

CARE International sponsors a camelid pilot project near Ambato in the Central Sierra (Calgua Chico-Llantantoma). The CARE site just happens to be within walking distance of two INEFAN camelid sites (Amballata and Putugleo Grande) so I was able to visit and contrast three sites with origins from different agencies in one trip (I hesitate to say "managed by" since INEFAN does not manage their sites). I was taken there by two CARE extensionists, who helped with explanations and observations. The contrast proved to be very revealing. It did not appear that CARE managed their project intensively but it was obvious that some thought and planning went into it and that the technicians made at least periodic visits.

The CARE project had acquired an impressive male alpaca from Dr. Stewart White and the results were immediately obvious. All of the offspring were beautifully wooled and healthy. A neighboring INEFAN site with the exact same forage and female llama stock had a sub-standard alpaca male, and the offspring were scraggly. The CESA site had an impressive infrastructure set up and system with a co-op of families who shared the expense, work and profit, an NGO that provided good technical support, and high quality breeding stock. They had
initially suffered from puma predation but quickly constructed a night corral and posted shepherds with dogs, and the problem ceased. The Polytecnica University experimental site had a resident technician (formally educated and trained), decent forage, a rotational grazing program, and consistent husbandry. The animals looked very good.

The CARE, CESA, and Polytecnica herds were by comparison relatively healthy. All but the Polytecnica site had recently been established so no hard data was available, but the animals appeared to be doing well, and the owners were positive and enthusiastic. Virtually all of the INEFAN camelid repopulation sites had suffered from management problems and the herds were essentially reduced to a handful of hardy if not ragged individuals. The animals suffered from endoparasites, (eggs and worms were visible in the manure); all herds had experienced outbreaks of scabies, which had decimated their young and old animals; none of the males had been neutered, yet had been kept in confinement with the "family group", creating uncontrolled breeding (e.g. poor genetics) and disruption of the social fabric; in one site (Ingisey) a puma had ravaged the herd at least twice, exacting considerable loss. Also, there had been a significant number of deaths and health problems which had not been diagnosed and could have been from any one of a number of things.

The INEFAN site camelid owners, generally a co-op of several families, owned other domestic livestock, but having no previous experience with camelids, knew nothing about them. Upon taking possession of the camelids the recipients received no education or training on any facet of husbandry or ecology. In all cases, co-ops had received animals from INEFAN, then had never heard from the agency
again. Needless to say, the herds were not living up to even modest expectations and no one had yet sold a shred of wool or a single offspring. In fact, they had not even saved enough offspring to service the debt agreement (ten offspring at the end of four years). So, they simply shrugged at most of the questions on the survey form, and I came away with information regarding mostly failure. The conclusion on the INEFAN "repopulation sites" is, sadly enough, that they all appeared to be slowly failing, and in most cases it could have been avoided or minimalized with training and follow up.

I expected that the INEFAN reserves, Chimborazo and Cotopoxi, being the centerpieces of the CRP, would provide the statistical data for my research. So, I was shocked to find that there was no established or consistent system of data collection and analysis, or even basic operations records. And, to make it even more confusing, nearly all of the reserve employees that I interviewed had different recollections and opinions of past operations and procedures (e.g. numbers of animals, diseases, etc.). There is an official MAG document stating the purpose of the reserves, but it is vague and there is no clear management plan outlining provisions for future dispersal of surplus animals or products such as wool. This could be fatal to the Sangay plan. The INEFAN reserve survey underscored the same institutional inadequacies that the repopulation sites had so graphically illustrated. Without a structured system, documented background and monitoring protocol to work with, it would be difficult if not impossible to formulate any sort of viable management priorities or projections.

A startling revelation to come out of the INEFAN Camelid reserve survey was that the animals were not viewed as a potential wage
earner by the INEFAN bureaucrats or by the local people who were
caretaking them. In some cases they were actually considered a
liability. For example, very little thought or attention had been given to
the potential for tourism at the Chimborazo vicuna reserve. With its
accessible location, gorgeous setting, and the fact that it is really the
only place in Ecuador that one can see wild vicunas, it would appear to
have tremendous potential. I proposed the idea, conducted a site survey
and wrote a diagnostic report with recommendations. I even offered to
initiate the project at no expense. I was never contacted regarding
further work. Also, there was several year's (crops) worth of camelid
wool being stored at the Cotopoxi reserve. It was rotting but could not
be sold or given away without being a "conflict of interest" by
competing directly with private producers.

As with everything it seems, money was always the predominant
issue. There was never enough money to conduct even simple
management tasks. And again, there was the failure to view the animals
as potential wage earners. Even if the government could not profit from
the animals, enough revenue could be gained by the sale of wool, and
increased tourism to possibly cover a portion of the management costs.
Budget shortfalls, which often hamstring the whole operation, could at
least be curtailed. Very often I would wait around two or three days to
go to the reserve, or spend a whole weekend waiting around to partake
in a roundup or some management activity on Monday, only to find out
it had again been postponed until the next day or week for lack of
operating funds.

Numerous issues face the INEFAN reserves which could affect the
Sangay camelid introduction. One problem for the reserves, is that
there is a disproportionate number of males to females. This is perfect for the initial stocking of the more remote areas inside SNP, since all-male groups are the prescription. There is also a problem with surplus wool from the reserve's camelids. This wool needn't be sold or disposed of but could be donated to the rural poor.

The Chimborazo reserve was experiencing problems using local people as herders and guardians. No doubt because of their poverty, and lack of training, accountability, and enfranchisement, the local people who were employed to care-take the animals at the Chimbo reserve were allegedly eating their charges on a frequent basis. It is possible that this was informally allowed to both keep the herders placated (their pay is abysmal) and to skim the excess numbers. It is a system that is currently sustainable, but if the repopulation plan ever begins in earnest those surplus animals will be needed. This "unauthorized utilization" could be remedied by an accounting system, and perhaps better pay in the form of structured enfranchisement. Also, one of the most noticeable problems was the lack of technical knowledge among the reserve employees. This could be remedied by providing initial technical training and annual refreshers.

The primary concern expressed to me by the various groups that I presented the INEFAN repopulation program to were, initially, just getting through all of the legal requirements. Though most of the co-ops have at least one member who is literate and capable of contending with paperwork, most of them feel vulnerable and suspicious. The next most pressing concern and by far the most real, was what to do in the event of a catastrophe such as major puma predation, disease, theft or any natural disaster out of their control. They invariably posed the
question "will we still be held to the commitment of providing ten offspring back to INEFAN if something prevents the animals from producing the surplus offspring?" The INEFAN reserve managers assured me that if a catastrophic event took place, it would be promptly investigated and the co-op would be relieved of their obligation, given there was solid evidence that it was indeed a legitimate claim. There is still, to me, a lot of gray area however. For example what would prevent a co-op from eating, or selling the animals and then claiming they were stolen? It may be very difficult to prove.

**Introduction or Reintroduction**

As was presented in the background information there is the potentially important issue of camelid prehistory in Ecuador. If camelids did not originally exist in the Ecuadorian highlands, or for only a brief period shortly before the arrival of the Europeans, then the plan is merely substituting an exotic with another exotic. Semantics can play a role as well, as in what constitutes or defines "native" and "exotic"? Camelids are native to the Andes, but probably not to the paramo. It is likely that wild camelids never existed in Ecuador (at least in the past 20,000 years) and that domestic camelids were introduced by indigenous people in the centuries preceding the European invasion, and only possibly have been herded in the paramo (they were most likely in the central valleys). If this proves to be the case then it is more of a question of "native" meaning from the continent or region, and "historic occupation" a seniority system with camelids beating out cattle by a few hundred years. The CISP, to be safe, should be promoted as what it most likely is: the substitution of an animal that is more versatile and
ecologically harmonious for potential sustainable use of a fragile ecosystem.

All of this may seem esoteric and superfluous, but it could become a political issue if "reintroduction" and "re-establishment" were used as a justification for permitting people to stay in protected areas because they are herding an animal that was previously extinct in that area. Many biologists, such as tapir ecologist Craig Downer, argue that there should be zero tolerance on use of the paramo in Ecuador's protected areas, especially in prime mountain tapir habitat. A camelid, some might say, is no different than a cow, it is still a domesticated grazer competing with endangered wildlife.

Potential Problems of in the CISP

Puma Predation

Puma predation in the higher altitude areas is a primary concern of current and prospective camelid owners. The concern is legitimate, as pumas are a proven threat to camelids and could be one of the greatest problems in the CISP in SNP. Pumas are a highly intelligent and adaptable animal, thriving in almost every climate and habitat from the Arctic to Tierra del Fuego. Puma populations are reportedly on the increase and biologists have asserted that it may be due to expanding livestock numbers and livestock invading areas not previously inhabited (Cajal & Lopez 1987). Also, because uncontrolled hunting has reduced natural prey such as deer, rabbits and mountain tapir, pumas are often forced to kill livestock.

The Cotopaxi Reserve technicians reported losing at least one animal per week to pumas, but seemed unconcerned about it. It was
easy for the technicians to uphold high ideals since the reserve had plenty of animals and the predation did not effect him personally. The campesino camelid owner on the other hand, could be effected dramatically. Manuel Abarca, a llama owner that lived in a Sangay perimeter community provided a juxtaposed view. He had nine llamas and lost four to a puma within a three month period. That's a 45% loss, and impossible for any economically marginalized family to absorb. Abarca had an unfavorable view of pumas, and would readily kill any he encountered, a sentiment I found to be universal among the campesinos in the area.

At the CESA camelid project site the campesinos had lost several head to a puma within the first few weeks of obtaining them. They knew that the losses must be stemmed immediately, so they built a ten foot high stockade corral, and every night the animals were herded in and locked up. A guard with dogs generally stayed in a hut close by. After the construction of the stockade they reportedly did not lose a single animal to predation. The corral, including materials and tools, cost the cooperative less than $50 and took a day to construct. The design is relatively simple and the labor was conducted by the owners.

One of the potential problems inherent to the daily use of these corrals, however, is the transmission of diseases such as mange, scabies, enterotoxemia, colibacilosis and coccidiosis (White, pers.com.). This can be at least partially avoided by treating the infected animals immediately with a topical containing Asuntol mixed in Vaseline, and rotating corrals, leaving infected corrals vacant for 3-4 months. White reports that a proven method he uses is to use a "night corral" for a
year or two, 3-6 rotations, then move the corral elsewhere. There is the added benefit of leaving behind a highly fertilized area for grass.

White (pers. comm.) reports watching a puma stalk one of his female llamas in the paramo section of his ranch. The puma was unable to make a successful kill due to both the wariness of the llama and possibly White's sudden appearance. Otherwise he has not experienced any other problems and attributes it to the presence of guard dogs and a herder in proximity of the corral at night. He agreed that most of attacks take place at night.

At the INEFAN repopulation site of Ingesey the herd had suffered numerous sub-adult deaths from puma predation. In March of 1995 Ingesey was chosen as a site to translocate 45 wild vicunas and 120 llama/huarizos from the overstocked Chimborazo Fauna Reserve. The animals were initially to be kept on land owned by the Ingesey cooperative. The co-op would be paid on a per head/per month grazing and caretakers fee, and nobody seemed to really know what kind of future management plan was to be enacted (e.g., Co-ownership/co-management? moved to inside the park? gifted to the co-op?). In the first week, a puma reportedly got into the herd of vicunas that were turned out onto open pasture and unattended, and killed several. Later, as a result of the puma carnage, a stockade was built and the animals were herded in and guarded every night. According to the reserve employees a month later the puma predation had ceased.

In northern Chile I visited Lauca national park and observed that the park contained thousands of wild vicunas and guanacos and also an undetermined number of domesticated alpacas, llamas, and huarizos. When I questioned some of the local herders about puma predation on
their animals, all claimed it was not a significant problem. There were pumas around, they said, and occasionally an alpaca was killed. Their biggest problem was foxes preying on the new born crias, which could be controlled by herder or guard dog presence. Without spending more time in the park and/or talking with local biologists one can only speculate as to exactly why the pumas don't bother the domestic stock. However, it may be because there is a sufficient wild prey base, and because the domestic animals are very closely guarded in concentrated areas.

Quantitative studies on predator-prey relationships between domestic camelids and wild predators are unavailable, however, some interesting facts which can be inferred from Cajal's (1987) study of puma predation on wild guanacos in Chile, and Flannery's (1989) study on traditional camelid herding in Peru. Throughout Chile, according to Wilson (1984), the increased production of domestic livestock has resulted in increased predation by pumas and possibly, in an increasing puma population. More pumas were observed in Torres del Paine when large numbers of domestic livestock were on the range (Wilson, pers. com. with O. Guineo) Ranchers complained of pumas killing as many as 100 sheep per month during the summer of 1980-81.

In the Wilson (1984) study information from 29 confirmed and probable puma-killed guanacos revealed that all but one adult female and one young male were killed during the peak winter months; that fifty percent of the young were assumed to be in poor physical condition when killed by pumas, and that the distribution of kills was not related to animal density. These numbers say it all as far as prey selection however: Sixty-six percent of the guanacos killed by pumas
were under the age of two; 48% of those killed were adult and sub-adult females, and 35% were young, of both sexes, under 15 months of age. Adult and subadult males, which comprise 40% of the overall population, only accounted for 17% of the prey. And it stands to reason given that the adult/subadult males are larger and more aggressive, which makes them a more formidable foe for the puma.

New world camelid social structure has been well documented (Franklin 1988), and has shown that a population is essentially comprised of two groups, the family group of all females and crias dominated by one alpha male, and the male or bachelor group. Flannery et. al. (1989) determined that native llama herders which generally kept all of their animals together had succeeded in overcoming the inherent conflict between males the same way cattle ranchers do, by simply selecting the best male as a leader/breeder and castrate the rest of the males. The castrated males, called "capones", grow larger and as strong or stronger than uncastrated males, are the optimum camelid as a beast of burden, and don't compete with the alpha male for dominance. Thus, it is essential to emphasize the importance of neutering non-breeding males to Sangay campasinos.

The pertinence of this information to a management plan for SNP would be to stock family groups in the buffer zones where they can be closely tended and their breeding controlled, and stock the park and more remote sites with capones. This is essentially what they do with cattle now. There will more than likely be some predation by pumas, but because healthy young males are more difficult to stalk and kill the number should be low. Furthermore the loss of a non-breeding male is
less of an impact than losing a breeding female. Only a test population will determine it for sure.

Carcass locations at Wilson's study site indicated that habitat played a role in puma predation on guanacos. Among 28 kills, 2 (7%) were made at the edge of a trail or road, 3 (11%) were made at the edge of *B. buxifolia* vegetation, 2 were animals hung up in fences, 11 (39%) were made in small depressions or gullies, and 10 kills (36%) were made on mattral/grass/forb covered slopes. Two direct observations of pumas chasing guanacos and hunting hares suggest that prey were hunted from elevated, hidden positions. This was further supported by the fact that 75% of 28 kills, and 87% of 15 winter range kills were made on slopes or in depressions where the predator could position itself above the prey. Based on this information, if campasinos are instructed to keep camelids, especially the family groups, away from gullies or breaks, the opportunities for pumas to stalk and ambush are greatly reduced.

Another element in the puma predation equation is the severe reduction or elimination of the puma's natural prey base due to human encroachment on habitat and overhunting. While living in Ecuador I was constantly amazed at the absence of large mammals (mountain tapir, whitetail deer, red brocket deer, pudu deer, spectacled bear) in the paramo and cloud forest in and around the park. There was certainly enough habitat, and the locals were always pining for the good ol' days when there had been substantially more big game. Overhunting is most likely responsible for the scarcity of game. Men hunt on horseback and use dogs and guns, and few large wild animals can elude them, even in
the shrublands. They kill, from my limited observations, anything and everything they encounter at all times of the year.

The Forestry, Conservation, Parks and Wildlife law (Ley Forestal y De Conservation De Areas Naturales Y Vida Silvestre) simply states that it is illegal to kill animals in protected areas. But it is not enforced. And no one in the courts takes a poaching case seriously. The only poaching case to be prosecuted by Sangay national park officials, a caught-in-the-act case of two men killing an endangered mountain tapir in the park, was reportedly thrown out of court by the judge as being a "waste of time" (Downer pers. com.). Poachers hunt in and out of the park with impunity (pers. obser.)

When I made presentations to the three respective SNP perimeter villages about the camelid plan, I always included a segment on predation. Because of the clause in the agreement that requires the owners/recipient to be responsible for replacement of the animals until they have returned ten offspring in four years, campesinos were always concerned about uncontrolled deaths and theft of the animals. In the open forum that followed the presentation the dialogue frequently centered on theft and predation. The campesinos always lobbied for inalienable hunting rights on pumas both in and around the park. The only solution, they argued, was elimination. I would then describe my observations and perspective about their hunting practices and suggest that one of the main reasons they had "puma problems" was because the pumas had nothing to eat. Then I would submit that if they would voluntarily curb their deer hunting to just males and to one period of the year, not only would they probably have a lot more deer and tapirs,
but less puma problems. Most of them seemed to agree. They would then blame the neighboring villages for over-hunting.

Campesinos always wanted assurance that in the event of excessive levels of predation they could kill the offending puma, regardless of whether it was in the park or not. This presents a management dilemma that goes to the core of protected areas doctrine. If livestock owners are permitted to kill predators in the park, then it ceases by definition to be a wildlife refuge. It could be argued however that in most protected areas "problem" animals are disposed of, for example "problem" bears in the U.S. parks.

**Parasites and Diseases**

Of the four greatest threats to domestic camelid survival: predation, poor husbandry, disease, and parasites, the latter seems to have taken the greatest toll on the herds that I observed in Ecuador. Of these, the liver fluke (*Fasciola hepatica,*), scabies (*Sarcoptes spp.*,), and coccidiosis are the most prevalent. The observations are supported by White (personal communication). Though management practices help to reduce and control these parasites, they must be carried out with consistency in order for them to be effective and this may be expensive, time consuming and complicated. Furthermore, in this case these activities will be taking place in a protected area, where physical-ecological manipulation should be minimal.

*Fasciola hepatica* exists throughout most of the Ecuadorian Sierra and regularly causes mortality of sheep and occasionally cattle (White and Bosco, pers. comm 1994). Both INEFAN reserves reported incidence of *Fasciola* in their camelids. The Polytecnica herd, the CARE herd, and
White's animals had all suffered from the fluke. I suspect, based on descriptions from the campesinos, that all of the INEFAN repopulation herds were infected as well. The fecal samples from Culebrillas reportedly had large loads of fasciola, and owner Tom Gillespie admitted that his cattle had carried it for as long as he had been there, but that it wasn't worth trying to combat it. Consequently, I think there is little reason for doubt that the majority of camelids in the country are exposed to it, and due to the swampy conditions of Culebrillas and to a lesser extent Plazapamba, it could be a considerable problem with no easy solution.

White states that the intermediate host of F. hepatica is an amphibious snail, and recommends the draining of swamps and application of molluskicides (copper sulfate) 1-3 times per year to reduce the incidence of the snail, and thus the disease. In addition, controlling the entry of other livestock carrying flukes, as well as rabbit and deer who harbor liver flukes, and the use of ducks to clear the swamps of the aquatic snails could reduce the disease incidence (White, pers. comm.).

While this may be feasible on private ground and small areas, it is not viable in SNP where there are possibly hundreds of hectares of infected ground. A possible management strategy would be to conduct periodic deparasitizations with a specific anti-fluke drug to reduce the worm burden for individual animals, and hope the animals eventually gain some resistance.
**Traditional Practices**

Change rarely comes easily, especially with economically marginal people who fear losing what little they have. During my field interviews of the people in the six western perimeter villages, I received overwhelming enthusiasm for the idea of raising camelids. The exception however were the vaqueros, who were opposed to giving up cattle. *Machismo* is still a predominant mentality and practice in rural Latin American and Andean Indigenous culture. South American cowboys are like cowboys everywhere, they like cattle and horses. Their whole sense of identity is based on these animals. Camelids are not comparatively large, aggressive, or dangerous. They cannot be ridden, roped, or fought with (as with *Los Toros*). Basically, they just aren't that exciting for someone with strong macho tendencies. Cattle are a culturally enshrined element in the high paramo culture, despite their inefficiency, and are a source of pride and identity much the same as horses. Many of the vaqueros that I spoke with were intrigued by the idea of camelids but generally as an addition to their cattle, not as a substitution. Many rubbed their chins and responded that the camelids would be good for the women and children, insinuating that they themselves would not be party to more than possibly some husbandry which required *machismo*.

Vaqueros could be a potential obstacle in a substitution plan, especially in the high paramo. Cattle can be released to survive on their own, camelids need to be tended. Livestock tending in Ecuador's paramo is the province of women, children and old people. For this reason, among others, the CISP should take place gradually, so as to permit the
vaquero identity to co-exist and eventually blend with the camelid culture.

**Rustling and Poaching**

"Rustlers were clearly not relatives, or neighbors from the *estancias* (ranches) of the puna, but people from the *kichwa* (farms) who needed capital for some festival such as Semana Santa" (Flannery 1989).

A problem more prevalent in the remote reaches of the high paramo is theft and poaching of livestock. The people of Huarallaja complained constantly of this and actually blocked the park guards and myself from passing through their land, en route to the park, on one occasion. The Huarhallenos demanded that something be done to curtail the alleged rash of cattle rustling that had been occurring. They claimed that rustlers were entering their land via the park and stealing cattle, and they wanted to be granted the authority to control who entered the park and when so as to limit the opportunities of rustlers. The park superintendent sanctioned it and we never heard another word.

With cattle it is a bit of a problem. With camelids, because of their more docile nature, smaller size (theoretically easier to catch, herd or kill), it could be a huge problem. The campasinos of Ingesey had experienced theft and poaching of their camelids and sheep until they began guarding them in a corral every night. Someone had reportedly shot and butchered four young male huarizos in the high paramo one
day, and the owners accused the people from Alao, a six hour hike to the South.

The potential for rustling, or even more so for poaching, is not to be underestimated. From my experience working with the four communities (San Antonio-Alao, Eten, Huarllaja, Ingesey) there seemed to be a lot of rivalry and contempt between the communities. For example, whenever the subject of poaching mountain tapirs or starting fires in the park came up, each village was quick to claim complete innocence and point the finger at the other villages. In reality a few individuals from each village probably commit these crimes, and everyone knows who they are. But it would be a breech of community solidarity to expose them to authorities (although on numerous occasions I was told in confidence who they were). It is just easier and safer to blame another village.

The rustling could be addressed in many ways. Keeping close books with brands and/or tattoos on the animals, checked and confirmed annually by INEFAN technicians and SNP staff as is currently done with a high level of success in Huascaron National Park- Peru. Close monitoring of the animals and corralling them at night and maintaining open lines of communication and co-operation between the villages and SNP. Deputize two or more men from each village to make arrests. Levy heavy fines or jail sentence for convictions, and publicize it widely is another possibility but may not be politically feasible. Although livestock rustling is taken very seriously in Ecuador. (There was an widely publicized event in January of 1995 where two rustlers were caught by campesino-vigilantes and publicly hung. Supposedly no one was officially charged with the murders).
CHAPTER V
SUMMARY and RECOMMENDATIONS

Land use and tenure disputes are omnipresent in all of Ecuador's protected areas today. In SNP all but the most remote portions of the paramo are being utilized by local people for grazing cattle. INEFAN and the SNP management plan, have thus far failed to address this problem and adequately protect the ecological integrity of the park. Much of the high paramo on the west side of the park is considered private domain by the local users and is exploited by burning, cattle grazing and poaching wildlife. These activities continue despite specific laws and regulations prohibiting them and are causing substantial damage as is evidenced by large soil slumps and landslides, severely eroded stream banks, deep boggy trails and reduced vegetation in the areas with cattle presence. If these pressures continue at the current or an increased rate the park's flora and fauna, and its watershed value will be detrimentally and perhaps irreversibly affected.

Although SNP is of national and international interest (it is a world heritage site), public support for the park at the local level is still lacking. When the park was established, the perceptions, needs and aspirations of the locals were not addressed, condemning the park to inevitable failure in the long run. Land tenure and exploitation along almost the entire west side of the park has been contested since the park's inception.

The administrative bodies (MAG, INEFAN, and Fundacion Natura) have not been successful in addressing the issues of the haciendas, cattle co-operatives and hunting law enforcement in Sangay park. Past
SNP superintendent Miguel Mijia made a sincere attempt to remove the pastoralists through legal extirpation but failed because of a lack of support and conviction from higher levels. Fundacion Natura has not fulfilled their objectives of information dissemination and local involvement. From these failings have evolved feelings of antagonism between the local people and the park authorities which could have been avoided with proper planning.

It is apparent that law enforcement alone cannot achieve the desired results, and that it has merely led to heightened conflicts between locals and the authorities. This study determined that several legal avenues to the land tenure dispute in the park, including total eviction, were possible, but proposes a more sustainable form of utilization of the legally protected land in the park such as the substitution of South American camelids for the cattle be implemented as a management alternative to eviction or the continuation of present abuse.

Based on protected area conflict case studies, and interviews with the involved actors the camelid idea and plan are shown to be politically and culturally feasible. Though there is no current quantitative analysis of the ecological cost/benefit comparison of camelids verses cattle, camelid proponents argue that based on their evolutionary adaptations (physical and behavioral make-up) to the paramo ecosystem camelids are superior. White has shown in his economic analysis that alpacas are economically competitive, if not superior to both cattle and sheep in the mid-paramo.

The Camelid Introduction Substitution Plan would be most effective if established and administered as a co-management scheme
between INEFAN, a conservation NGO and local people. There is camelid seed stock available and legal terms upon which the CISP can be administered.

Miller et al. (1983) rightfully warned that implementation of management for economic return requires "substantial augmentation of the biological data bases upon which effective conservation plans must be based." Thus, the economic argument for wildlife and wilderness conservation must be based upon sound biological principles and data. Important considerations are the lack of established markets, disease, predation, and lack of political interest (domestic funding). Each of the cited obstacles has viable solutions however, and there is a growing interest in the CISP idea among pastoralists and agencies as a viable, sustainable use of paramo.
Recommendations for the CISP in Sangay National Park: Findings and Recommendations of the Camelid Site Survey.

Numerous problems face the CISP in the of physical, cultural, and perhaps even philosophical realm. None of the problems, however are insurmountable. For every problem a practical solution has been identified.

*Problem: Providing timely and appropriate training for camelid owners (husbandry, care of wool and meat).
  Solution: Provide training before, during and after the distribution of the animals to the communities. Hire and train extensionists.

*Problem: Cultural acceptance of the substitution.
  Solution: Education; gradual introduction and integration; proof of economic advantages/benefits.

*Problem: Predation; Pumas, Foxes, Dogs.
  Solution: The herd needs to be tended and guarded by dogs (with a herder close by) at night, preferably in a corral with high, tight walls.

*Problem: Endoparasites; Liver fluke *Fasciola hepatica*.
  Solution: Periodic treatment of swampy areas with chemicals; deparasitization with triclabendazol.

*Problem: Ectoparasite/scabies.
  Solution: Vaccinated with Ivomec; infected animals separated and isolated from the flock if possible; corral rotation when there is an outbreak.

*Problem: Tavanid flies (rife in parts of the paramo).
  Solution: Herd the animals to high, exposed, windy slopes.

*Problem: Rustlers/poachers.
  Solution: Close guarding of the flock; brand, ear tag and or lip tattoo; periodic accounting; deputize several individuals in each community; publicly prosecute and publicize offenders.

*Problem: Ecuador's "Camelid Commercialization Prohibition" law: Descreto #193, official register #506, 3/6/74 (prohibits the slaughter of camelids for commercial sale of the meat).
**Solution:** Amend or repeal it through lobbying parliament regarding the camelid situation in Ecuador, that it has changed and needs market incentives to progress.

**Problem:** Lack of a data base on paramo ecology in relation to camelids.
**Solution:** Construct a network of interested academics and technicians; solicit research funds from national and international conservation organizations; establish research sites.

**Problem:** Is the proposed introduction consistent with World Heritage status, park management plans and the local culture.
**Solution:** Contact all persons that may have an influence on whatever legal decisions are required, construct a network of authorities, and establish a forum; perhaps enlist a graduate student to examine it as a thesis or dissertation. (I contacted IUCN/UNESCO's representative Jim Thorsell with the CISP proposal and he responded "its worth a try, as anything is better than a cow" which I interpreted as a green light).

**Problem:** Conflicts and competition with native wildlife, especially the red backed brocket deer and mountain tapir (IUCN red listed).
**Solution:** Investigate causes, effects and extent of conflicts, explore potential compromises, write and implement a management plan. Funding should be sought for field research and monitoring, especially to determine disease and parasite transmission and interspecific foraging competition.

**Problem:** Separation of llamas and alpacas to prevent uncontrolled hybridizing.
**Solution:** Training and education for the recipient communities. A close accounting, at least initially of the breeding could be conducted by the field technicians.

**Problem:** Government interest and support; lack of funding, personnel, extension and infrastructure.
**Solution:** Set up a task group of credible experts such as Drs. P.S. White, Gonzalo Bosco and Angel Paucar to lobby parliament, MAG and international NGOs for the needed legal support and lobby conservation and development organizations for financial commitment.

**Problem:** Lack of information sharing among scientists, managers, and private owners.
Solution: There seemed to be a universal fear of losing one's professional position or status by sharing research results or consulting other authorities on management decisions. Accredited professional conferences would help facilitate professional networking.

*Problem: How to get alpacas from Peru; legalities, prices, transport.  
Solution: Enlist the help of P.S. White, who has done it several times and knows the system.

*Problem: Establishment of carrying capacity at introduction sites. Development of management plans for each individual area (as they will vary in political nature, productivity, and infrastructure).  
Solution: Field research is needed to determine paramo ecology in relation to camelid ecology. A good place to start is with White's research in southern Ecuador. Once a standard carrying capacity formula is established, introduction based on minimum numbers could begin.

*Problem: Markets for camelid offspring and products.  
Solution: An educational campaign to spark the public's awareness. Cotopoxi reserve is perfect for establishing a demonstration site that would be available to the public. Many of the artisans I talked to wanted to but alpaca wool but didn't know of any sources. A network of co-op producers should be established and made available. Peace Corps volunteers (small business enterprise, rural development, and animal production programs) could be instrumental in guiding this.

Recommendations specifically for the proposed introduction sites in Sangay Park:

* Male llamas in Culebrillas, Plazapamba, Collarines and Atillo.  
* Female llamas, huarizos and male alpacas in and around the communities.  
* Round-up and processing performed by INEFAN, in conjunction with the owner co-ops.  
* Trail maintenance could be conducted jointly by park personnel, livestock owners and the guide and porters association. The park could provide food and transportation.
Other considerations:

* A change of protected area category from National Park to Biosphere Reserve status to accommodate utilization of the areas.
* Controlled hunting for problem pumas.

Recommendations specific to other protected areas:

* Special puma-proof corral construction conducted to prescribed specifications and in areas surveyed to provide maximum protection and minimal environmental impact.
* A professionally produced map of all suitable CISP locations and their boundaries (to be enforced).
* Carrying capacity to be determined, established and strictly enforced.
* Annual roundup of all animals in the park and close perimeter areas and herd inoculation/treatment for predominant diseases and parasites. Associated with this will be a census and systematized accounting of the owners, animals, conditions, etc. Excess animals can at this time be removed. This procedure should be conducted by INEFAN, MAG, and Sangay park officials (this is the system currently being used at Huascarán National Park in Peru with very high success).
* Prompt and consistent prosecution of any livestock owner found guilty of killing wildlife while in the park.

I was fortunate to have observed two integrated protected area-livestock systems while traveling in South America, which illustrated that co-management is possible. The administration of the Huascaran National Park in the White Mountains (Cordillera Blanca) of Central Peru, in accepting the fact that livestock have been a part of the local economy for some time, have designed a program which permits, yet controls livestock in the park, and is preparing for an eventual camelid substitution. The system seemed to be efficient. All park livestock owners, their family members, and number of livestock are registered with the park. Each owner is assigned a brand and every year a roundup is conducted by the campesinos, park employees, and technicians from the ministry of livestock. Each animal is sexed, branded, vaccinated for common diseases, and entered on the register. The roundup and processing only requires two days per zone, and the park officials need only be there for one.

I was allowed to observe the processing and talk with the campesinos, which further confirmed the practicality of the system.
Besides providing the park with an instrument for control and management, it also seems to aid park-campesino relations. The vaccines were subsidized and technical help provided free of charge, and the campesino did not seem to view it as control but as an added tool against rustling or confusion of ownership.

**Field Extension**

Based on the findings of the site survey, much of the success of an introduction plan would hinge on the extent and quality of technical support and extension provided by INEFAN and other agencies. The majority of campesinos that expressed interest in raising camelids already owned other domestic livestock but knew nothing about camelid husbandry.

Before animals are granted to campesinos, it is crucial for a trained animal husbandry technician to visit the proposed site and make an assessment of the conditions. A report should then be evaluated by the managers, and a decision made as to the probability of success. If the site is deemed acceptable, the technician should return to the site and conduct an introductory clinic on how to prepare for camelids and what to expect. The technician could also help establish a management plan with the campesinos and make recommendations for necessary infrastructure.

Technicians should accompany the animals to the site and spend at least two days ensuring proper care and minimal stress of the animals. An extensionist should make bimonthly visits to the site for the first six months to one year, followed by a visit every month or two in the second year to monitor the health and production of the animals. During these visits information could be collected and reports filed to establish a database. Special attention should be given to selective breeding, castration of all substandard males, nutrition, and control of parasites. All inoculations for disease or parasites should be conducted initially by the extensionist and possibly subsidized.

Also, for the purpose of peer networking and dissemination of technology and information, a meeting of the managers and extensionists should be held at least annually.
APPENDIX  I

Agencies, organizations, and other current or potential actors in the Camelid Introduction Substitution Plan.

**MAG** - Ministry of Agriculture and Livestock (Ministerio de Agricultura Y Ganaderia). The blanket federal bureaucracy that oversees INEFAN. Bureaucratic support by MAG for all INEFAN projects is essential. MAG would have the ultimate word on all major aspects of the CISP such as tenure issues, the repeal of the camelid slaughter law, and importation of alpacas from Peru.

**INEFAN** - Ecuadorian Ministry of Forestry, Parks and Wildlife. (Instituto Ecuatoriano Forestal, Areas Naturales y Vida Silvestre) This is the primary government natural resource management agency. It would also be the government agency most instrumental in the CISP. INEFAN administers all of Ecuador's protected areas including Sangay National Park and the Chimborazo and Cotopoxi Camelid Reserves. INEFAN should be enlisted for overall coordination, provision or securing of operational funding, initial and follow-up training (extensionists) and enforcing federal and international laws (Sangay is a World Heritage Site and harbors CITES red listed species).

**Sangay National Park** - The park would serve as a pilot site for the introduction of South American camelids in exchange for cattle. The park administration could serve as a liaison to the communities and stock owners, and perhaps aid in the logistics of transporting personnel and equipment. Park facilities (ranger stations) could serve as hubs for training, monitoring, coordination and communication. Park rangers could monitor the camelid operations and aid in the biannual round-up, processing and accounting (as in Huascaran National Park - Peru).

**Chimborazo Fauna Reserve** - This reserve would be responsible for providing the seed stock groups of camelids. Also, the reserve would provide technical training (extensionists) to the recipients, and follow-up extension until the plan was deemed self-sufficient. It is quite convenient that SNP and CFR are both governed by INEFAN and share offices in Riobamba.

**Cotopoxi Fauna Production Area** - This reserve could provide seed stock animals (for better genetic mix) and technical support by means of management data and husbandry and veterinary assistance.
University of Riobamba - Polytechnica - This college is located in Riobamba, just a couple of kilometers from The INEFAN offices. Polytechnica has an impressive agriculture and animal science department, a resident camelid specialist and an experimental herd of their own. The school could be instrumental in providing training for the campasinos, students to conduct studies for future management. Polytechnica could also do technical laboratory work for pathology and act as a venue for breeding, nutrition, and health workshops for agency personnel and recipients.

Catholic University and University of San Francisco in Quito - Two large private universities in Quito. Both offer bachelor's degrees in animal science and rural development. Reportedly there were two students who were completing Master's theses on camelid ecology. As with Polytechnica, they could provide students for field studies, technical laboratory work and a literature/data base.

Community of San Antonio-Alao - Indigenous/Mestizo village on western perimeter of SNP. Owners of Culebrillas cattle. Site for initial camelid introduction/substitution. Area of future production. On site SNP ranger station which could operate as a staging post for Culebrillas introduction.

Community of Huarllaia - Indigenous village on west central perimeter of SNP. Owners of Plazapamba cattle and purveyors of historical conflict. Site for initial introduction (a co-op there currently has a small herd of camelids, acquired from the Chimborazo reserve on 4/95). Area of future production. Staging area for Plazapamba.

Community of Ingisey - Mestizo village on NW perimeter of SNP. Site currently used for both wild vicuna and domestic camelid production. More clearly defined tenure structure. INEFAN project currently in place.

Candelaria - Mestizo village on NW perimeter of SNP (just below Ingesey). Site of SNP ranger station. Potential for primary production in and around the village. Potential for substitution in the Collarnes valley. Collarnes is a long, glaciated, high altitude valley that borders SNP just below Los Altares volcano. Presently there are 150-200 cattle and horses there, and they routinely invade the park. There was a rumor that the owner was interested in the camelids at Ingesey.
Atillo - Indigenous village on the west perimeter of SNP. Site of militant anti-park sentiment and wide spread burning and grazing both in and out of the park. Also, site of the controversial Macas road which will transect the park and a of new SNP guard station. Atillo residents expressed sincere interest in camelids. The area has a high potential for production and substitution.

Tom Gillespie - Owner of Hacienda Santa Rosa and the Culebrillas area inside SNP. Gillespie expressed very keen interest in the substitution idea but was interested mostly in Alpacas. The hacienda includes hundreds of acres of prime valley land that would be ideal for primary production, as well as the Culebrillas valley for capones. Gillespie is currently one of the primary actors in the tenure confusion.

Guide and Porters Association of San Antonio-Alao - A group of indigenous men that act as guides and porters for expeditions into SNP, generally to Sangay volcano. They are interested in the use of camelids as pack animals for eco-tourism.

Dr. Stewart White - Owner of camelid production operation in south central Ecuador (on the southern boundary of SNP) and one of the leading authorities on camelids in the country. Dr. White has published numerous scientific papers on camelid husbandry and ecology, as well as being the main author of the proposal for the expansion of SNP. Dr. White could provide expertise in establishing a credible introduction/management plan, extension program and data base system (most likely as a private consultant). White could also provide seed stock animals and could possibly co-ordinate an acquisition of alpacas from Peru.

U.S. Peace Corps - A well established grass-root development agency that could aid in coordination, training, and science by providing skilled volunteers with the affiliated agencies or at the introduction sites.

Global Environmental Facility - A division of the International Bank for Reconstruction and Development (the World Bank). In 1994 GEF granted $6.7 million to the government of Ecuador for "Biodiversity Protection." Of that, $925,000 is slated for SNP. Numerous sub-headings of needs, activities, and projects to be funded by this money could be applied to the CISP.
UNESCO - United Nations Education, Science and Culture Organization. Possible source of financial support for research, training, and management. Has a bit of a vested interest in SNP and seeing that it succeeds as an unthreatened protected area since it is a World Heritage Site.

Other Organizations (that could contribute to the CISP): CARE International, CESA - Swiss development NGO, CREA - German development NGO, U.S. AID, World Wildlife Fund, Conservation International, IUCN.
APPENDIX II
Survey Questionnaire

Site Name
Location
Owner(s)
Manager
Organization (affiliation/support)
Date

Llamas - count origin
# Females Males

Alpacas - count origin
# Females Males

Huarizos - count origin
# Females Males

Average age
Average weight
General health

Total deaths per year
Age 0-1 1-2 2-3 3-4 4-6 6-8 8+
% deaths males % females
Causes of death

Depredation
Diseases (type and extent)
Parasites (type and extent)

Fecundity (# of offspring to mature females)
Frequency of offspring (ave/3 years)
Sex ratio of offspring
Age of weaning
Problems
Selective breeding
Vaccination
Castration
<table>
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<tr>
<th><strong>Teeth trimmed</strong></th>
<th><strong>Feet trimmed</strong></th>
<th><strong>Parasite treated</strong></th>
<th><strong>Vitamin/mineral supplement</strong></th>
<th><strong>Special feed</strong></th>
<th><strong>Estimated cost/head of annual maintenance</strong></th>
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<tr>
<th><strong>Habitat type</strong></th>
<th><strong>Topography</strong></th>
<th><strong>Altitude (%)</strong></th>
<th><strong>Slope</strong></th>
<th><strong>Temperature avg. - Summer</strong></th>
<th><strong>Winter</strong></th>
<th><strong>Rain - Summer</strong></th>
<th><strong>Winter</strong></th>
<th><strong>Predominant forage</strong></th>
<th><strong>Trees (species, % ground cover)</strong></th>
<th><strong>Water</strong></th>
<th><strong>Stocking rate (animals/hectares)</strong></th>
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<tr>
<th><strong>Price paid per animal (ave)</strong></th>
<th><strong>Price sold (ave.)</strong></th>
<th><strong>How many sold per year</strong></th>
<th><strong>Wool sold (yes/no)</strong></th>
<th><strong>Where</strong></th>
<th><strong>Quantity sold</strong></th>
<th><strong>Price per pound</strong></th>
<th><strong>Time and frequency of shearing</strong></th>
<th><strong>Dominant colors</strong></th>
<th><strong>Price difference on colors</strong></th>
<th><strong>Meat sold</strong></th>
<th><strong>Amount sold</strong></th>
<th><strong>Price per kilo</strong></th>
<th><strong>Cargo</strong></th>
<th><strong>Other uses</strong></th>
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<th><strong>Relations with community</strong></th>
<th><strong>Contract/agreement</strong></th>
<th><strong>Benefits</strong></th>
<th><strong>Problems</strong></th>
<th><strong>Future plan</strong></th>
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APPENDIX III

INEFAN Camelid Repopulation Plan requirements

The following criteria must be fulfilled by campasinos who desire the acquisition of domestic camelids from INEFAN.

1) A letter of solicitation directed to the Executive Director of INEFAN.
2) A copy of the "General Assembly of Comuneros Act" in which you substantiate your participation in the program.
3) A copy of the Ministerial Agreement in which legal representation is cited.
4) A certificate from IERAC that indicates ownership of communal land natural pasture.
5) Certificate from the Technical Office stating the grade of communal activity that is maintained by the community.
6) A list of the members of the actual cooperative (cabildo?)
7) A letter of exchange (financially binding agreement) addressed to INEFAN for $880,000 sucres as a guarantee for the eleven animals.
8) A copy of the regulations or statutes.

The INEFAN plan, titled "Camelid Repopulation Program" is mandated to reestablish domestic camelid populations in Ecuador by allocating, or distributing, domestic camelids from the two government reserves to groups of marginalized campasinos, with preference given to indigenous people. The designated allotment is ten mature females, and one male per co-operative, although at the sites I visited there was generally a higher ratio of males to females.

The primary concern expressed to me by the various groups that I presented the program to were, initially, fulfilling the legalities. Though most of the co-ops have at least one member who is functionally literate and capable of contending with paperwork, most of them feel vulnerable and are suspicious. The next most pressing concern, and by far the most real, was what to do in the event of a catastrophe such as a major puma predation, disease, theft or anything natural disaster out of their control. They inevitably posed the question: Would they still be held to the commitment of providing ten offspring back to INEFAN if something prevented them from producing the surplus offspring?
APPENDIX IV

Common Treatments for the predominant diseases and parasites that effect camelids in the paramo

Fasciola hepatica: The swamp treatment is with copper sulfate, although there are more specific mollusquicides now available in the developed world. Control of liver flukes includes:
1. Drainage of swamps. This is not hard, really, since most swamps in the paramo have a good slope to them, and are not too big. This drainage reduces the area of aquatic snail habitat.
2. Periodic deparasitizations, every 2-6 months, depending on local incidence, seasons and altitude. I use triclabendazol (Fasinex), which is active against larvae of 1-2 weeks in the alpaca liver.
3. Application of mollusquicides periodically (1-3 times per year, though 1-2 is usually enough).
4. Control of entry of other livestock carrying liver flukes.
5. Control of the rabbit and deer populations (these also harbor liver flukes). I’ve read of the use of ducks to clear swamps of aquatic snails and of grass with metacercariae.

Mange: This mite is present in the herd but doesn’t normally cause clinical illness. The exceptions are:
1. Crias, who tend to show hair loss on the nose and ears, but which we treat topically with Asuntol (coumaphos, I think) and Vaseline. One or two applications eliminates the clinical manifestations; and
2. Sick or weakened alpacas, whose immune response is limited. Apparently it is Psorpotes spp. that causes most of the sarna in alpacas.

Clostridium perfringens type A enterotoxemia in Ecuador camelids (crias): Not one case in 10 years. This is quite amazing, given that this bug causes so much loss in Peru. Why the difference? No one is sure, but one possibility is that soil acidity is greater here and the pathogen is a soil resident. Or maybe some other quality of soil here as compared to the Altiplano.

Enterotoxemia, bacterial diarrhea associated with unsanitary corrals, kills an average of 50% of newborn alpacas before they are 40 days old (Fernandez Baca 1971). Because that does not occur in wild camels, and such short term massive hunting of newborn is unknown, Wheelers evidence suggests that enterotoxemia or a similar disease already affecting herds of domestic llama and alpaca at this Junin site 4,300 years ago (Novoa and Wheeler).
Dormideros or night corrals: In Peru, enterotoxemia is the main disease resulting from nightly concentration; also colibacilosis and coccidiosis. White had problems with coccidiosis (Eimeria spp.) until he began to rotate the night corrals, leaving dirtied corrals free of alpacas for 3-4 months, giving time for the oocysts of Eimeria to die. Now he only has problems when he fails to rotate corrals frequently enough. White's pattern is to use an area as a night corral for a year or two (3-6 or 7 rotations) then move the corral elsewhere; this has the great advantage of leaving the grass fertilized. It is possible that roundworm loads will increase also if the dormideros are not rotated. This applies to situations where the corrals are covered in grass and the alpacas eat this grass at night while in the corrals.

Parasite list for Camelids in Ecuador:
Eimeria spp.
Trichostrongylus spp.
Ascaris spp.
Cooperia spp.
Bunostomum spp.
Haemonchus spp.
Strongyloides spp.
Nematodirus spp.
Trichuris spp.
Moniezia spp.
Fasciola hepatica
Dicrocelium dentriticum
APPENDIX V - LOCATION MAPS

[Map of the Galápagos Islands and the surrounding region, including Ecuador and Colombia, with various locations and boundaries marked.]
Sangay National Park showing original zoning of 1982 management plan (source: Armstrong and Macey, 1979).


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