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Hunting, Habitat, and Indigenous Settlement Patterns: A Geographic Analysis of Buglé Wildlife Use in Western Panama

by Derek Anthony Smith

B. A., McGill University, 1991

M. A., Louisiana State University, 1993

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BY D. SMITH

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Submitted to the Department of Geography and the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy

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Abstract

This dissertation analyzes indigenous wildlife use from a geographic perspective, focusing on the relationships between hunting, habitat, and settlement patterns. Fieldwork took place among five neighboring communities in the Río Caloveborita watershed in western Panama over one year. The methodology included ethnographic research, mapping land cover and house sites, and participatory research whereby trained local investigators conducted a census, facilitated community mapping sessions, and administered weekly hunting activity questionnaires among 59 households. During their interviews with hunters, local investigators drew sketch maps showing the location of game kill sites, which were later plotted onto topographic sheets and entered into a Geographic Information System for analysis.

The research shows that Buglé hunting is a predominantly male activity practiced exclusively for subsistence. The primary technologies used are firearms, rock-fall traps, hunting dogs, the bow and arrow, and slingshots. Roughly 2,500 animals were caught over a period of eight months, with a total yield of 2,580 kg within a hunting zone of 131 km^2. Hunters captured well over 100 different species, but just five mammals account for over half of the total yield (*Agouti paca*, *Dasyprocta punctata*, *Dasypus novemcinctus*, *Tayassu tajacu*, and *Alouatta palliata*). Nearly half of all game (by weight) was encountered in agricultural areas. Six taxa caught primarily in anthropogenic habitats are classified as "garden game" while six others caught primarily or exclusively in mature rain forest are classified as "deep forest game." The spatial distribution of the 1,278 game kill sites that were documented shows a striking concentration around the study area villages. All of the principal species, with the exception of primates, are caught close to settlements, indicating that little game depletion has occurred. Indeed, approximately 90 percent of all game was caught within two kilometers of a hunter's house, showing that while the hunting zone may be large, much of it is used lightly. I argue that conditions are ideal for the coexistence of indigenous communities and wildlife in the Caloveborita region and that anthropogenic habitats resulting from shifting cultivation likely provide critical foraging opportunities for certain species when foods in mature rain forest are scarce.

Resumen

Esta disertación analiza el uso de la vida silvestre indígena desde una perspectiva geográfica, enfocándose en las relaciones entre la cacería, el hábitat y los patrones de asentamiento. El trabajo de campo se realizó en cinco comunidades aledañas ubicadas en la cuenca del Río Caloveborita por un periodo de un año. La metodología incluyó la investigación etnográfica, el mapeo de la cobertura de tierras y la ubicación de casas, e investigación participativa en donde investigadores locales capacitados condujeron un censo, facilitaron sesiones de mapeo comunitario y aplicaron cuestionarios semanales sobre la cacería en 59 hogares. Durante las entrevistas con cazadores, los investigadores locales dibujaron croquis mostrando sitios donde se encontraron las presa, los cuales fueron ubicados en mapas topográficos y registrados en un Sistema de Información Geográfica para ser analizados.

El estudio muestra que la cacería por parte de los buglé es una actividad predominantemente masculina practicada exclusivamente para la subsistencia. Las principales tecnologías empleadas son armas de fuego, trampas, perros de cacería, el arco y flecha y hondas. Aproximadamente 2,500 animales fueron capturados en un periodo de ocho meses dentro de una zona de cacería de 131 km^2. Los cazadores atraparon más de 100 diferentes especies, pero solamente cinco mamíferos constituyen más de la mitad del total de la cosecha (*Agouti paca*, *Dasyprocta punctata*, *Dasypus novemcinctus*, *Tayassu tajacu* y *Alouatta palliata*). Casi la mitad de la caza (por peso) se encontró en áreas agrícolas. Seis tipos de presa que se obtuvieron principalmente en los hábitats antropogénicos fueron clasificados como "caza de huerta" mientras que otros seis que se encontraron principalmente o exclusivamente en la pluvioselva fueron clasificados como "caza de bosque remoto." La distribución espacial de los 1,278 sitios de presa que fueron documentados muestra una concentración pronunciada alrededor de las comunidades del estudio. Todas las especies principales, a exepción de los primates, fueron atrapados cerca de los asentamientos, indicando que poca depauperación de la fauna ha ocurrido. De hecho, aproximadamente 90 por ciento de toda la cacería fue capturada en un radio de dos kilómetros de las casas de los cazadores, demonstrando que aún cuando la zona de cacería podría ser grande, una gran parte de ella es ligeramente utilizada. Yo argumento que las

condiciones son ideales para la coexistencia de las comunidades indígenas y la vida silvestre en la región de Caloveborita y que los hábitats antropogénicos que resultan de la agricultura rotativa probablemente proporcionan oportunidades críticas de forraje para ciertas especies cuando los alimentos en el bosque maduro son escasos.

Preface and Acknowledgments

The dissertation research presented here is the result of a lengthy journey involving innumerable people, places, ideas, and experiences. The roots of my interest in indigenous forest use lie in my undergraduate training in geography, followed immediately by my first explorations in Central America in 1991, during which time I was overwhelmed by the beauty and diversity of the region's physical and cultural landscapes. Since then I have returned frequently on field courses, as a research assistant, and gradually began my own independent investigations. Throughout this time, I have been greatly impressed by the resilience of indigenous cultures in the face of many formidable threats to their distinctive way of life. I have also been repeatedly amazed by the profound understanding that indigenous villagers have of their natural surroundings, and how they use their knowledge to make wise use of their lands.

A fascination with indigenous wildlife use took firm hold of me in the latter half of 1997 while working in Honduras as a research assistant for the Proyecto Biósfera Río Plátano (see Herlihy 2001). This international conservation initiative was designed to help local communities in and around the country's largest protected area document their land use activities and develop a grassroots management plan for the region. One of my tasks was to work together with local indigenous surveyors to document where people farm, fish, hunt, and conduct other pursuits, and during the process we added thousands of placenames to the topographic maps representing their lands. It was an experience that demonstrated to me in a very concrete way the detail and accuracy of the mental maps of indigenous persons, and their extensive knowledge of vast forest areas. Subsequent outings and conversations with hunters reaffirmed my interest in the interface between culture and ecology, and the many interactions that occur between people and wildlife in the tropical rain forest setting.

My first brief, two-week visit to the Buglé region in western Panama occurred later that same year after working on the Plátano project, with the support of a University of Kansas Pierre Stousse Award for Field Research. During this time I visited several Buglé communities and started learning about how, what, and where villagers hunt. I also became familiar with the workings of the political federation shared by the Ngöbe and Buglé, and met with indigenous authorities to discuss my research plans. Meetings with Panamanian and other professionals in the capital opened up avenues for collaboration and exchange. I received permissions for the research from indigenous and state authorities in Panama and began the process of seeking financial support for the research. I received funding through a Tinker Foundation Grant for Field Research, a Conservation and Research Grant from the Chicago Zoological Society, and a Dissertation Improvement Grant co-funded by the Cultural Anthropology and Geography and Regional Sciences Programs of the National Science Foundation.

I returned to Panama to begin my 12-month doctoral research period in June 1999. Most (about 90 percent) of this time was spent in the field, but I also made short trips to either Santiago or Panama City about every eight weeks or so. I first met with Ngöbe and Buglé leaders to review the research proposal, discuss methods, and identify the study area communities. I obtained a new letter of support from the indigenous authorities outlining the goals of the investigation and requesting local leaders to provide assistance as needed. I was then escorted along the trail from the town of Santa Fe to Caloveborita, an arduous trip across the continental divide over rugged terrain. Soon after my arrival, three community meetings were organized to present and discuss the research with villagers and solicit their approval for the project. The meetings were promoted extensively and were well attended, along with representatives from the indigenous political federation and neighboring communities outside of the study area.

Caloveborita, like most other villages in the region, is a community of thatched homes located along a shallow river of cool, clear water. The nearest telephone or electrical socket is a full day's walk away, but a communication radio is available when needed, and a variety of basic items can be purchased at a small store that is open at least a few hours every day. I made my base in Caloveborita, eventually moving into a small thatched house of my own that simultaneously served as a house and a research station. My gracious hosts provided food, lodging, and laundry services in exchange for modest sums of money. However, I frequently also stayed overnight in the four other study villages – Río Pedregoso, Alto Limón, Río Palmar, and Quebrada Larga – after long meetings, celebrations, special

outings, when swollen rivers made it impossible to return home, or simply to provide ample time to visit with different families.

When in the field I accompanied villagers in their daily activities, conducted numerous interviews, and mapped settlement and forest cover as part of the investigation. However, I was not alone in my efforts. In addition to my independent activities, several local people became intimately involved in the data collection process. By the end of the field study, over a dozen residents in the study area had participated in the research as local investigators. Their main tasks were conducting a census, facilitating community mapping sessions, and administering weekly questionnaires in their respective communities. The local investigators received training during four workshops, followed by regular supervision for the duration of their research activities. Not only did the local investigators help collect valuable information, but they were also instrumental in things such as explaining what the research was about to fellow villagers in their own language, providing their own insight into ecological dynamics and hunting patterns.

While my primary collaboration was with the local residents of the study area and the Congreso Regional Ngöbe-Buglé de Veraguas, a formal liaison was also made with the Smithsonian Tropical Research Institute, and relationships were developed with government and other institutions, most notably Património Histórico at the Instituto Nacional de Cultura, and the Universidad Nacional de Panama, where I met with anthropology classes on two occasions and was invited to give a presentation on my research activities toward the end of my stay in Panama.

I would like to first extend my deep gratitude to the residents of Caloveborita, Río Pedregoso, Río Palmar, Alto Limón, and Quebrada Larga for their patient cooperation in the administration of dozens of questionnaires, for letting me accompany them in their daily activities, and for answering innumerable questions. I am especially thankful to the many people who went out of their way to make me feel welcome in their communities and in their homes. I would also like to thank the local investigators for their dedicated work and for making the research experience so enjoyable. These people are Edilberto Carpintero, Ventura Concepción, Celedonio García, Pedro García, Rodolfo García, Cisinio González, Iván González, Roberto Don Gordillo, Alberto Santos, Faustino Santos, Flavio Santos, Herminio Santos, Lucio Santos, Acernio Sibala, Virgilio Valdez, Alberto Vásquez, Antonio Virola, and Jorge Virloa. The research would not have been possible without their commitment and expertise. The support of several indigenous leaders was also extremely valuable, especially that of Camilo Ortega, Victor Guerra, Ramiro Concepción, Everardo García, and Saturnino Rodríguez. Francisco Herrera, Carlos Fitzgerald, Francisco Villalobos, and Vernal "Zimi" Zimmermann also provided much appreciated support in Panama in various ways.

This dissertation would never have come to fruition without the guidance and hard work of my advisor, Peter Herlihy, who provided tireless assistance through every stage of my doctoral program. His unfaltering support included helping me develop and refine my research ideas, editing proposals and countless other manuscripts, and providing all manner of coaching in and out of the field. He has instilled in me an admiration for the rich traditions of cultural geography and has shown by example the value of dedication and enthusiasm in the life of a scholar. He has also been a good friend. I would also like to thank my other committee members, Garth Myers, Robert Timm, Bart Dean, and Robert Nunley, as well as Pete Shortridge and Charles Stansifer for their contributions to my graduate education and insightful comments and critiques of my work. I would also like to express my gratitude to Professor William Davidson who introduced me to the adventure of fieldwork in Central America and made it possible for me to undertake my first independent investigation along the Río Bocay in Nicaragua. Many fellow graduate students at the University of Kansas offered advice over the years, and I would like to thank David Cochran, Christy Knight, Ratna Radhakrishna, Bjorn Sletto, Kirk White, and Elmor Wood in particular for their encouragement and friendship.

I would also like to thank my wife, Alison Molina, for her constant support. Her companionship and assistance over several months in Caloveborita, and her unwavering encouragement during the subsequent stages of the dissertation work were tremendously important to me. My family has also been a great support to me throughout the evolution of this dissertation, including my father, Vernon, my stepmother Claire, my brother Duane, and my mother Carol, whose gentle and wise spirit continues to inspire me.

Finally, I would like to acknowledge the generous financial support of the National Science Foundation (Doctoral Dissertation Improvement Grant, NSF 19540/990818), the Chicago Zoological Society (Conservation and Research Grant), the Tinker Foundation (Tinker Foundation Field Research Grant), and the Pierre Stousse Memorial Fund, University of Kansas, that made the research possible.

Note:

For the purposes of this dissertation, Spanish words are written in *italics*, while Buglé words are written in **bold**, with accents (e.g., **é**) to indicate stress in pronunciation when it does not lie on the second last syllable of a word, and a circumflex mark over vowels to indicate nasalization (e.g., **ô**). An inverted circumflex (for example, "**ǎ**") for vowels that are both nasalized and require accents to indicate stress in pronunciation.

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1. Indigenous Peoples and Neotropical Wildlife

Neotropical rain forest regions are home to a rich cultural heritage and tremendous biological diversity. These areas escaped many of the impacts of conquest and colonization because they typically did not have exploitable mineral deposits and were not suitable for European forms of land use. Consequently, many of the distinct indigenous peoples that have survived to the present are found in these remote rain forest regions. Indigenous peoples residing in these regions practice traditional forms of land use including shifting agriculture and the harvest of plants and animals from the forests and fallows surrounding their settlements. Despite centuries of contact with outsiders and the penetration of market economies into the most remote areas of the isthmus, from the Petén in Guatemala (Nations 1992) to the Darién of eastern Panama (Herlihy 1989a), indigenous languages, customs, and stewardship of the land endure. Their relative isolation, however, is rapidly diminishing as outsiders encroach on their lands and their forests become the focus of international conservation efforts. Indigenous peoples, who have for the most part served as good stewards of natural environments, have found themselves at the center of a debate about how rain forests should be used and managed (Alcorn 1993; Redford 1990; Redford and Stearman 1993). In response to these developments, in many cases indigenous leaders have joined transnational networks of human rights and conservation professionals and organizations to help assert their rights to use and manage their historic lands.

Rapid deforestation by colonists on the frontiers of indigenous homelands prompted the establishment over 100 new protected areas in Central America during the 1980s, and by 1990, a total of 240 reserves covered 13 percent of the isthmus (Herlihy 1992:32; 1997:231). Many of the largest protected areas, such as the Río Plátano Biosphere Reserve in Honduras, the Bosawás Natural Resource Reserve in Nicaragua, the Sierra de Las Minas Biosphere Reserve in Guatemala, the La Amistad Biosphere Reserve shared by Costa Rica and Panama, and the Darién Biosphere Reserve in eastern Panama are either inhabited by indigenous communities or contain resources used by nearby native villagers to meet many of their basic needs (Herlihy 1997:231-235). Yet, the definition and establishment of most protected areas has been done without any consultation with local resident populations who are affected most. Often, management plans for protected areas (if they exist) do not adequately take into account the use of large forested areas by resident or nearby communities. Most conservation approaches aim to provide strict protection of natural areas by limiting their use, with ostensible purpose of ensuring the "rational" use of natural resources. Ironically, many areas that were thought to be pristine contain habitats that are anthropogenic to some degree, showing that human use is in fact a "natural" component of many ecosystems (Balée 1989; Gómez-Pompa, Flores, and Sosa 1987; Posey 1985). While new models of protected areas now include cultural zones used by local resident populations, most notably the biosphere reserve approach sponsored by the United Nations, there remains great inertia against incorporating indigenous leadership into the management of these areas. Much of the discussion about the relationships between indigenous peoples and conservation continues to be framed as if indigenous peoples are passive agents of change, when in fact they are knowledgeable "folk ecologists" with a vested interest in sustainable forest management.

Increasingly, conservationists and policy-makers acknowledge that the ecological integrity of parks, reserves, and other key conservation areas inhabited by indigenous peoples depends on sound management by these resident peoples (Herlihy 1992:39-40; Houseal et al. 1985:11). The extraction of rain forest products by indigenous and peasant populations has been highlighted as an example of how local resource exploitation can be maintained without compromising conservation goals, but the long term ecological and economic viability of these activities are poorly understood, and especially questionable when rain forest products are commercialized (Anderson and Ioris 1992:179; Boot and Gullison 1995:897-901; Coello Hinojosa 1992:254-257; Hartshorn 1995; Herlihy 1992; Melnyk and Bell 2000; Nations 1992:216; Peters, Gentry, and Mendelsohn 1989; Redford and Robinson 1985; Salafsky, Dugelby, and Terborgh 1993:44; Shaw 1991:24-26). This pragmatic approach, however, does not address the cultural values of forest products and the historic rights of indigenous peoples to continued access to the natural resources in their homelands.

Although it is widely accepted that indigenous groups are less destructive in their use of rain forest environments, there is no a priori assurance that their subsistence activities will not deplete or degrade natural resources. The conditions of low population density, dispersed settlement, and lack of involvement in national or international markets in the remaining indigenous homelands of the lowland tropics are waning (Vickers 1991:53). Consequently, the sophisticated, ecologically sound land use practices that developed in rain forest areas over centuries may no longer be sustainable without improved management at the regional level. New policies, however, must recognize the resource rights of indigenous peoples and include their participation as a core element of the conservation process.

Wildlife has become a focus of international conservation efforts because of the vulnerability of many species and the important roles that animals have in ecological dynamics. Moreover, the status of wildlife is arguably the key indicator of the success of conservation initiatives in the neotropics. Indigenous spokespeople have also expressed serious concern about the exploitation of wildlife in their homelands (Ventocilla, Herrera, and Núñez 1995:4). The use of wildlife remains a contested issue, with a variety of perspectives. The debates about how to use and mange neotropical wildlife revolve around issues such as indigenous land rights, changing cultural traditions, economic development, and ecological dynamics. The effects of indigenous game extraction are especially difficult to understand because hunting activity is very dynamic and sensitive to change, and the impacts on even just one species can have a series of ecological ramifications throughout the rain forest ecosystem. The difficult nature of the issue is manifest in conflicts over how to use, manage, and conserve faunal resources. Governments, conservation organizations, and indigenous peoples all have different views about how fauna should be used and protected. One means of assistance is to provide concrete, empirical evidence about what the impacts of indigenous hunting actually are, and to promote an understanding of the underrepresented point of view of indigenous communities.

1.1 Cultural landscapes and garden hunting

One aspect of the relationships between indigenous peoples and wildlife that has received little scholarly attention is the influence of shifting cultivation on wildlife ecology and the importance of agricultural lands as a source of game. Indigenous agriculture in the humid neotropics is based primarily on shifting cultivation, a rotational system whereby fields are used only for a few years before being left in fallow to recover their fertility. This type of cultivation creates cultural landscapes that include gardens, fallows, and undisturbed vegetation – habitat mosaics that significantly affect wildlife populations. Indigenous agriculture and deliberate forest management have influenced the structure, floristic composition, and ecological dynamics in the rain forests surrounding past and present indigenous settlements. A wide variety of animals forage in indigenous gardens and fallows, and hunting in agricultural lands has been an important component of indigenous subsistence for centuries. Thus, the dichotomy separating humans and nature is perhaps somewhat misleading and may be partly the result of a tendency for ecologists to avoid conducting research where human influence interferes with "natural" processes. In fact, many ecological studies have tended to disregard significant histories of anthropogenic disturbance (Hamburg and Sanford 1986).

1.2 The spatial patterns of hunting activity

At present there is also a large gap in our knowledge of the spatial patterns of forest product extraction and there have been few attempts to determine the full geographic extent of indigenous hunting areas or "home ranges" (Hiraoka 1992:146; Vickers 1983:452). An understanding of the spatial extent of hunting is critical in evaluating human impacts on wildlife populations. Evaluating whether or not a particular game species is being over-hunted requires documentation of not only harvest rates and rates of reproduction, but also some knowledge of the size of the hunting territory from which animals are being removed. Documenting the geography of game extraction is also important because it reveals the distribution of forest lands that are not used by hunters that may serve as de facto conservation areas.

1.3 The Buglé

The Buglé, who are the focus of this study, are one of six indigenous groups that remain in Panama. One of the primary areas of Buglé settlement is found between the Chucará and Guazaro rivers in the northeastern portion of the Ngöbe-Buglé Comarca (an indigenous territory established in 1997) and adjacent portions of northern Veraguas. The relatively remote location of Buglé villages on the northern side of the Serranía de Tabasará has buffered the impacts of conquest and precluded colonization, and the Buglé continue to practice a distinctly indigenous way of life. Yet, from the early period of contact with Europeans to the present, they have undergone significant changes in settlement, economic orientation, and cultural expression. The influence of manufactured goods, wage labor, land incursions, and foreign political systems continues to grow in the region. The resilience of the Buglé over the past few centuries, and their adherence to traditions amid great change and disruption attests to the vitality and strength of their culture. However, if the remoteness of their homeland wanes through the construction of roads and greater integration with the national society, their persistence as a distinct cultural group will likely become increasingly threatened. One aspect of their culture that distinguishes them from their non-native neighbors is their heavy reliance on and knowledge of hundreds of plant and animals species found in the forests surrounding their villages. Hunting plays an important role not only in their diet, but also in their cosmology and way of life.

1.4 Research objectives

This dissertation is an ethnogeographic study of wildlife use by the Buglé and other hunters living in the Río Caloveborita watershed located in northern Veraguas, Panama. The research provides a geographic analysis of hunting behavior that elucidates our basic understanding of the relationship between culture and environment in the rain forest setting, as well as an ethnographic investigation of a Central American indigenous population that has received very little study. The research was done in a humid tropical setting, but many of the themes addressed are important in other environments around the world. The study area that was chosen offers a particularly good opportunity to investigate the relationships between indigenous peoples and wildlife. The Buglé communities that participated in the research live surrounded by large tracts of rain forest, and rely heavily on it for subsistence hunting. The region has also attracted the attention of conservationists, and when field research began, part of the Buglé subsistence lands had been included in a proposal for a national park.

The research design was guided by previous studies by geographers, anthropologists, and ecologists. Most studies of hunting in the humid neotropics have been done by anthropologists who have tended to adopt either an ethnographic or a quantitative approach. These studies have done much to improve our understanding of the symbolic and social importance of wildlife in indigenous societies, and a whole suite of variables that condition hunting patterns. Conservation biologists have also made important contributions, focusing on observable impacts of hunting on game populations. The geographic perspective, however, has been largely absent from debates concerning the relationships between indigenous peoples and wildlife, and the sustainability of indigenous hunting.

The broad goal of this research has been to investigate indigenous wildlife use from a geographic point of view to gain a better understanding of the relationships between hunting, habitat modification through shifting cultivation, and human settlement patterns. Two aspects of hunting of particular interest to geographers were of primary concern. The first was the role of agricultural lands as a source of game. In particular, I wanted to compare the type and quantity of game caught in garden and fallow areas and in mature rain forest habitat. Another aspect of the research centered on the spatial patterns of game extraction in relation to settlement patterns. I believed that much could be learned about the relationships between indigenous communities and wildlife populations by mapping the locations where different game species are caught. Another broad goal of this study has been to help explain how indigenous peoples adapt to the rain forest environment while demonstrating that they are not passive foragers independent of their cultural background, but knowledgeable resource managers with the skills to participate in new conservation initiatives. As such, the research adopted an approach that is becoming much more widespread in the social sciences: the use of participatory research methodologies that help promote the role of local people active researchers, rather than simply the objects of scientific investigation.

The two primary hypotheses of the research are as follows:

Hypothesis 1. The agricultural landscapes created through shifting cultivation have significant impacts on wildlife foraging patterns, and in turn, hunting yields. Depending on diet preferences, reproductive rates, and other characteristics, certain game species are caught more frequently in anthropogenic habitat, while others are captured primarily or exclusively in mature forest.

Hypothesis 2. Certain game species are more vulnerable to hunting pressure than others, which will be reflected in the distribution of game kill sites. While some game species are caught frequently in areas relatively close to indigenous villages, other less resilient species will be caught primarily on the peripheries of subsistence lands, which will be evident in an absence of kill sites near human settlement.

Three specific, interrelated objectives were chosen to test these two hypotheses and to satisfy the broader aims of the research. These specific objectives are as follows:

- To document the hunting techniques and strategies employed by the Buglé through participant observation and interviews.
- To document the type and quantity of game caught in both mature forest and agricultural areas through weekly household questionnaires administered by trained local investigators.
- To map the distribution of game kill sites through a participatory research process in order to evaluate the spatial relationships between hunting, habitat, and human settlement.
- To identify which, if any, game species are being hunted at unsustainable rates within the study area.

1.5 Theoretical context of the study

This study falls within the field of cultural ecology, which focuses on the dynamic interplay between society and nature. Cultural ecologists struggle to understand human adaptation to their environment, as well as how they alter their environment across space and over time. It is a particularly useful approach to understanding wildlife use because hunting, which represents just one component of the overall subsistence strategies of swidden horticulturists, is conditioned by a wide range of both cultural and environmental variables. The study also represents a continuation of a lengthy tradition of ethnogeographic research among Latin Americanist cultural geographers focusing on specific ethnic groups and cultural regions.

1.6 Structure of the dissertation

Following this introduction, Chapter 2 describes the theoretical context of this study and reviews past research on hunting in the neotropics. Chapter 3 provides a brief description of the study area and the Buglé people, followed by a description of the research methodology in Chapter 4. The next chapter provides an overview of the contemporary way of life in the Caloveborita region. Chapter 6 describes hunting among the Buglé in detail, and presents the quantitative results on hunting yields in relations to various variables. The next chapter focuses on the spatial distribution of game extraction in relation to settlement patterns. The significance of the research results are discussed in Chapter 8, followed by a summary of the research findings and some concluding remarks in Chapter 9.

The story that emerges from the ethnographic and quantitative results, combined with the spatial analysis, is of a profound, ecological relationship between the Buglé and neotropical wildlife populations. The connections are much more complex than a simple predator-prey relationship. Many game species appear to benefit from the presence of humans through the creation of anthropogenic habitats, and appear to be able to coexist with people indefinitely even where they are hunted. Each species, however, is affected differently. On the other hand, game species not only make an important contribution to the

Buglé diet, but are also integral to their way of life and world view. This dissertation presents a different case study of indigenous hunting from a geographic point of view, with an emphasis on the mutual interactions between people and wildlife, a dynamic interplay that has existed in rain forest environments for centuries.

2. Theoretical Context and Past Research on Indigenous Hunting in the Neotropics

Much has been written in the last century about the relationships between people and the environment in humid tropical settings. Early discussions of indigenous resource use based on deterministic theories and limited field research gradually gave way to new perspectives focusing on cultural adaptation to the rain forest environment. The detailed ethnographic and quantitative field studies on indigenous agriculture, forest use, and ethnobiological knowledge that followed broadened our understanding of indigenous culture and economy considerably. These investigations led to an appreciation of the sophistication of indigenous resource management and the complexity of the relationship between nature and culture in neotropical rain forest regions. More recently, growing concern for the relationships between indigenous peoples and the conservation of biodiversity in the neotropics has fueled a proliferation of research on the impacts of indigenous hunters on wildlife populations.

This chapter describes the theoretical context of this dissertation and reviews current understandings of indigenous hunting in the neotropics. First, the field of cultural ecology is reviewed, followed by a general description of what is presently known about indigenous hunting in rain forest environments. Subsequent sections discuss issues that are especially pertinent to this study, including game depletion and the importance of agricultural lands as a source of game. I then review recent research that focuses on measuring the sustainability of indigenous hunting, and highlight the importance of understanding the spatial patterns of game extraction when evaluating impacts on game populations.

2.1 Cultural ecology

This dissertation addresses a theme that has been prominent in the discipline of geography since its beginnings: the relationships between people and the environment. In the early part of the twentieth century, environmental determinism was widely accepted, a perspective that considers human societies to be largely the product of different environmental conditions. This perspective has its roots in the work of Friedrich Ratzel who discussed the importance of habitat and territoriality in the development of cultural diversity in the late 1800s (Johnston 1997:42; Moran 2000:31; Norton 2001:35-36). It was also embraced by the first generation of geographers in the United States, who were eager to apply their training in geology and other physical sciences to the study of human society (Mikesell 1974:2). Environmental determinism was especially evident in the subsequent work of geographers Emerson (1908-1909), Huntington (1915), and Semple (1931) who emphasized the role of climate and geomorphology in shaping human society and history, although all three did qualify their statements and allow for the influence of other variables (Lewthwaite 1966:10). In a similar fashion, the leading founders of modern anthropology postulated that the cultures of the world could be located along a single evolutionary scale, from primitive to civilized (Morgan 1877; Tylor 1871), a perspective that had lasting influence well into the twentieth century. It was widely held that egalitarian societies depending on hunting, gathering, and subsistence agriculture would gradually develop hierarchies, surplus production for trade, and the arts as they progressed along this unilinear evolutionary path (Langness 1982:12-14).

Deterministic models explaining cultural differences were sharply criticized by the next generation of leading scholars in anthropology and geography. In anthropology, Franz Boas gave impetus to historical possibilism, an approach that emphasizes that diffusion, history and culture itself have more important roles in the development of distinct societies, rather than environmental constraints or predetermined evolutionary paths (Boas 1940:251-258; Langness 1982:49-50; Moran 2000:39). Robert Lowie, in *Culture and Ethnology* (1917), pointed out that Native American peoples in similar environments had striking cultural differences; natural resources, he stated, are not used in the same way by different groups, because they are culturally defined (Moran 2000:41). The environment, however, was not rejected completely in anthropology as a variable influencing cultural patterns. For example, Wissler (1926) and Kroeber (1953) – by no means environmental determinists – recognized the importance of natural environments in shaping indigenous societies. In geography, Harlan Barrows (1923:3) also reacted against environmental determinism, defining geography as "human ecology," whose purpose is to understand the mutual relationships between natural environments and the distribution and activities of people. At the same time, Carl Sauer began to exert a tremendous influence on how geographers looked at the relationships between people and the environment. Sauer and his students highlighted the impress of human activity on natural landscapes over long periods of time. He recognized the dynamic and mutual interaction of nature and society, stating that geographers are interested in the earth's surface because "we are part of it, live with it, are limited by it, and modify it" (Sauer 1963:325-326). Human agency as a force altering natural systems and landscapes came to the fore with the publication of *Man's Role in Changing the Face of the Earth* (Thomas 1956).

Sauer (1963:343) stated that "within the wide limits of the physical environment of area lie many possible choices for man... this is the meaning of adaptation." This concept, borrowed from ecology, guided anthropologists and geographers who together developed the field of cultural ecology, which was defined explicitly for the first time by anthropologist Julian Steward. Steward was influenced by the work of geographer Daryll Forde (1934) who advocated empirical studies of habitat, subsistence, and economy among indigenous peoples around the world (Butzer 1989:197). Steward's interest focused on the "*cultural core* – the constellation of features which are most closely related to subsistence activities and economic arrangements" (Steward 1955:37). He postulated that cultural adaptation to available resources to meet subsistence needs, while flexible to some degree and conditioned by technology, has pervasive influences on a wide variety of cultural patterns – in particular social organization (Steward 1955:39-41).

In the early 1960s, Wagner and Mikesell (1962) recognized cultural ecology as one of the four primary themes in cultural geography. In contrast to early deterministic models, cultural ecology, or "the study of the role of culture as a dynamic component of any ecosystem of which man is a part" (Frake 1962:53), looks not only at how people adapt to their environment, but also how they use their knowledge and tools to reshape their relationship with their natural surroundings. Geographers tend to place more emphasis on land use and spatial patterns, defining cultural ecology as the study of "the interrelationships between people, resources, and space" (Butzer 1989:192). This dissertation follows in the tradition of cultural ecology in that it looks at the relationships between indigenous peoples and their natural surroundings, and how subsistence practices in a rain forest environment are conditioned by a wide variety of both cultural and ecological variables.

Soon after the development of cultural ecology, geographers and anthropologists began to incorporate the concept of adaptation into research on human-environment relationships, and broadened its scope to include political, historical, religious, and other cultural variables. Barth (1956), for example, borrowed the niche concept from ecology to describe the interdependence of farmers and pastoralists in Pakistan. Geertz (1963:3) contrasted intensive rice farming and shifting cultivation in Indonesia to better understand "the relations between selected human activities, biological transactions, and physical processes by including them within a single analytic system, an *ecosystem.*" Rappaport (1968) demonstrated the importance of ritual in mediating relationships between culture and resource use among Tsembaga agriculuralists in Papua New Guinea. Denevan (1966, 1970) used the cultural ecological approach to help reconstruct pre-contact indigenous settlement in the Amazon basin and applied the ecological concept of carrying capacity to explain precolumbian forms of intensive agriculture in South America.

These early studies helped catalyze a growing body of empirical field investigation that included research on the subsistence practices of indigenous peoples and other groups in rain forest regions to help understand how people adapt to and modify their natural surroundings (Bennett et al. 1974; Carneiro 1957; Conklin 1954; Denevan 1971; Gordon 1982; Harris 1971; Hiraoka 1989a; Meggers 1974; Nietschmann 1973; Ruddle 1974; Smole 1976; Turner 1974). Ecological concepts have been prominent in this work. A common theme in these studies is the depth of indigenous ecological folk knowledge and the sophistication and adaptive qualities of indigenous land use practices (Alcorn 1989; Carneiro 1983:78-79; Clay 1988; Posey 1985). Shifting cultivation is the most common agricultural system in the humid neotropics, and became a focus of research. It was discovered that indigenous agriculture varied considerably in relation to cultural and environmental conditions. For example, research demonstrated that the combination of crops, distribution of fields, and the length of the fallow period vary depending on population density, climate, soil, cultural preferences, and the personal histories and goals of individual farmers (Carneiro 1983:65; Orejuela 1992:61-62; Nations and Nigh 1980:9; Nietschmann 1973:134; Smole 1989:116, 119, 126). Several studies documented the management of fallow fields so that they contain an abundance of plants that are useful to their caretakers (Anderson 1990:70-81; Balée 1995:106; Denevan and Treacy 1987:45; Gordon 1982:81-88; Medellín-Morales 1990; Posey 1984, 1985). Another prevalent topic of discussion that emerged from these and other studies is how indigenous groups in the humid neotropics have influenced the structure, floristic composition, and ecological dynamics of rain forests and other ecosystems through transplanting, burning, deliberate seed dispersal, and selective weeding, thereby blurring the division between natural and cultural environments (Alcorn 1981:413; Balée 1989; Eduards 1986; Gomez-Pompa, Flores, and Sosa 1987; Gómez-Pompa and Kaus 1992; Gordon 1982; Medellín-Morales 1990:21; Melnyk and Bell 2000:471; Posey 1985:141; Smole 1989:126-127). As it became increasingly clear that indigenous peoples and other groups in remote parts of the world were not isolated from exogenous influences, and that unequal power relations influence their use of their natural surroundings, the field of political ecology emerged within geography. Political ecology seeks to "understand the political sources, conditions, and ramifications of environmental change" and its practitioners have investigated such things as the political economy of soil erosion, the impact of government trade policy on small farmer production, and the social forces behind peasant deforestation (Blaikie 1985; Bryant 1992:13; Grossman 1993; Schmink and Wood 1987). The field of political ecology is still defining itself, but already this approach has provided valuable insights into how indigenous peoples negotiate their rights to use and manage resources within the context of growing international concern for the conservation of biodiversity (Escobar 1998).

While the research presented here is a study in cultural ecology, it also represents a continuation of a tradition among geographers interested in specific peoples or cultural regions (both past and present), mainly – but not exclusively – in Latin America. This field might best be called "ethnogeography," which focuses on the relationships between ethnic groups to their physical surroundings, with a frequent emphasis on mapping and local environmental knowledge (Mathewson 1993:129 West 1998:67). The term still awaits a definitive statement. Scholars involved in ethnogeographic research share an interdisciplinary approach and pay attention to common themes such as historical processes, ethnic distributions, subsistence activities, and cultural landscapes (Bennett 1962; Brand and Sauer 1931; Davidson 1982, 1987; Herlihy 1986a; Hiraoka 1989b; Kniffen 1939; Lovell 1985; Wagner 1958; West 1948, 1957, 1993). This tradition continues to be vibrant, which is evident in vehicles such as the *Geoscience and Man Publications* series published at Louisiana State University and the *Journal of Latin American Geography.*

2.2 Early writings on indigenous hunting

Early research and writing by geographers and other scholars on the relationships between people and wildlife include Gilmore's (1950) ethnozoological survey of South America, Bennett's (1959) comparative study of hunting in Panama, and Leopold's (1959) book on the game species of Mexico. Most of the early research and writing on wildlife use among indigenous peoples, however has been done by anthropologists who focused primarily on hunting and gathering societies, with less attention to hunting that takes place among agriculturalists. In 1965, anthropologists gathered during a symposium to examine and discuss research on the world's remaining hunting peoples, resulting in *Man the Hunter* (Lee and DeVore 1968). This volume provided a new perspective of hunting societies as stable and ecologically sound, as opposed to primitive and precarious. Lathrap (1968:25, 29), however, suggested that the indigenous peoples of the elevated interfluves of the Amazon basin were "degraded" descendants of riverine peoples who practiced intensive agriculture before the consequences of contact with Europeans.

In the period that followed these important works, researchers began to engage in empirical studies of hunting among indigenous peoples of the humid neotropics, guided primarily by the perspective of cultural ecology. The concept of adaptation was very prominent in their approach. One of the primary debates that emerged centered on the "protein hypothesis," the notion that population densities in the Amazon basin were kept in check by the scarcity of protein-rich foods. Game was seen to be the main limiting factor determining the carrying capacity of the environment, due to the limited use of domestic animals, limited fishing opportunities, and dependence on starchy crops. Researchers theorized that settlement fission and relocation, infanticide, patterns in the division of labor, and access to female sexual partners in indigenous societies were related to protein scarcity (Carneiro 1970:331; Gross 1975:535, 1983; Nietschmann 1980; Siskind 1973:95-96. cf. Chagnon and Hames 1979; Spath 1981; Vickers 1975). Holmberg (1969:67) suggested that dependence on hunting has been a deterrent to the development of permanent, intensive agriculture due to the necessity of relocating villages every time game in a local area becomes scarce. It was even postulated that warfare between Amazonian peoples developed in order to establish intervening, unoccupied hinterlands that serve as game preserves that maintain the productivity of hunting and ensure the long term survival of these groups (Harris 1979:91; Ross 1978:7).[1]

Other ethnographic studies placed more emphasis on the role of unique cultural beliefs associated with food taboos and ritual needs in shaping hunting practices, while retaining the concept of adaptation remained a guiding principle. Ross' (1978) influential work addressed the apparent paradox of why indigenous peoples in the Amazon would have taboos preventing them from consuming game animals when protein is in such limited supply. He hypothesized that large game is tabooed where human population density is high, favoring the use of more dependable small game species, in order to help ensure that they would be available over the long term. Amid calls for more rigorous studies, a number of field researchers began collecting more quantitative data on game harvest rates to better understand the complex interplay between indigenous adaptation and cultural institutions in the humid neotropics. As ethnographic and quantitative information accumulated, it became clear that hunting patterns and harvest rates are conditioned by a wide variety of both cultural and environmental variables. The efficiency of different hunting technologies, caloric returns on hunting effort, optimal foraging theory, time-allocation studies, and the productivity of different types of habitat were some of the more prominent themes in these studies (Balée 1985; Bergman 1980; Hames 1980; Hames and Vickers 1983). It was argued that hunters adapt to available faunal resources by maximizing their returns through technological choice, by focusing on the most productive habitats and prey items during different seasons, and by shifting their activities away from hunting in response to declining yields (Beckerman 1983; Hames 1979; Nietschmann 1972; Stocks 1983). Although many of these scholars did look at cultural variables, many were attracted by optimal foraging theory and some tended to evaluate the resource use strategies of indigenous peoples as if they were passive foragers independent of their tradition, heritage, and knowledge (Beckerman 1980, 1983; Stocks 1983; Werner et al. 1979; Yost and Kelley 1983). Other studies addressed this deficiency by evaluating indigenous ethnozoological knowledge and looking at how indigenous peoples deliberately manage their lands to increase hunting productivity. At the same time, tropical ecologists unveiled the myth that tropical rain forests are uniform, demonstrating that indigenous peoples are faced with biotic environments that are highly variable across space and over time (see Janzen 1983; Leigh, Rand, and Windsor 1982; and references therein). More recently, growing concern about the impacts of indigenous communities on wildlife populations has led to a spate of research focused on measuring the sustainability of hunting in rain forest environments (Alvard et al. 1997; Robinson and Bennett 2000).

Although a great number of informative studies on indigenous hunting in the humid neotropics has accumulated, there remains much to learn about how indigenous peoples use and manage game species, and the impacts of their subsistence activities on wildlife populations. Hunting, although very important in the culture and economy of indigenous peoples, is extremely variable according to unique cultural beliefs, differences in faunal composition, the role of hunting within a diversity of economic strategies, and varying degrees of external influence due to the penetration of market economies, government policy, and international conservation initiatives. Evaluating the sustainability of hunting is likewise a complex and difficult task. The population density of different game species and the ecological interactions between people, plants, and animals all vary from place to place. One of the objectives of this thesis is to provide new insights into these dynamics through a case study of indigenous hunting in the rain forest setting. However, in addition to investigating the hunting strategies and technologies used, and the type and quantity of game caught, this study also examines two underappreciated aspects of hunting that are critical for understanding the relationships between indigenous peoples and wildlife: (1) the role of agricultural lands as a source of game and (2) the spatial patterns of game extraction in relation to human settlement.

2.3 *Indigenous hunting in the humid neotropics*

This section describes our current understanding of indigenous hunting in neotropical rain forest regions. Although reliance upon game among indigenous groups is virtually ubiquitous, hunting patterns vary considerably in relation to numerous interdependent factors (Table 2.1). The harvest rates of game animals are conditioned by cultural variables like human population density and settlement (Gross 1975), technology (Hames 1979; Yost and Kelley 1983), proximity to markets (Godoy, Brokaw, and Wilkie 1995; Nietschmann 1972:62-63), cultural preferences and proscriptions, and the seasonal scheduling of other subsistence activities (Bergman 1980:135; Grenand 1992:37). Harvest rates are also mediated by the role of hunting within broader economic strategies. The type and quantity of game is also conditioned by ecological variables like the behavior, distribution, fecundity, and seasonal availability of different animal species (Bodmer 1995; Nietschmann 1972:41).

2.3.1 Overview of indigenous hunting

Broadly defined, hunting encompasses "the process and strategy employed by a human population to locate, acquire, and use the animal resources in its ecosystem" (Sponsel 1981:63). Wild meat makes a very significant contribution to the diet of indigenous peoples, who tend to rely heavily on starchy root crops and grains. For example, hunting provides roughly 60 percent of all protein in the diet of the Siona-Sicoya in northeastern Ecuador (Vickers 1980:18), 70 percent for the Ye'kwana of southern Venezuela, and 80 percent for neighboring Yanomamö (Hames 1980:35). Forest animals are also prominent in indigenous cosmologies, which is mirrored in the arts, legends,

Table 2.1. Cultural and ecological variables that condition the type and quantity of game caught by indigenous hunters.

Cultural	Ecological
Settlement patterns and human population density	Faunal species composition
Role of hunting within the overall subsistence system (alternative protein sources, seasonal scheduling)	Abundance and distribution of game species
Hunting technologies	Distribution of different habitats
Food taboos and other cultural prohibitions	Animal behavior (activity patterns, diet, calls, wariness, response to humans)
Game preferences	Detectability of different game species
Proximity to markets	

calendars, and rituals of rain forest peoples (Benson 1997; Carneiro 1970:338-340; Jackson 1983:48-49; Johnson 1989:215-216; Reichel-Dolmatoff 1971; Reina and Kensinger 1991; Ribeiro and Kenhíri 1989:99; Siskind 1973; Smole 1976:180-181). Several indigenous belief systems view forest animals as persons within their own societies who are related to humans in reciprocal relationships that govern the use of game (Århem 1996; Descola 1994; Reichel-Dolmatoff 1996; Rival 1996). Food taboos and ritual needs that condition hunting activity are widespread. Cultural proscriptions may be enforced universally, seasonally, in specific areas, or by gender (Balée 1985:499, 501, 504; Basso 1973:39; Hames 1979:239; Jackson 1983:47; McDonald 1977; Nietschmann 1972:54; Peres 1990:54; Reichel-Dolmatoff 1971:66; Ross 1978; Siskind 1973:89-90; Smole 1976:181; Vickers 1991:71), but may be ignored when they apply to large game animals or dissipate through contact with missionaries and other outsiders (Johnson 1989:217; Stearman 1995:212; Vickers 1991:66).

Hunting is practiced primarily by men, but women and children are sometimes involved, especially in the harvest of smaller animals, opportunistic hunting, or as participants in large hunting groups (Gordon 1982:115; Herlihy 1986a:130; Mena et al. 2000:64; Romanoff 1983; Smole 1976:175; Stearman 1995:211-212; Vickers 1991:70; Yost and Kelley 1983:205). Hunters pursue prey by themselves or groups of varying size depending on personal preferences, cultural traditions, or the type of prey that is sought (Beckerman 1980:95-96; Goldman 1979:57; Jackson 1983:46; Smole 1976:176). Sometimes the hunt is directed towards a specific species, and the expedition proceeds to an area where that animal is expected to be found, but general searchers are also common (Alvard 1995:791-792; Carneiro 1970:334; Holmberg 1969:51). The white-lippped peccary (*Dicoteles pecari*) is a unique game species in that it travels in large, migratory herds and many individuals can be captured in a single encounter. Usually, when someone discovers a herd, he or she will report back to the village and a large hunting party will formed immediately to pursue them (Holmberg 1969:56; Yost and Kelley 1983:205).

Hunting strategies include stalking game in the forest, locating burrows, moving along the banks of rivers in canoes, or waiting at fruiting trees, salt licks, or other spots known to attract animals (Carneiro 1970:336; Goldman 1979:57; Herlihy 1986a:134; Smith 1976:456-458; Ventocilla 1992:104-108; Vickers 1991:69, 71). In some areas, hunters prefer to move along rivers in gallery forest, while in other areas hunting is more common in the deep forest in interfluvial areas or along trails following ridges (Balée 1985:485; Hames 1979:231, 1980; Yost and Kelley 1983:204). Among some indigenous groups, individuals tend to limit hunting trips to a day or less in order to avoid sleeping away from home (Balée 1985:500). Among others, periodic expeditions of two or more days in the vicinity of distant agroforestry plots or to forest areas of higher game abundance are common (Mena et al. 2000:63; Nietschmann 1972:58; Vickers 1983:457), and in some cases, much longer expeditions also occur (Werner 1983:225-226).

Indigenous hunters in the humid neotropics rely on technologies made from locally available forest products, including bows, arrows, blowguns, lances, slingshots, and poisons (Carneiro 1970:333, 336; Gordon 1982:115; Jackson 1983:46; Moran 1982:258; Stearman 1995:230). The use of dogs is also widespread (Carneiro 1970:336; Goldman 1979:57; Herlihy 1986a:130; Jackson 1983:47; Smole 1976:179-180; Vickers 1991:69; Yost and Kelley 1983:205). Animal traps are also used, including box traps, rock fall traps, and snares (Gordon 1982:115; Rydén 1950; Smith 1976:458). Introduced technologies include flashlights for night hunting (Gordon 1982:102; Nietschmann 1973:162) and firearms, although the use of rifles or shotguns can be significantly limited due to the scarcity or expense of ammunition (Beckerman 1980:93; Hames 1979:224, 247; Mittermeier 1991:102; Stearman 1995:214, 230). New opportunities to earn wages can contribute to a dramatic increase in the use of firearms (Mena et al. 2000:59-60). Despite their economic costs and the fact that reports from firearms will cause animals in the forest to scatter, guns tend to quickly replace the bow and arrow, blowgun, and other traditional technologies as the preferred weapon because of its range, projectile speed, and higher overall hunting efficiency (Hames 1979:238, 245; Herlihy 1986a:131; Yost and Kelly 1983:191, 223). The adoption of firearms can also lead hunters to begin hunting animals that were previously difficult to obtain (Mena et al. 2000:58). However, firearms may not be used for small animals that do not provide a sufficient amount of meat in relation to the cost of ammunition (Alvard 1995:794). The expense of firearms as the weapon of choice may induce people to specialize, investing in either a rifle or fishing equipment to provide for their family (Nietschmann 1972:56). However, various weapons may be employed during a single hunting expedition, and used for different species located at different levels of the forest structure (Herlihy 1986a:131; Yost and Kelley 1983:210-211). The introduction of canoes and outboard motors can open up new hunting areas previously out of reach (Hames 1979:231; Stearman 1995:215).

Mammal species are by far the most important game species in the humid neotropics, followed by birds and then reptiles (Vickers 1984:370). The type and quantity of game caught varies considerably from place to place, it is not uncommon that hunters focus on a few preferred species, although a wide variety of animals may be considered edible (Nietschmann 1972:54-55). Research comparing hunting yields between nearby settlements has revealed that the type and quantity of game caught can vary dramatically even between neighboring communities due to differences in habitat, prey availability, and ethnic composition (Escamilla et al. 2000:1597-1598).

2.3.2 Hunting within the overall subsistence strategy

Although indigenous families in neotropical rain forest regions depend on game for much of their protein intake, the bulk of their food comes from agriculture. As such, the amount of time people spend hunting is sensitive to agricultural labor requirements (Carneiro 1970:334; Hames 1980:47, 53). This, combined with seasonal fluctuations in the availability of game species, can result in a marked variability in the quantity and composition of game harvested over the year (Beckerman 1980:105; Grenand 1992:36-38; Vickers 1991; Yost and Kelley 1983:217-219). For example, short morning or evening hunts by the Ye'kwana and Yanomamö close to the village occur most frequently when labor is needed for other activities like clearing vegetation for garden plots (Hames 1980:47). At other times, longer trips farther from the village are more common (Hames 1980:47, 53). The same is true for the Wayapi in French Guiana, who harvest most of their game from nearby secondary forests when much time is devoted to preparing new gardens (Grenand 1992:37). During other periods, game is not caught in these areas because people turn instead to productive fishing opportunities (Grenand 1992:37-38).

Productive fishing opportunities may reduce reliance upon game and tend to be more important near coasts or during specific seasons (Berlin and Berlin 1983:318; Stearman 1995:215). During the dry months in northern Bolivia, as inundated savanna lakes begin to evaporate, fish become concentrated and provide the Sirionó with over half of their animal protein intake (Stearman 1992:114). Among the Shipibo in the Peruvian Amazon, game yields are high from January to March when water levels are at their highest and animals are concentrated on a reduced amount of dry land, but outside of this season hunting is almost completely abandoned in favor of productive fishing opportunities (Bergman 1980:135).[2] Among the coastal Miskito of eastern Nicaragua, game harvests increase during the rainy season when green turtle fishing opportunities decrease and terrestrial game become concentrated in non-flooded areas (Nietschmann 1972:51).

Other seasonal factors condition game harvest rates as well. The Yanomamö tend to prefer hunting in the drier months when it is easier to travel through the forest (Hames

1980:53). In other areas, the rainy season is preferred due to a greater prevalence of identifiable animal tracks (Siskind 1973:90). Yanomami in the interfluvial areas of their homeland make long expeditions or "treks" away from their gardens, primarily in response to the depletion of crops at their homesites, during which time the amount of game harvested almost doubles (Good 1995:115-116). The Mekranoti of Central Brazil likewise spend more than three times as much time hunting while on treks away from the village during the dry season (Werner 1983:227, 232-233).

Hunting, however, is complementary to many subsistence activities. Gathering may occur during hunting trips, and vice versa – the two activities are often intertwined (Smole 1976:182; Stearman 1995:211-212). Fishing and hunting may also overlap (Chicchón 1995:235; Mathewson 1984:98). If game animals are occasionally encountered on the way to gardens, hunting weapons may be carried to these sites (Baksh 1995:197). Reliance upon game is also conditioned by the importance of domestic animals (Berlin and Berlin 1983:318; Herlihy 1986a:130). For example, when the Emberá and Wounaan of eastern Panama were forced to abandon pig husbandry due to restrictions designed to prevent the northward spread of hoof-and-mouth disease from South America, they were forced to rely more heavily on forest animals for fresh meat, which contributed to dramatic increase in hunting activity in the area (Herlihy 1986b:60).

Indigenous and other rural peoples throughout the humid neotropics have cash needs that they meet in a wide variety of ways, sometimes through the sale of bushmeat, animal skins and pelts, and pets from the wild (Bodmer et al. 1994:32-33; Peres 1990:57; Redford 1992:414-417; Stearman and Redford 1992). The economic strategies of indigenous peoples have in some cases shifted towards greater involvement in cash economies and regional, national, and even international markets. This can result in intensified hunting pressure on species that have higher market value (Nietschmann 1972:62-63). The commercialization of game also disrupts traditional kin-based reciprocal exchange systems, leaving some families outside of meat distribution networks (Nietschmann 1972:65-66). Market economies can also affect hunting patterns indirectly. For example, the entry of rubber tappers into previously uninhabited regions of the Amazon resulted in the decimation of vulnerable woolley monkeys (Peres 1991:93). In recent times, Miskito villagers in Honduras went to remote, mountainous rain forest areas for several weeks at a time to pan for gold as a means of obtaining cash, relying heavily on hunting for food while on these trips (D. Smith, unpublished field notes).

2.3.3 Ethnozoology and indigenous wildlife management

Much of the discussion revolving around the relationships between indigenous peoples and biodiversity is based on synchronic, quantitative studies that have been done by researchers who seem to view hunters are passive foragers when in fact they are resource managers. Indigenous peoples have intimate knowledge of animal behavior, diet, and distributions in the forests that surround their communities. Detailed knowledge is promoted by three primary factors: (i) management of the local environment occurs on a daily basis, (ii) information is shared between community members and passed down to children, and (iii) the knowledge is necessary for effective exploitation of natural resources (Sponsel 1981:53).

The study of local ecological folk knowledge is called ethnoecology, which in its early stages focused primarily on the documentation of indigenous taxonomic systems (Berlin and Berlin 1983; Fowler 1977:218-219; Hardesty 1977:290; Sponsel 1981:50). However, the breadth of indigenous ethnozoological knowledge is reflected not only in detailed folk taxonomies, but also in the ability of hunters to mimic animal sounds, and recognize calls, scents, tracks, excrement, and their knowledge of nesting habits, breeding behavior, habitat preferences of different animals species (Baksh 1995:191; Berlin and Berlin 1983:306; Berlin, Boster, and O'Neill 1981; Carneiro 1970:335; Holmberg 1969:51-62; Smole 1976:175; Yost and Kelley 1983:194-195). This knowledge has great practical value. For example, when in the forest Yuquí hunters survey the status of resources for future use, have a knowledge of fruiting phenologies, animal feeding habits, and have "an almost uncanny ability to cognitively mark resources for later use" (Stearman 1995:211-212). Machiguenga hunters use many senses to detect the presence of game, including smell (Johnson 1989:216). "By age four children generally accompany their parents on foraging treks and are thus exposed during their impressionable years to most of the micro-environments they will encounter as adults" (Johnson 1989:217). It should not, however, be assumed that indigenous peoples have a complete understanding of the myriad complexities of rain forest ecology. They may rely on encultured "scripts": resource management practices based on routine steps and cues from the environment that are passed on from generation to generation (Alcorn 1989:65-67).

In tropical humid neotropical environments, the distribution of different soils, water regimes, tree-fall gap successional stages, areas disturbed by humans, and the non-synchronous phenologies of different plant species produce an ecological landscape that is far from homogenous. The distribution and abundance of mammal species is tied to the resulting irregular distribution of available resources (Eisenberg and Thorington 1973:152). The geographic distributions of game species also vary over the year, in part because of the seasonal variation in leaf growth, fruiting, and flowering of different tree species in response to biotic and abiotic factors (van Shaik et al. 1993:367). Primary consumers respond to fluctuations in the availability of foraging resources in a variety of ways, including dietary switching, seasonal breeding, change in the use of ranges, and migration (Peres 1994:104-108; van Shaik et al. 1993: 353). Consequently, some game species are fairly evenly distributed in the forest, with individual territories (for example most terrestrial mammals), while others move across large areas in search of food (Moran 1982:257).

For hunters, the varied distribution of vegetation results in special, resource-rich patches used by animals. These include tree fall gaps that provide abundant, palatable herbaceous growth that attracts certain game species (Foster 1980: 83; Stearman 1995:210-211). Indigenous peoples in fact, recognize a great variety of different biotopes – "the smallest natural area or space characterized by a particular environment" (Cain 1966: 47) – within their homelands. Different animals are associated with different biotopes, and hunters direct their efforts according to these cognitive habitat classifications (Frake 1962:55; Nietschmann 1972:57). The Kayapó recognize over 20 distinct ecological zones (Posey 1985:140-141). Another forest people in northeastern Brazil, the Ka'apor, classify vegetation into six major categories, four of which sustain hunting as a principle activity (Balée and Gély 1989:131-132). The Siona-Secoya similarly recognize a number of different micro-environments suitable for hunting and other activities (Vickers 1980:15).

Indigenous peoples make use of their knowledge of animal ecology to enhance opportunities to acquire game, through direct or indirect forms of wildlife management. One common strategy involves the manipulation of plant composition in agricultural fallows, as well as in mature forest. Forests on the floodplain of the Amazon estuary that are adjacent to garden areas, for example, are managed by rural *caboclos* to increase the number of trees that attract game (Anderson 1991:354-358). The Kayapó of the Brazilian Amazon plant trees along trails or near campsites to create "forest fields" used as hunting grounds (Posey 1984:117). The Kuna protect one of the main tree species that provides green iguanas with leaves, helping to ensure a permanent supply of these animals (Ventocilla, Herrera, and Núñez 1995:49). Fallow fields are likewise deliberately managed to attract game. In young Ka'apor fallows, almost half of the trees found are described locally as "game food" species, many of which are planted (Balée and Gély 1989:134-137). The managed fallows of the Lacondon in southern Mexico have been described as "managed wildlife areas" that are preferred grazing areas for certain game species (Nations and Nigh 1980:15).

Another form of wildlife management involving the rotation of hunting zones was documented by Hames (1980:55). He found that Ye'kwana and Yanomamö hunters abandon areas where game is depletion so that wildlife populations are replenished over time, in a manner analogous to shifting cultivation. With longer "fallows," hunting zones become more productive (Hames 1980:57).

2.3.4 Garden hunting

A wide variety of game animals are attracted to the foraging opportunities found in agricultural fields and fallows, whether they are deliberately managed for this purpose or not. Some of the common visitors including tapirs, collared peccaries, sloths, agoutis, squirrels, pacas, rabbits, and many birds (Balée 1985:499; Balée and Gély 1989:137-138; Berlin and Berlin 1983:316; Borge and Castillo 1997:86; Dufour 1990:656; Gordon 1982:99-103; Hames 1980:38; Posey 1984:116; Smole 1989:123). Indeed, in indigenous folk taxominies, similar animals are sometimes distinguished by naming them according to whether they are seen more frequently in secondary or primary forest. Animal raids on garden crops can be very destructive, and farmers may overplant to compensate for these losses (Balée and Gély 1989:139; Carneiro 1983:83; Dufour 1990:656). Alternatively, farmers may plant crops in special areas exclusively to attract game (Nations and Nigh 1980:13; Herlihy, personal communication). Some farmers disperse their fields within nearby forest to create so-called "game farms" near their settlements (Posey 1985:147-148).

Given that many game species forage in gardens and fallows, and that fallows are often deliberately managed to attract game, it is not surprising that indigenous hunting in gardens and fallows is reported frequently (Balée 1985:495; Carneiro 1970:336; Gordon 1982:101-107; Hames 1980:52-53; Herlihy 1986a:226-227; Medellín-Morales 1990:8; Naughton-Treves 2002; Nietschmann 1973:161; Posey 1985:148; Ross 1978; Ruddle 1974:111; Smole 1976:182; Vickers 1991:69). Moreover, archaeological research in western Panama provides evidence that garden hunting has been an important element of indigenous subsistence for centuries (Linares 1976). From the few quantitative studies of hunting in anthropogenic habitat that have been undertaken, it is evident that agricultural lands contribute a disproportionate amount of game relative to the total hunting area. Roughly one quarter of all game brought home by the Ka'apor is captured in garden areas (Balée and Gély 1989:137). A study in a Wayapi village shows that while secondary forests account for less than 4 per cent of their total hunting area, they provide 27 per cent of the total mammal and bird harvest (Grenand 1992:38).

Chicchón (1995:232-241) demonstrates the variability in time spent hunting and the types of animals captured in anthropogenic and natural habitats by different Chimane villages in northern Bolivia, and how differences are related to their location. Villages located next to a road and closer to non-indigenous settlement obtained over 40 percent of game from agricultural fields and fallows, relying heavily on rodents, while more remote communities captured more game from undisturbed habitat. The results suggest that game depletion in mature forests leads to increased reliance on smaller animals in secondary growth and gardens.

2.3.5 Game depletion and the sustainability of indigenous hunting

While there remains much to learn about the impacts of indigenous hunting on wildlife populations, it is clear that some degree of game depletion around indigenous communities is common. This is a concern for both endangered species and the rain forest as a whole. Overhunting can result in "empty forests" with potentially dramatic ramifications, including major changes in the floristic composition of a forest though impacts on seed dispersal, seed predation, herbivory, and other ecological processes (Dirzo and Miranda 1991; Janzen 1981; Redford 1992:418-421). Already in Panama alone there are 16 mammals and 16 bird species that are listed as either endangered or vulnerable on the *2000 IUCN Red List of Threatened Species* (Hilton-Taylor 2000). The primary reason for the large decline in wildlife populations is deforestation by non-natives, but indigenous hunting also threatens the survival of some species. Large mammal species are especially vulnerable to hunting pressure because they are usually preferred by hunters and at the same time tend to have lower population densities, as well as smaller litters and longer interbirth intervals (Eisenberg 1980:40; Mena et al. 2000:67; Robinson and Redford 1986:670; Vickers 1980:17). Primate species that form large, widely spaced groups, and the white-lipped peccary which travels in herds, are also at a greater risk because encounters can result in the capture of several individuals (Peres 1990:57).

Localized depletion of certain species has been documented in a variety of settings as indicated by declining yields over time (Baksh 1995:192; Good 1995:114-115; Mittermeier 1991:105). The Yuquí of Bolivia, for example, depleted primates within five kilometers of recently formed villages (Stearman 1995:215). In southwestern Colombia and northeastern Ecuador, Awa hunting has led to the decline of monkeys (*Alouatta palliata, Ateles seniculus*), the spectacled bear (*Tremarctos ornatus*), Baird's tapir (*Tapirus bairdii*) and other mammals (Orejuela 1992:73-74). In the Ecuadorian Amazon, the Siona-Secoya have depleted the great currasow (*Mitu salvini*) locally, and the woolly monkey (*Lagothrix lagotricha*) and trumpeter bird (*Psophia crepitans*) at a larger regional scale, although the majority of game animals seem to be harvested at sustainable rates (Vickers 1991:77). Game depletion in one of their villages during the 1970s was reflected in the need to travel farther to find game; a 50 percent reduction in the efficiency of hunting; a large increase in the frequency of unsuccessful hunting trips; and a 44 percent drop in overall yields (Vickers 1980:15, 17, 21). Hames (1980:48, 54) demonstrates that both hunting efficiency and the amount of game taken by indigenous communities in southern Venezuela generally increased with greater distance from settlements. Game depletion has been shown to be one of the primary reasons for the relocation of indigenous settlements in the past (Herlihy 1986a:134-135, 1986b:59-60; Vickers 1983:471). However, today, in much if not most of the humid neotropics, suitable uninhabited lands are not available.

Researchers have also attempted to measure the impact of hunting on wildlife populations by comparing animal population densities in areas with different degrees of hunting pressure. Peres (1990, 2000a, 2000b) compared the population density of game species at over twenty sites in the Brazilian Amazon that have experienced varying degrees of hunting pressure. Although the total densities of diurnal vertebrates did not significantly differ between the different sites, total biomass was almost two thirds lower at heavily hunted sites compared to unhunted sites, due to a reduced number of large game species (Peres 2000a:246, 248). Some of the species that appear to be most sensitive to hunting pressure include large tinamous and currasows, brocket deer, white-lipped peccaries, tapirs, woolly monkeys, and spider monkeys (Peres 1990, 1991). Another study compared mammal densities in two nearby sites in Costa Rica, showing that species favored by hunters are consistently less abundant where hunting pressure is higher (Carrillo, Wong, and Cuarón 2000). The only commonly hunted game species that did not show significant differences in abundance between sites was the common opossum (*Didelphis marsupialis*), an opportunistic forager with a high reproductive rate (Carrillo, Wong, and Cuarón 2000:1589). Results from transects measuring mammal abundance in infrequently and consistently hunted sites in an area of the Peruvian Amazon inhabited by *ribereños* showed declines in mammal abundance where hunting was more frequent, especially for species with lower rates of natural increase such as tapirs, primates, and carnivores (Bodmer, Eisenberg, and Redford 1997:462, 465). On the other hand, species with higher reproductive rates, such as deer, peccaries, and large rodents, did not seem to be overhunted (Bodmer 1995:874-876). Similar results from a study in Ecuador corroborate the conclusion that hunting pressure causes decreases in the abundance of many game species (Mena et al. 2000:67-69).

Another participatory research project measured the impact of Ache hunting on large vertebrate populations in Paraguay (Hill et al. 1997). Indigenous assistants recorded encounters with game species and signs of human activity along transects in zones classified according to distance to human settlements and degree of hunting frequency. Lower encounter rates indicate that tapirs, brocket deer, armadillos, and capuchin monkeys have been depleted in hunting areas near Ache settlement[3] (Hill et al. 1997:1349-1350). However, for many species there was no significant difference in encounter rates in zones with different levels of hunting activity (Hill et al. 1997:1351).

Another approach to evaluating whether or not a particular game species is being overhunted involves comparing the number of animals captured with an estimate of how many can be removed from the population year after year without causing steady population declines. To do this one needs to document harvest rates, estimate rates of reproduction, and measure the size of the hunting territory. In theory, as long as harvest rates remain below the maximum sustainable harvest, the species in question will be able to persist in the environment. One preliminary study of 14 common neotropical game species provides estimates of maximum sustainable yields based on averages of population density and intrinsic rates of reproductive growth under optimal conditions (Robinson and Redford 1991). In one study of wildlife use of the Piro communities in the Peruvian Amazon, these estimates were compared with game harvest rates to measure the sustainability of hunting, finding that tapirs in particular are being harvested at unsustainable rates (Alvard et al. 1997:979). Yet, the hunting area used was calculated crudely using the average maximum distance hunters travel from their village, resulting in a spherical hunting area with a radius of 10 kilometers.

This approach is also subject to other problems. Importantly, the application of average population density estimates from the scientific literature to a specific study site where hunting occurs introduces a significant potential for erroneous results. The population densities of game species are conditioned by habitat heteogenetity, the abundance of food, predators, and competitors, and there is great variability in a species density from one place to another; estimates are also biased toward measures taken from protected or otherwise pristine sites free of hunting pressure (Peres 2000b:48). A laudable effort at getting better measurements of sustainability is found in a study of Huaorani hunters in the Ecuadorian Amazon in which researchers measured both game harvest rates and animal population densities in two hunting areas (Mena et al. 2000). Three of ten important game species were harvested at rates above the maximum sustainable yield in the frequently hunted area, but only one of these was harvested at rates above natural increase in the adjacent infrequently hunted area, suggesting that on the whole Huarorani hunting is sustainable (Mena et al. 2000:74-75). While the estimates do not take into account the mortality of fatally wounded animals that are not captured, and the measurement of the hunting zone areas are crude, their analysis is one of the best that has been published to date.

An even more sophisticated measure of the sustainability of hunting can be obtained by taking into account the effects of harvest rates on age and sex dependent reproductive and survival rates (see Bodmer et al. 1994). The reproductive value, or reproductive potential, of individuals within a species population is far from uniform. The reproductive value of juveniles and very old individuals is lower due to high mortality rates; among males, reproductive rates are extremely variable, and population increases are more dependent on the number of reproductively active females. The selective removal of juveniles, males, and very old individuals over reproductive females, then, would have a considerably lower impact, but although such studies are scarce, the information that is currently available indicates that this form of wildlife management is not practiced among indigenous hunters. For example, Tirio hunters in Suriname prefer to shoot female monkeys (*Cebus apelia*) as opposed to males (Mittermeier 1991:95). Female primates may be preferred because their infants can be captured alive for use or sale as pets (Peres

2000b:57). Alvard (1995:796-800) found that the Piro do not selectively choose prey according to age or sex to minimize the impacts of hunting. An absence of selective harvesting according to age or sex, however, which is a western model of game management, does not preclude the existence of other forms of indigenous wildlife management or practices or beliefs that promote wildlife conservation.

When a particular game species is depleted near an indigenous settlement, hunters are normally forced to travel farther to encounter it. In ecological terms, this is termed "resource depression" and is associated with the "central place effect." It appears that if the amount of effort going into procuring game is not rewarded with adequate success, indigenous people may reduce the time spent hunting for other activities – the threshold among the Barí is reported to be about ten to twelve hours hunting effort per kilogram of game (Beckerman 1980:104-105). On the other hand, hunting is not simply an economic activity, but a pleasurable or spiritually significant one and does not necessarily conform to the ideals of cost-benefit efficiency and optimal foraging theory (Bergman 1980:210-211; Reichel-Dolmatoff 1996:84-88). The probability of a successful expedition is another important factor: the coastal Miskito seem to prefer turtle fishing over hunting because the percentage of successful trips is about 35 per cent greater (Nietschmann 1972:59).

2.3.6 The geographic perspective

At present there is a large gap in our knowledge of the spatial distribution of forest product extraction, and there have been few attempts to determine the full geographic extent of indigenous hunting lands or "home ranges" (Hames 1983:23; Hiraoka 1992:146; Vickers 1991:57). A significant exception is the documentation of indigenous land use areas in Honduras through participatory research that incorporated over 20 indigenous surveyors (Herlihy and Leake 1997; MOPAWI and MASTA 1993). The work involved mapping resource use locations to show the extent of lands used by 17 multi-community subsistence zones in relation to the distribution of over 150 indigenous and ladino villages. A similar project was undertaken in the Darién province of Panama (Congreso Emberá-Wounaan-Kuna and CEASPA 1995; Herlihy 2003). These projects have substantiated the vast extent of indigenous forest use areas, and demonstrate how indigenous subsistence zones overlap, demonstrating that to fully understand hunting patterns, regional analysis is essential. At present, however, there are few published maps that show the actual limits of indigenous hunting areas (for rare exceptions, see Leeuwenberg and Robinson 2000:378; Vickers 1983:452, 1991:55).[4]

An understanding of the spatial extent of hunting is critical in evaluating human impacts on wildlife populations. Evaluating whether or not a particular game species is being over-hunted requires documentation of harvest rates, rates of reproduction, and an accurate knowledge of the size of the hunting territory. Hunting areas are irregularly shaped, and can not be easily estimated without prolonged participant observation or participatory mapping with local experts knowledgeable about the geography of community subsistence lands.

Documenting the geography of game extraction is also important because it reveals the size of areas that are outside of hunting territories, if such areas exist. The impact of game depletion in a local area may not be as severe if there are adjacent zones that are not hunted. In regions with large expanses of rain forest, core areas remote from indigenous communities may be able to sustain viable populations that serve as source areas for repopulating hunting grounds. Identifying these areas can also be used to delimit conservation zones that recognize local wildlife use. Whereas in the past indigenous communities were extremely mobile and relocation due to the depletion of natural resources was frequent, indigenous peoples are today generally more sedentary. Settlement has become nucleated around sites where there are schools, health clinics, or transportation routes.

Although many uncertainties remain about which game species are being hunted at unsustainable rates in different settings, it is clear that some species are less resilient than others and may need some form of protection. Documenting the size of hunting zones, as well as other spatial aspects of indigenous wildlife use, is a critical element in assessing which species are being over-exploited. While there are many potentially effective measures to promote wildlife conservation, the delimitation of zones with different types of regulation are likely to be an important component of any successful strategy.

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[1] Unoccupied, de facto game preserves can also be created through the impacts of modern warfare. In Nicaragua, for example, the abandonment and forced relocation of dozens of indigenous and other communities during the Sandinista-Contra conflict in the 1980s provided a measure of protection for game species living in large areas of rain forest in the that were previously used by hunters (Nietschmann 1990).

[2] Hames (1980:35) notes that between the neighboring Yaomamö and Ye'kwana, the Ye'kwana's lesser dependence on hunting is partly due to the location of their settlements on the banks of rivers, close to fish resources.

[3] Importantly, their analysis of indirect as well as direct encounter rates demonstrated that the species has not simply become more wary, taking flight more readily with the approach of people, but that their populations were in fact lower (Hill et al. 1997:1349).

[4] Smole (1976:77-78) provides a map of a Yanoama village territory within a region of forest and savanna, but in this case, much of the area is not used for hunting.

3. The Study Area

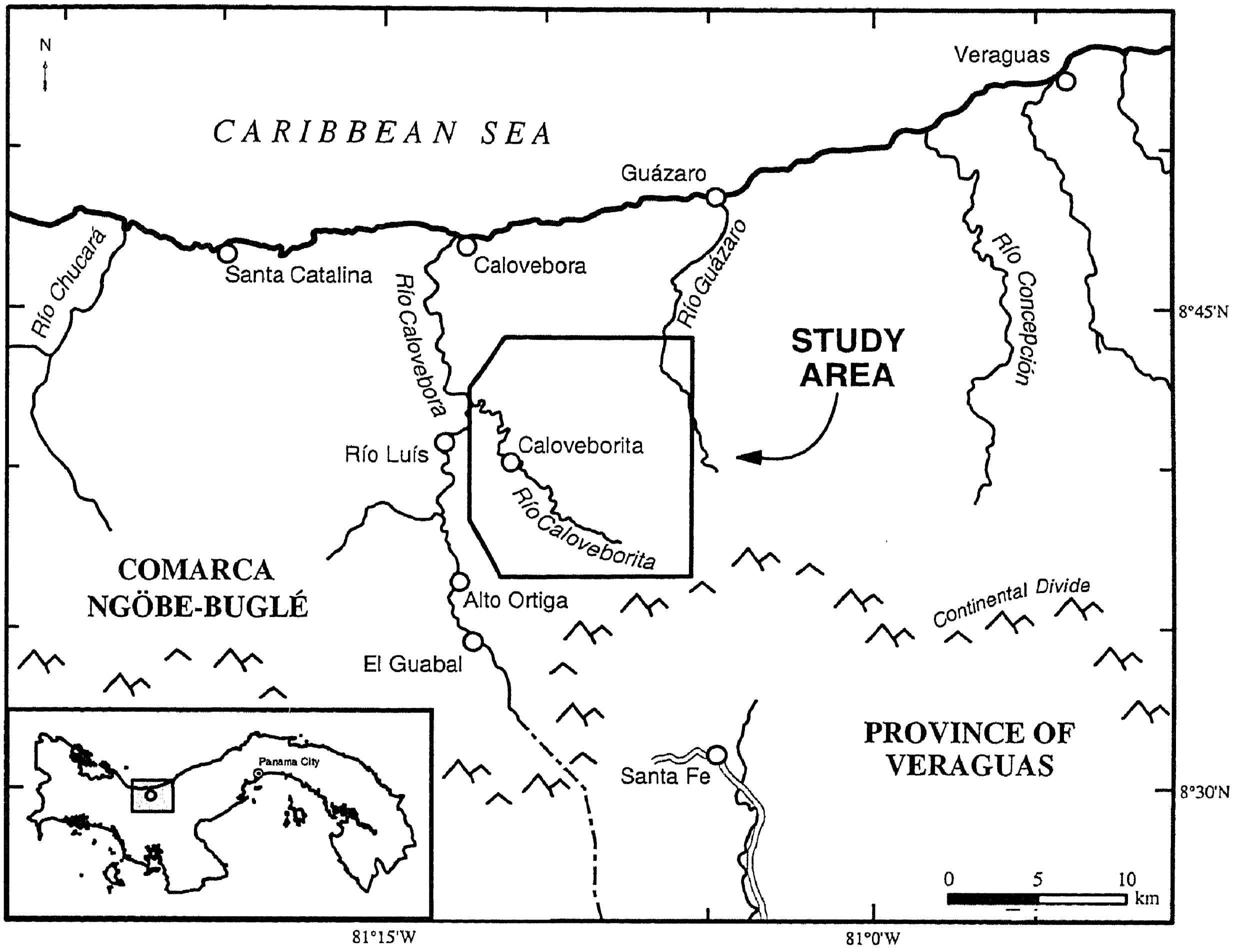
The study communities selected for this research consist of five neighboring villages in the Río Caloveborita watershed. The villages are found on the rugged slopes of northern Veraguas in western Panama. Humid, maritime air arriving from the sea supplies abundant precipitation, and the region is characterized by heavily dissected landscapes covered by verdant rain forest. The region appears to have been rapidly depopulated soon after Spaniards first arrived to the isthmus (Castillero Calvo 1995:135-137), but is today home to two distinct indigenous peoples. The Buglé, who are the main focus of this study, have been gradually migrating to northern Veraguas from neighboring areas to the west. The Ngöbe are relatively recent arrivals from more distant areas.

This chapter describes physical and cultural aspects of the study area (Figure 3.1), as well as some recent developments affecting human-environment interactions in the region. A review of Buglé ethnohistory helps contextualize the study. It ends with a demographic profile of the study area based on the results of a household census.

3.1 The physical environment

The physical environment of northern Veraguas is characterized by uneven, heavily dissected topography, a humid tropical climate, and rain forest vegetation and wildlife. The underlying geology is comprised of volcanic rock that gradually emerged from the sea to help close the bridge between North and South America roughly six to three million years before present (Coates 1997:22-23). The coastal plains are very narrow, and elevations rise rapidly to mountain peaks of about 1,400 to 2,000 meters elevation along the continental divide, with intervening passes as low as 800 meters. The largest river in the region is the Río Calovebora, which serves as part of the border between the province of Veraguas and the Ngöbe-Buglé Comarca, a relatively new, semi-autonomous indigenous territory (see 3.2.1 below). Other major rivers, from west to east, are the Río Guázaro, Río Concepción, Río Veraguas, and finally the Río Belén (which separates the provinces of Veraguas and Colón), all of which drain directly into the Caribbean Sea. Aside from alluvial soils along limited

Figure 3.1. Location of the study area.



floodplains and coastal areas, soils tend to be highly weathered and unsuitable for intensive agriculture.

The slopes of northern Veraguas experience anywhere from about 2,500 to over 5,000 mm of rainfall per year, with higher amounts closer to the coast. The Río Caloveborita region where field research took place receives about 3,500 mm of rainfall annually according to a precipitation map of Panama (IGNTG 1988:42). Daily rainfall measurements that I took in the field indicate that in at least some years, the total may exceed these amounts by 25 percent or more.[1] A few weeks of reduced rainfall usually occur around March or April, but it is questionable whether a true dry season exists. Even the drier months can be expected to receive 200 mm of precipitation. The wettest time of year, with monthly rainfall well over 500 mm generally occurs in December and January. Given the close proximity to the sea and the steep climb from the coast, orographic precipitation fueled by northeasterly trade winds can be sudden and intense, causing dramatic (and dangerous) increases in water levels of the principal rivers. Abundant rainfall, combined with mean monthly temperatures ranging from about 21 to 28°C (IGNTG 1988:38) give the region a "tropical wet" (Af) climate according to the Köppen classification system.

Vegetation in northern Veraguas where undisturbed is evergreen rain forest, with premontane vegetation at higher elevations where several plant species associated with temperate regions are near their southern limits (Gordon 1957:2). The three life zones that are present according to the Holdridge classification system are humid tropical forest, very humid tropical forest, and very humid premontane forest. The forests surrounding the study communities do not conform to the archetypal tall, closed canopy rain forest, however, but are rather variable in structure, as well as in floristic composition. In some places, the forest has a relatively even, closed canopy that reaches heights of 30 meters or more, with large trees with diameters at breast height of one to two meters or more, tall palms, and an understory limited primarily to a blanket of ferns, herbaceous species, and other ground plants less than a meter tall. Here, thick lianas (with diameters > 15 to 20 cm) climbing up into the canopy are common. In other areas, large trees are more scattered, the canopy is uneven, and there is a less structured understory that includes many shorter, slender trees.

Judging from a lack of evidence pointing to major natural disturbances, this type of forest structure is possibly a result of reduced sunlight due to frequent cloud over, steep slopes that allow more light to penetrate between the tree tops of the canopy, or other factors.

Rain forests are typically diverse, and those found in northern Veraguas are no exception. As yet, it appears that little ecological research has been undertaken in this part of Panama, although species composition and dynamics are likely similar to those found in humid tropical forests that have been studied extensively in other Central American lowland locations (see Gordon 1982:9-21; Leigh, Rand, and Windsor 1982; McDade et al. 1994). In the forests of Barro Colorado Island (in the Panama canal waterway), one can expect to find well over 150 tree species in any given hectare (Thorington et al. 1996:86). Some of the larger, commonly known trees found in the Caloveborita region are *bateo* (*Carapa guianensis*), *pera* (*Couma macrocarpa*), tropical cedar (*Cedrela odorata*), *palo frío* (*Dipteryx panamensis*), fig trees (*Ficus* spp.), *níspero* (*Manilkara zapota*), *barrigón* (*Pseudobombax septenatum*), *panamá* (*Sterculia apetala*), *cerillo* (*Symphonia globulifera*) and *guayacán* (*Tabebuia guayacan*). Forest palms are also abundant, in particular the *jira* (*Socratea exhorrhiza*) and *palma real* (*Attalea butyracea*). Although zoological inventories have not been undertaken in the region, the fauna is diverse, with probably of at least 85 non-volant mammal species (according to published species ranges) with evolutionary roots in both the North and South American continents (Eisenberg 1989; Emmons 1990; Reid 1997; Webb 1997). The avifauna is also diverse. Although the exact number of species present in the Caloveborita region is unknown, an ornithological study in the mountains about 25 km to the south found a total of 245 bird species, although several of these are high elevation species with restricted distributions (Rodriguez Pinilla 2000:19). In terms of reptiles, again there is little information on what species are found in the humid lowlands of western Panama. In similar environments in southeast Costa Rica, however, there are about 90 reptile species, as well as over 60 amphibians (Savage and Villa 1986:9-19), and it seems likely that similar numbers would be found in northern Veraguas. Despite the paucity of good information for this region then, it remains clear that these forests are biologically diverse, and an important link in the Mesoamerican Biological Corridor (or "*Paseo Pantera*"), a system of protected areas and moderately modified landscapes designed to conserve natural and cultural diversity along the Central American isthmus (Herlihy 1992; Illueca 1997).

3.2 The Buglé

The Buglé are one of seven indigenous peoples in Panama, and one of the least understood cultural groups in Central America. Very little is known about their history and culture, largely because most of the available ethnographic information stems from two brief field excursions, one in the 1920s, and the other in the 1960s (Herrera and González 1964; Nordenskiöld 1928:169-191). Adding to the confusion, they have also been referred to as Bokotás, Bukuetas, and Murires, and have usually been identified until recently as a sub-group of the Ngöbe, despite the fact that they have mutually unintelligible languages (Herrera and González 1964:57; Torrez de Araúz 1980:295; Wassen 1967; Young 1965:20, 1995:31). In fact, it has been common for the Buglé and Ngöbe (the most populous indigenous group in Panama) to be grouped together under the term "Guaymí." While it is true that they are distinct peoples, the Ngöbe are also a Chibchan-speaking people and the closest relatives of the Buglé. Genetic and linguistic studies indicate that these two peoples diverged from a common ancestral population within the last 2,000 or 3,000 years (Barrantes et al. 1990; Barrantes 1993). Gradual changes in the archaeological and paleoecological record also indicate that these and other groups (the Boruca, Bribri, Cabécar, Maleku, Teribe, and Kuna) descend from a common, ancestral paleoindian population consisting of dispersed, highly mobile bands that hunted animals like ground sloths, mastodons, white-tailed deer, and peccaries at least 7,000 to 8,000 years ago (Cooke and Ranere 1992:289-290; Cooke 1997:138, 142). It is likely that the Buglé and Ngöbe, who are today found in close geographic proximity in western Panama, can trace their origins back to the central archaeological region of Panama, a "discrete culture province" defined by distinctive pottery, metalwork, and stone artifacts that began to emerge as early as 5,000 BC (Cooke and Ranere 1992:247, 263-265). Close cultural connections between the Buglé and Ngöbe are also evident in the fact that there are legends and other ceremonial songs that Ngöbe elders sing in the Buglé language (Santamaría and Baker 1983:72; Torres de Araúz 1980:295).

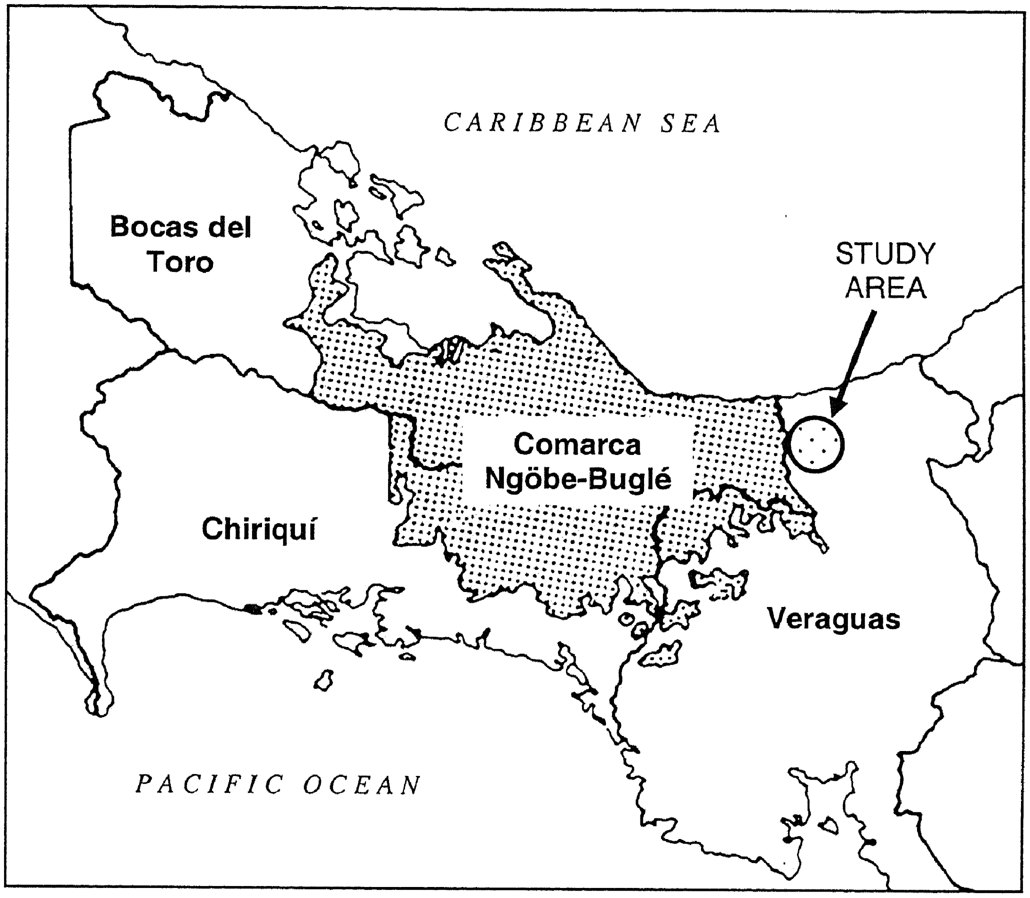
Recent population estimates for the Buglé vary considerably. While the 1990 national census (the first to count the Buglé as a separate cultural group), places their total population at around 3,800, mainly in the former province of Bocas del Toro and the province of Veraguas (República de Panama 1991:249-254), Young (1995:31) estimated that only 1,200 to 1,500 people would claim Buglé as their ethnic identity. The 2000 census, however, recorded almost 19,000 Buglé, with about one third in the Ngöbe-Buglé Comarca, another third in the province of Chiriquí, 17 percent in Bocas del Toro, and another nine percent in the province of Veraguas (República de Panamá 2001, see Figure 3.2).[2] Mapping all Buglé settlements individually would of course provide much better information about their current distribution, and reveal clues about their culture history, but this has yet to be done. Not surprisingly, exactly where the Buglé lived at the dawn of the conquest is even more uncertain.

A primary area of Buglé settlement, where they make up the majority of the population, is found on the Caribbean slope of western Panama between the Río Chucará and the Río Guázaro (Herrera and Gonzáles 1964:58; República de Panama 1992:7). Other Buglé families live in the savanna areas south of the continental divide in close association with the Ngöbe. These Buglé (sometimes called "*sabaneros*") are likewise poorly known, but are thought to be distinct from other Buglé in that their culture has been heavily influenced through interaction and miscegenation with their indigenous neighbors (Torres de Araúz 1980:295). The moisture conditions on the southern slope are also much drier, leading to significant differences in habitat and associated cultural adaptations. Although these two Buglé populations have mutually intelligible languages, they have different vocabularies and pronunciation (Gunn and Gunn 1974:32).

3.2.1 Buglé lands and the Ngöbe-Buglé Comarca

At present, the legal status of Buglé lands in northern Veraguas is unresolved. Since the early 1980s, local indigenous leaders in the Caloveborita region and other neighboring areas were part of a larger struggle to gain an indigenous territory. Their goal, shared with Ngöbe and Buglé leaders and villagers throughout much of western Panama, was the establishment of a comarca. A comarca is a legally defined indigenous homeland and

Figure 3.2. Location of the Ngöbe-Buglé Comarca



* Adapted from an unpublished map obtained from the Instituto Geográfico Tommy Guardia, Panama City.

semiautonomous geopolitical district under the jurisdiction of the state (Herlihy 1989b:19-21). While it remains part of the state, it is a separate political unit in which land rights are guaranteed and indigenous cultures are respected and promoted. One of the most important principles of the comarca is that lands within it are held in common and can not be sold to outsiders.

The Ngöbe-Buglé Comarca was established in 1997, with a system of indigenous governance based on the example of the Kuna comarca established in the 1930s (Herlihy 1989b:18). The comarca is approximately 5,000 square kilometers in size making the largest in the country, representing over six percent of the nation's land area. However, none of the lands of Veraguas north of the continental divide were included within its delimitation as they were in earlier proposals, despite the fact that there is a large indigenous population there. This issue remains a source of disagreement in the region between those who want additional areas included in the comarca, and those (primarily non-indigenous mestizos) who are fervently opposed.

The majority of indigenous people living in northern Veraguas, however, continue to recognize the authority of the federation shared by the Ngöbe and Buglé. This system of indigenous government (which predates the establishment of the comarca by over 30 years) is comprised of local leaders (community *Voceros* and multi-community *Jefes Inmediatos*), district leaders (*Caciques Locales*), regional leaders (*Caciques Regionales*), and a "national" leader (the *Cacique General*), as well as administrative committees at the higher levels. All leaders are elected by their respective communities. Issues of concern among the general populace are discussed and important decisions and resolutions are made at public assemblies known as *Congresos*. The Ngöbe, the largest indigenous group in Panama with a population well over 150,000, have for the last few decades taken a leading role in political mobilization, incorporating the much smaller Buglé group into their organizational hierarchy and struggle for self-determination (República de Panamá 2001; Torres de Araúz 1980:310; field notes from interviews, 1999-2000). An issue of great importance is the degree to which the Buglé are represented within the political structure of the comarca and adjacent indigenous areas. As yet, they have had very little voice in the management and future of this shared territory which remains a source of resentment among some Buglé leaders. For more information on the workings of the indigenous government, see Bort and Young 1985, Gjording 1991, and Torres de Araúz 1980.

3.2.2 Buglé ethnohistory

There is no concrete evidence that shows where the Buglé resided when Spaniards first set foot on the Central American mainland five centuries ago. The archeological record in Panama is incomplete both spatially and temporally, and to my knowledge, no excavations have been conducted in areas where the Buglé now live. Ethnohistorical information on the indigenous populations of western Panama from the colonial period is also incomplete, and difficult to interpret due to the sporadic nature of contact with indigenous groups in hinterland areas; the inconsistent use of a plethora of ethnic terms; and the tumultuous changes that occurred through warfare, disease, slaving, forced resettlement, and miscegenation (Herrera 1982:69-71; Johnson 1948:51-53; Torres de Araúz 1977:72). Moreover, indigenous toponyms that can sometimes be used to infer past geographic distributions of distinct indigenous ethnic groups are equally scarce (see Davidson and Cruz 1988; Smith 1993:29; West 1998:68). During the conquest of western Panama, there was an explicit policy – under the *Ordenanzas de Descubrimiento y Nueva Población y Pacificación* of 1573 – to "rebabtize" places with Christian names (Castillero Calvo 1995:141).

Nevertheless, several opinions have been published regarding the geographic distribution of the Ngöbe and Buglé at the time of contact. Young (1970:23) suggests that they may have lived in the mountainous areas of the central cordillera as part of a "large politically integrated peasant substratum of the coastal chiefdoms." A similar argument is that the "Guaymí" peoples are the descendants of "interior polities, probably small chiefdoms, that were centered in the foothills and higher Pacific and Caribbean slopes of the western cordillera, adjacent to other centralized polities centered on the Pacific coastal plains and on the lower Caribbean valleys" (Helms 1989:416). Cooke and Ranere (1992:297-298), who discuss the origins of the Buglé specifically, favor the idea that they descend from a single aboriginal "nation" that extended from the Pacific to Atlantic coasts.[3]

The Buglé who live on the northern slopes of western Panama are unanimous in their assertion that they came from somewhere else. Elders from several communities told me that their ancestors arrived as refugees, fleeing war that ensued with the arrival of the Spanish. One account describes how all of Panama's indigenous peoples used to live in the vicinity of the present capital, when the rest of the country was uninhabited. With the arrival of the foreign invaders, the Buglé and the other indigenous peoples were forced to take refuge in different parts of the country, each to where they reside today. Others simply say that the Buglé originally lived in the areas around Santiago and Santa Fe, and that they have been successively forced to retreat farther and farther to the north, eventually to the lands they presently occupy. Another explanation of their origins comes from a legend of how the Buglé used wings to fly across the mountains to where they are now from the savanna areas, and yet another tells of how it was the Ngöbe who pushed them off their previous lands (Herrera and González 1964:61-62). A Buglé leader from the community of Guayabito, located in the mountains on the Pacific slope, told me that the Buglé who now live on the northern slope fled during armed conflicts at the turn of the twentieth century, and have since migrated north in search of land to farm and animals to hunt.

The oral history of the Buglé indicating that they lived elsewhere at the time of contact is consistent with the accounts left by the first Europeans to visit northern Veraguas. During Columbus' fourth voyage in 1502 to 1503, he and his crew explored the Caribbean coast, where they founded an ephemeral settlement at the mouth of the Río Belén (Cooke 1982:38; Sauer 1966:134-135). During the trip they saw small riverine and hilltop settlements, met with village leaders, bartered small items, and later kidnapped several natives which resulted in reprisals that forced them to abandon the area (Castillero Calvo 1995:135; Colón 1959; Cooke 1982:38-41; Sauer 1966:135-136). When an armada returned less than ten years later, they did not encounter a single native inhabitant, and had to penetrate the headwater regions close to the cordillera before finding cultivated fields and other clues of recent occupation (Castillero Calvo 1995:135-137). It appears that the indigenous population that lived in northern Veraguas at the beginning of the sixteenth century either fled or were decimated by introduced diseases, and we have few clues about their cultural affiliation.

Although no archaeological excavations have been undertaken in the Caloveborita watershed and surrounding areas, there is little doubt that the region was inhabited in preColumbian times. Simple, undecorated *metates* and accompanying grinding stones are commonly found in the area and used by local families. Petroglyphs (or pictographs) have been etched into boulders in at least three locations in the region, each shortly upstream from the mouth of stream. Although it is not possible to date these drawings, they have the rounded surfaces resulting from what appears to be decades if not centuries of natural abrasion and weathering. If these etchings were made by those peoples who disappeared from northern Veraguas during the early contact period – which is more than likely – they would almost certainly be at least 500 years old. I was also shown a small stone axe head (roughly eight cm in length) that was found while digging a latrine in the village of Río Luís, located along the Río Calovebora. Shards of monochrome pottery can also be found in the region. Interestingly, the Buglé attribute all of these artifacts not to their own ancestors, but rather to the industry of the **daba dbimu**, a "people" who are said to live in a parallel world inside of the surrounding mountains.

When the Spaniards arrived to the central cordillera on the Pacific plains of western Panama from the east, they encountered large villages, chiefs with domain over distinct provinces, and class-based societies. War was endemic among the chiefdoms in the region, and resistance to the conquistadors was fierce, with native forces of up to 3,000 or more warriors (Linares 1977b:74-75). Gaspar de Espinosa launched the first *entradas* into the mountains of Veraguas between 1516 and 1520, but he and his soldiers failed to overcome indigenous resistance in the rugged, forested terrain (Cooke 1982:44). Natá, an important exchange center of some 1,500 people, was conquered in 1522, and became a base for additional expeditions into the highlands between 1530 to 1550 in hopes of capturing slaves and securing a route to gold producing areas in the north (Castillero Calvo 1995:136; Cooke 1982:45 Linares 1977b:73). Several indigenous leaders, among them Urracá and Esqueva, successfully repelled invaders from the headwater areas of the Río Santa María for several decades (Cooke and Ranere 1992:294; Linares 1977b:74). These areas are directly south of where the Buglé live today, and it is not improbable that these populations who resisted the Spanish are their ancestors.[4]

The Spaniards did manage to establish a relatively secure foothold in the highlands in 1558, when Santa Fe was founded by Francisco Vásquez (Castillero Calvo 1995:143). From this base, the gold mining area of Concepción was established on the Caribbean slope by 1560 (Castillero Calvo 1995:135). During the same period, rival colonizers from Cartago (Costa Rica) were exploring new territories in Bocas del Toro to the west, and in 1574 they found the "Valle de Guaymí" (Cooke 1982: 46; see Gordon 1982:34-35). Yet, despite ambitions plans on the part of several actors, efforts to bring the Caribbean lowlands under control were unsuccessful and conquest was limited primarily to the immediate vicinity of Santa Fe (Castillero Calvo 1995:141; Cooke 1982:45-46). However, the colonists and governors of Santa Fe undertook slave raids and may have caused widespread destruction of indigenous communities in surrounding areas (Castillero Calvo 1995:137).

The Spanish crown authorized the distribution of *encomiendas* in the same year that Santa Fe was founded. These consisted of land grants which obliged grantees to congregate Indians in new settlements where they were to be converted to Christianity and forced to pay tributes of agricultural products and labor (Castillero Calvo 1995:138). But in the areas around Santa Fe probably few natives were subjugated – in 1604, there were only eight *encomenderos* in the Santa Fe area, with probably no more than several dozen subjects in total (Castillero Calvo 1995:140, 145). Concepción was abandoned around 1590 and new mining settlements established along the Río Coclé and the Río Belén were likewise abandoned shortly thereafter (Castillero Calvo 1995:142). Missionary activity in western Panama, first undertaken by Dominicans and Jesuits, and later by Franciscans, began in earnest in the seventeenth century, but likewise had little impact in the humid northern lowlands (Young 1970:15-16). However, Buglé who were living in the foothills of the Pacific slope may have been incorporated into mission towns such as Cañazas, San Francisco, and Calobre, or forced to seek refuge in the mountains (Castillero Calvo 1995; Young 1970:16).

Thus, the rugged central highlands and humid, northern lowlands of western Panama were never successfully conquered, and served as important refuge areas where indigenous traditions are maintained to this day. Nevertheless, native peoples incorporated new crops and domestic animals into their traditional subsistence systems, and manufactured goods became valuable trade items. After the initial devastating effects that occurred with the arrival of the Spanish, many segments of the indigenous population were left in relative isolation with minimal interference (Bort and Young 1985:1). Interaction with foreigners, however, did occur when other Europeans traders, buccaneers, and pirates began to frequent the Caribbean coast. Indigenous inhabitants here found opportunities to trade various foods in exchange for iron tools and trinkets, and some likely found work on Jamaican plantations as early as the eighteenth century (Esquemeling 1684-1685:225; Herrera 1982:70). The British were firmly established on the Caribbean coast of Panama by 1739, the year in which they captured Portabelo (Perez-Brignoli 1985:23). The English presence was also felt indirectly through their indigenous allies, the Miskito of eastern Nicaragua and Honduras who extended their tribute at least as far as Bocas del Toro by the early nineteenth century (Roberts 1827:53). The Ngöbe and Buglé, however, even if they were subordinate to the

Miskito for a time, may have benefited from their help in keeping the Spanish at bay. Wary residents of Santa Fe, fully aware of the fierce reputation of the Miskito, were reluctant to explore the northern rain forests. A missionary in the nineteenth century reported that Santa Fe residents retreated every year when the Miskito arrived to fish for turtles (Herrera 1982:72; Cooke 1997:37). The last Miskito attack in Panama was in fact a raid on Santa Fe as late as 1805 (Cooke 1997:176). Foreigners continued to visit the native inhabitants of the northern slope of western Panama, but the activities of missionaries and explorers looking for minerals or transisthmian routes in the nineteenth century were sporadic and short-lived (Gjording 1991: 39, 279-280).

The first evidence that firmly places the Buglé on the map does not appear until the late 1920s when Swedish ethnographer Erlan Nordenskiöld visited eastern Bocas del Toro (now within the Ngöbe-Buglé Comarca) (Nordenskiöld 1928:169-191).[5] He found the "Bogotá" living in communities west of the Río Calovebora, with a total population he estimated at around 200 (Wassen 1967:272). Among his numerous observations, he notes that the Buglé at this time lived in round houses, wore garments made from a bark cloth, used bows and arrows for hunting, and practiced a system of shifting cultivation in which their fields were not burned before planting (Wassen 1967:272-274). Two Panamanian students returned to the same area in the 1960s to undertake a short ethnographic tour of the Buglé region (Herrera and González 1964). They provide a map of Buglé settlement, on the northern slope ranging from the Río Chucará to the Río Calovébora (they were also aware of Buglé families living in the savannas south of the Serranía de Tabasará in Veraguas whom they did not visit) (Herrera and González 1964:58, 61). The Buglé population at this time was estimated at around 800.[6] Among many interesting observations, the authors highlighted the dispersed nature of settlement, widespread distrust of outsiders, the adoption of rectangular house construction, the use of traps for hunting, and polygamy (Herrera and González 1964:66-75).

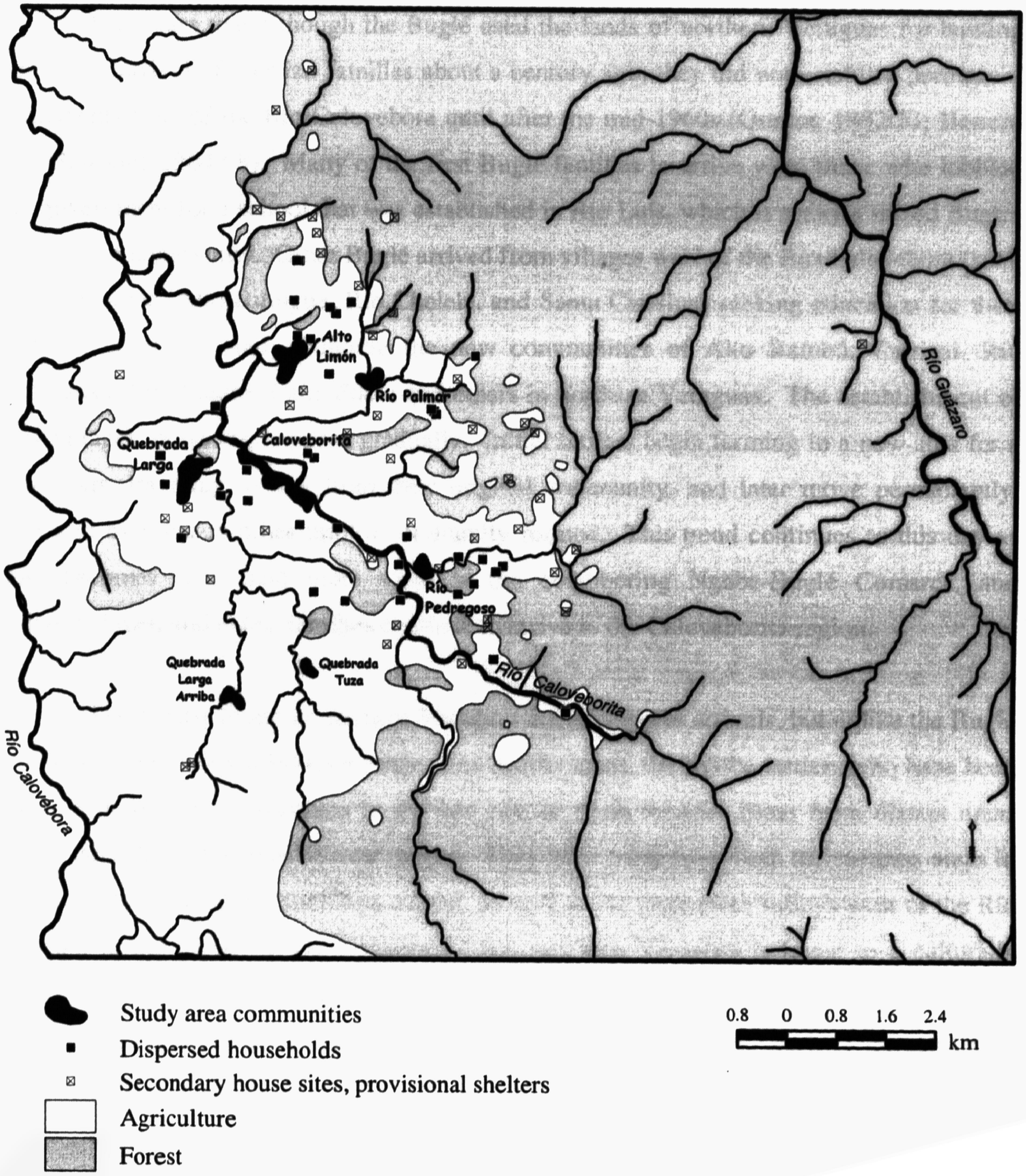
3.3 General characteristics of the study area

The study area where field research was concentrated consists of the lands used by all of the households located in the Río Caloveborita watershed in northern Veraguas (Figure

3.3). (Here and elsewhere in the text, the "Caloveborita region" refers to the watershed of the Río Caloveborita, as well as neighboring forest areas to the east used by the study communities.) This study area was chosen in collaboration with indigenous leaders and knowledgeable informants. A primary objective was to include several neighboring settlements in an area where hunting is an important activity. The families living along the Río Caloveborita and its tributaries were chosen as the study population, consisting of five villages and associated hamlets and roughly 100 households. The communities are interrelated through both proximity and kinship, and the areas each communities use for farming and other subsistence activities overlap considerably. All are found within a short distance of a vast expanse of contiguous rain forest to the east, and within one day's walk of Santa Fe, the nearest market town. Rivers are numerous, but only the largest streams are navigable by canoe along their lower reaches. Most travel occurs on foot along trails. Almost all families rely on subsistence agriculture, complemented by hunting and fishing, as well as occasional wage work and sale of domestic animals. Most of the people living in the Caloveborita watershed are of Buglé decent, but Ngöbe and "Campesino"[7] families are also present, as well as many persons of mixed heritage.

Part of the reason why northern Veraguas continues to be relatively remote and lightly settled is because the region continues to be one of the least accessible in Panama. On the northern coast, rough seas and large distances to commercial centers have inhibited the development of regular transportation routes out of the region by sea. In the 1950s, the road to Santa Fe from the Pan American highway was only passable during dry periods, and government maps from the early 1960s do not even show a gravel road leading to this town (Gordon 1957:1; República de Panamá 1965:132). An old trail between Santa Fe and Río Luís was widened into a seasonal road in the early 1980s (Gordon 1982:24; Puleio 1985:41), but soon fell into disrepair. By mid-2000, bridge and road construction made this road passable again, allowing vehicles to reach the town of El Guabal (Figure 3.1). Already forest clearance along the route across the central cordillera by cattle ranchers is a major concern for local people, and evidence from rain forest regions elsewhere in Latin America suggest these and further road improvements will facilitate the encroachment of farms and pastures of mestizo settlers onto the forested lands of native residents.

Figure 3.3. Settlement and land cover in the study area, 1999-2000.



3.4 *Settlement history of the Caloveborita region*

It appears that although the Buglé used the lands of northern Veraguas for hunting before the arrival of mestizo families about a century ago, they did not establish permanent settlements west of the Río Calovebora until after the mid-1960s (Gordon 1982:23; Herrera and González 1964:58). Many of the first Buglé families to arrive were those who lobbied the government for a school that was established in Río Luís, which is today a mixed Buglé-Campesino community. Other Buglé arrived from villages west of the Río Calovebora (such as Río Grande, Alto Bilingüe, Río Chelelé, and Santa Catalina) seeking education for their children or arable land, founding the new communities of Alto Bambú, Carrizal, Río Pedregoso, Los Azules, Caño Sucio and others in northern Veraguas. The establishment of new villages, however, happens gradually. Initial settlers begin farming in a new area for a few years, traveling to and from their original community, and later move permanently, followed by other families until a community formed. This trend continues to this day as land becomes more and more scare in the neighboring Ngöbe-Buglé Comarca, and individual men and entire families continue to arrive to the Caloveborita region.

The Ngöbe living in northern Veraguas are also recent arrivals, but unlike the Buglé who have simply expanded their range from nearby areas, the Ngöbe settlers who have been arriving in significant numbers in the last two or three decades come from distant areas where land shortages have become severe. They have come from both the savanna areas in the foothills south of the cordillera central, as well as the large river valleys west of the Río Chucará in the Ngöbe-Buglé Comarca. Thus, northern Veraguas is home to a culturally diverse population that continues to experience modest but steady colonization. As yet, most of the region remains unsettled, but if current trends continue, much of the remaining forest will be cleared for agriculture in the coming decades.

Caloveborita is the oldest of the five communities in the study area, founded shortly after the turn of the twentieth century by a handful of refugees. The Campesinos were in fact the first people to settle the interior of northern Veraguas after it was depopulated in the sixteenth century. According to oral history interviews, mestizo families first arrived from communities near Santa Fe, Cañazas, San Francisco and other parts of Veraguas Province during the *Guerra de los Mil Días*, a bloody civil conflict between the main political parties of Colombia that occurred around the turn of the twentieth century (shortly before the independence of Panama). They crossed the cordillera to escape forced conscription and armed conflict, arriving to a vast, uninhabited forest where they founded the towns of El Guabal and Alto Ortiga along the Río Calovebora. From these sites other settlements were established nearby and along the northern coast, fueled by natural population increase and the search for fertile lands. Virtually all of the mestizos (apart from schoolteachers) living in northern Veraguas today are descendants of the original refugee families. In the last 50 years or so, many Buglé families have also moved to Caloveborita.

Quebrada Larga, Río Pedregoso, and Río Palmar (Figure 3.3) were settled beginning in the 1950s when the first farms began to be cultivated, followed by larger numbers of settlers over the next decade or two. Quebrada Larga was settled primarily by Buglé from nearby communities west of the Río Calovebora as well as some Ngöbe-Buglé from the savanna areas of the district of Cañazas. Río Pedregoso was settled mainly by Buglé from Alto Bilingüe which is located along the Río Chelelé, a western tributary of the Río Calovebora. Río Palmar consists of several related Buglé households that descend from a single polygamous family. Alto Limón was settled more recently, beginning in the early 1970s, primarily by Buglé and Ngöbe-Buglé from the Río Grande valley and savanna areas near Agua de Salud, Batata, and Guayabito, respectively.

3.5 Population of the study area

Results of the participatory research described below showed that there were 99 households and 725 people in the five villages of the study area at the beginning of the field research in 1999 (Table 3.1). Although Buglé is the most widespread language spoken at home, the ethnic makeup of the region is very diverse, with significant Ngöbe and Campesino representation. About one third of the population of the village of Caloveborita is made up of just two extended Campesino families that have been growing here over the generations in the past century. There are also several households with mixed ethnicity, especially Ngöbe-Buglé families in Quebrada Larga and Alto Limón. Less than half of all households were identified as purely Buglé, but over two thirds are at least partly Buglé.

Fairly similar results are obtained when looking at the level of the individual.

59 households (primarily Buglé and Ngöbe-Buglé) were included in more intensive data collection focused on hunting activity, but all of the families in the region participated in various aspects of the research to varying degrees. It should also be noted that the indigenous population here is highly mobile, and that the census results presented here represent just one point in time. Many people changed residence during the study, moving to another household or village within the study area, or even out of the region. Some families have residences in more than one village and move between them periodically.

Table 3.1. Population and ethnicity of the study area (a) by community and household and (b) by individuals, Caloveborita region, 1999.

(a)

	Total population	Households						
		Total	Buglé	Ngöbe-Buglé	Buglé-Campesino	Campesino	Ngöbe	Ngöbe-Buglé-Campesino
Caloveborita	261	45	11	1	4	29	-	-
Río Pedregoso	117	20	14	2	2	1	-	1
Quebrada Larga	113	14	4	9	1	-	-	-
Alto Limón	97	14	9	4	-	-	1	-
Río Palmar	24	6	6	-	-	-	-	-
Total	725	99	44	16	7	30	1	1

(b)

	Total	Buglé	Ngöbe-Buglé	Buglé-Campesino	Campesino	Ngöbe	Ngöbe-Buglé-Campesino
Ethnicity of individuals	725	189	145	59	164	26	29
Percent of total	100	31	24	10	27	4	5

Source: Data from participatory research undertaken by local investigators, September 1999.

[1] Measurements were taken every morning between 6:00 and 6:30 am in the village of Caloveborita from September 1999 to May 2000 using a standard rain gauge mounted 1.5 meters above ground level. A trained assistant measured precipitation on days when I was absent.

[2] On the day of the census, Buglé respondents had the choice of identifying themselves as either "Buglé" or "Bokota," for reasons that are unclear. Whatever the logic (or lack thereof), the tabulations were made for both groupings separately. Almost 18,000 people identified themselves as Buglé, and about 1,000 more as "Bokotá." Those who identified themselves as "Bokotá" may include those people who want an indigenous territory separate from the Ngöbe who have in the past tried to disassociate themselves with the term Ngöbe-Buglé which in fact is often used as if it refers to just one indigenous group. One possible explanation for the dramatic increase in the number of Buglé is the fact that they were given the choice of identifying themselves as such, rather than "Bokotá" – in the 1990 census many Buglé, not recognizing the term Bokotá (which many in fact derive from the regional term "bocatoreño" after the province [Gordon 1982:24]) may have instead identified themselves as "Guaymí." This would not be surprising given the fact that Buglé in the highlands of Chiriquí and Veraguas have often been called "Guaymí Sabanero."

[3] This latter hypothesis is based largely on both archaeological and early ethnohistorical evidence "suggesting either that individuals traveled from coast to coast or that an interfamily exchange network was in operation," as well as an eighteenth century reference to Buglé speakers near the Pacific coast (Cooke and Ranere 1992:290; Pinart 1882). Linares (1977a) also argues that the peoples living on either side of the continental divide in western Panama were linked in order to exploit complementary resources from different environments. At the Sitio Conte site in Coclé province dating from AD 500 to 900, articles made from manatee bones were found, demonstrating that there was some form of interaction between the Pacific plains and the Caribbean coast (Linares 1977b:71). Oveido (1944, 7:76) wrote in the early sixteenth century (sometime between 1520 and 1530) how he witnessed cross-cordillera exchange of gold from the north for cotton in Natá. Fray Adrían de la Roche mentions in the eighteenth century that the Ngöbe traveled to the savannas in Chiriquí to trade items like indigo and achiote for axes, knives, and most of all dogs (Cooke 1982:54). Nevertheless, reports of Buglé speakers in the vicinity of Parita Bay that would support this circumstantial evidence remains inconclusive, given that missionaries actively resettled indigenous peoples from different areas to places where they were more easily controlled and supervised, and the citation used comes from over 200 years after the initial conquest.

[4] One legend has it that Urracá (a famous *cacique* who is represented on Panama's one-cent coin) entered into a mountain overlooking Santa Fe, and that he will reemerge to defend Buglé lands again if necessary.

[5] Unfortunately, Nordenskiöld's important work, "Indianerna på Panamanäset" (1928), has not been translated into Spanish or English. Excerpts and details from the research are available from Wassen (1967), a close colleague.

[6] This figure was based on an interpretation of the 1960 national census, which unfortunately does not distinguish between different indigenous groups

[7] In most contexts, c*ampesino* is a generic term that is used to refer to rural subsistence-oriented farmers. In the Caloveborita region, however, "Campesino" refers to rural mestizo people with modest economic status. The term is capitalized here because it is an ethnic term for a distinct cultural group, similar to how the terms "Buglé" and "Ngöbe" are used.

4. Research Methodology

Field research for this dissertation began with a reconnaissance of the Buglé region in 1997, followed by a 12-month stay in the study area from June 1999 to June 2000. The research methodology included several distinct components. One preliminary step consisted of consultations with indigenous authorities and the study area communities to gain approval for the project. Throughout the investigation, I undertook participant observation, conducted interviews, carried out field mapping, and accompanied hunters during their activities whenever possible. The research methodology also included a participatory component whereby local investigators were trained to conduct a census, facilitate community mapping sessions, and administer hunting activity questionnaires. As the principal investigator, I also coordinated the work of the local investigators. After field research, quantitative data and field notes were compiled, and spatial data on hunting activity was entered into a Geographic Information System (GIS) for analysis and map production. This chapter describes these interrelated methods. I also provide an expanded discussion of participatory research, a relatively new approach in the social sciences that was a cornerstone of this study.

4.1 Collaboration with indigenous authorities and local communities

Conducting research among indigenous groups requires collaboration with and approval from indigenous authorities. During my fist reconnaissance to the Buglé area, I was told that my presence in the region was not acceptable without authorization from higher authorities living outside of the area. The authorities I subsequently met[1] were supportive and they gave me letters of approval for the research. When I returned to Panama a year and a half later in June 1999, I again met with these authorities, and together with local community leaders from the Buglé region, we reviewed the research proposal, discussed methods, and drew sketch maps to identify an appropriate study area. Together, we decided to change the study area that I had originally proposed to a neighboring region. This was done in part because it is an area with greater reliance on hunting, and also because of the expressed desire of the indigenous leadership to document the indigenous presence in an area that had been excluded from the Ngöbe-Buglé Comarca.

Although the proposed research was a well-defined problem that I formulated based on my own interests, the topic was of genuine interest to Buglé leaders. Activities associated with an international conservation initiative known as the Mesoamerican Biological Corridor had occurred with limited consultation with Ngöbe and Buglé leaders, and rumors of a national park (the Parque Nacional Santa Fe, a roughly 750 km^2 reserve established in December 2001 along the mountainous continental divide in Veraguas province) that might restrict their subsistence activities were of great concern. These outside "interventions" led to much discussion, and eventually, formal resolutions at indigenous assemblies pertaining to conservation. Local people are adamant that they have been good stewards of their homelands, and that outsiders do not have the right to impose restrictions on their traditional land use practices. They emphasize that this is especially true in light of the fact that their way of life and their well-being depends on the use of natural resources rather than earning wages. However, villagers from many communities lament the depletion of game around their settlements, and are supportive of efforts to address the problem of declining wildlife populations. All formal resolutions to date, though, have been vague when it comes to specific conservation strategies, in part due to the lack of detailed information on the present use of wildlife. The indigenous leaders that I met quickly saw the value of my proposed research to gain detailed, empirical information on hunting activity to help them develop specific wildlife management norms and pursue collaborative arrangements with outside organizations that might be willing to provide financial assistance to pursue common conservation objectives.

The research, however, was not supported unanimously by residents in the study area. There currently exists in northern Veraguas a conflict between those who support the expansion of the Ngöbe-Buglé Comarca so that it would include parts of northern Veraguas, and those who are firmly opposed. Although I stressed my neutrality on this issue and that the research was intended to support the resource rights of all people in the region, a few Campesinos did not want to participate in the study because of my collaboration with and recognition of the indigenous leadership.

Soon after my arrival to the study area in July 1999, regional and local community leaders helped organize community meetings in the villages of Caloveborita,[2] Alto Limón, and Río Pedregoso to present the proposed research and listen and respond to the concerns and comments of villagers in the study area (Table 4.1). During the lengthy meetings, which were facilitated by local leaders, there were lively discussions (in Spanish, Buglé, and in Alto Limón, at times in Ngöbe) about the objectives and significance of the study, explanation of the methods that would be used, and how the results would be shared. Both men and women were well-represented, although almost all of the talking was done by men. The research was approved during all of the meetings. Local investigators were also approved at these meetings, as explained below.

During the first several weeks of fieldwork I accompanied villagers during their daily subsistence activities, visited families in their homes, and conducted informal interviews, activities that I carried out throughout the research. Participant observation during agricultural tasks and hunting and fishing trips, the initial documentation of Buglé ethnozoology, and becoming familiar with the geography of the study area, were essential preparations for implementing the participatory component of the research.

4.2 Participatory research

Participatory research encompasses a wide variety of methods and collaborative relationships that seek to increase the level of involvement of local people in scientific research (Park 1993, 1997; Perez 1997:4-5). Usually, providing training and applying the research results to problems identified by the host community are explicit objectives of the participatory research process. Some stress that to be fully participatory, the research agenda should be defined by the study group itself, and that the results should be applied to bring about needed social change (Park 1993:1-2, 1997:8; Perez 1997:4-5). The role of the principle researcher is to help convert an unarticulated problem into a clear topic that is investigated to produce knowledge that can be understood at the local level and by outsiders as well (Park 1993:9). Including local investigators in the research process also helps to break down the subject-object dichotomy of conventional research, and empower

Table 4.1. Meetings and workshops organized to implement participatory research, Caloveborita region, 1999.

Event	Duration	Location	Participants
July			
Meeting with indigenous leadership to discuss research objectives and nominate local investigators	Half day	Caloveborita	Local and regional leaders and key informants
August			
Community meeting	One day	Caloveborita	Villagers and leaders from Caloveborita, Río Palmar, Quebrada Larga, and Quebrada Larga Arriba
Community meeting	Half day	Río Pedregoso	Villagers and leaders from Río Pedregoso
Community meeting	One day	Alto Limón	Villagers and leaders from Alto Limón
September			
First workshop, held to discuss objectives of research, provide training in how to conduct a census and facilitate community mapping sessions	Two days	Alto Limón	Local investigators, local and regional leaders
Community mapping session	One day	Caloveborita	Local villagers and facilitating local investigator
Community mapping session	One day	Río Pedregoso	Local villagers and facilitating local investigator
Community mapping session	One day	Alto Limón	Local villagers and facilitating local investigator
Community mapping session	One day	Río Palmar	Local villagers and facilitating local investigator
Community mapping session	One day	Quebrada Larga	Local villagers and facilitating local investigator
Community mapping session	One day	Quebrada Larga Arriba	Local villagers and facilitating local investigator
Second workshop, held to review census and community mapping work and provide training in how to administer hunting activity questionnaires	Two days	Caloveborita	Local investigators
October			
Third workshop, held to review hunting activity questionnaire work	One day	Caloveborita	Local investigators
Fourth workshop, held to review hunting activity questionnaire work	Half day	Caloveborita	Local investigators

disenfranchised people to do their own independent research to address their unique problems (Park 1993).

With respect to research among indigenous and other rural communities in the Americas, however, the term "participatory" continues to used in different ways. The term has been chosen to refer to merely interviewing local people about their environmental knowledge (Calheiros, Seidl, and Ferreira 2000) to actually providing training to community members so that they can become part of a field research team (Flora et. al. 1997:22-23; Hanks and Pokotylo 1989:145; Robinson 1996:130; Sarri and Sarri 1992). While this research approach seems to be gaining ground among geographers (see for example, Herlihy and Leake 1997; MacNab 1998; Nietchsmann 1995), as far as I know, a comprehensive review about the use of participatory methodologies in this discipline has yet to be written.

Participatory mapping, which can be considered to be one type of participatory research, has gained considerable momentum in recent years, and is the subject of a special upcoming issue of the journal *Human Organization* (Bird 1995; Herlihy and Knapp 2003; Poole 1995, 1998; Walsh 1998:28-30). Participatory mapping projects among indigenous peoples in Latin America by geographers and others have trained local field investigators how to facilitate community sketch mapping, use Global Positioning System (GPS) receivers, and administer questionnaires to document the use of land and marine resources (Dana 1998; Denniston 1994; González, Herrera, and Chapin 1995; Nietschmann 1995; TMCC and TAA 1997:140-142). A primary aim of most of these mapping projects has been to document indigenous occupancy to substantiate legal recognition of their historic resource rights. Trained Ye'kuana and Sanema field investigators, for example, drew sketch maps and used GPS and computer software to make maps to generate an "authoritative presence" in Venezuela and Guyana (Poole 1998:38-40). In eastern Nicaragua, the Miskitu and other local peoples undertook a major mapping project in collaboration with a local research institution to document the boundaries of the lands of over 100 communities (Dana 1998). Participatory mapping projects in Honduras and Panama have included training for local surveyors to draw sketch maps and collect questionnaire information on land use activities and socioeconomic conditions (Herlihy 2001:111-112, 2003; Herlihy and Leake 1997). Additional examples of participatory mapping projects can also be cited (Brown et al. 1995:56-57; Robinson, Garvin, and Hodgson 1994; Smith 1995:44-45). These initiatives have shown that indigenous peoples living in neotropical rain forest regions have extremely detailed metal maps of streams, topography, and land cover over large areas surrounding their villages and that they have the skills necessary to make important contributions to geographic research.

The dissertation research included a participatory research component, in which local investigators were trained to undertake a census of the study area, facilitate community mapping sessions, and administer weekly questionnaires to collect information on hunting and fishing activity in their respective villages. The participatory research component broadened the scope of the research, allowing for the administration of questionnaires among a larger number of households belonging to five communities in an area characterized by dispersed settlement. Moreover, the approach was chosen to increase the direct involvement of local people in the research process. Working with me, the local investigators' geographic skills and intimate knowledge of their lands resulted in standardized maps and quantitative results that can be communicated to outsiders.

4.2.1 Selecting and training local investigators

During coordination of the research with the indigenous authorities, we discussed how to select local investigators. Ideally, the local investigators would conform to several requisites that I proposed and which were accepted by the indigenous authorities: they had to be long-standing and respected residents of the area, fluent in the languages used in their respective communities, knowledgeable of nearby and distant forest lands in the region, and preferably, to be literate.[3] After some discussion, the indigenous authorities and I agreed that they would receive a wage of $7 per day for their work, roughly double what is paid for agricultural labor. Candidates were identified during a meeting in the study area with local and regional leaders and key informants. All of the six nominated investigators were men, mainly because men generally have more experience as hunters and are more familiar with forest lands far from home. Nevertheless, I requested that at least one woman be involved. However, the female candidate that was selected did not accept the nomination. Some of the work involved, in particular a lot of traveling on foot and conducting interviews away from home, was seen as unsuitable for women. Whether completely accurate or not – this assertion was made primarily by men – I decided to accept this situation and try to incorporate women's participation in other ways.

The proposed local investigators were presented during the village meetings held in August 1999, and all seven nominees were approved by their communities. In Caloveborita, which has a number of native Campesino families, I agreed to include an additional, Campesino local investigator and several Campesino households south of the intended study area in response to their request for grater participation in the research.

4.2.2 Census work and community mapping

The first of a total of four training workshops for the local investigators was held in Alto Limón over two days in early September 1999. The event was primarily aimed at training the selected local investigators but also served to educate a number of regional and local leaders about the research. Each investigator kept a "workshop notebook" to keep notes during the training session. On the first day I reviewed the nature of the research, and we discussed the responsibilities of the principal (myself) and local investigators. It was very important that the local investigators understand all of the facets of the research well enough so that they could explain them to people in their communities in their native language. On the second day, training focused on how to implement two preliminary components of the research – a census of the entire study population and community sketch maps of subsistence lands. One of the most lengthy discussions revolved around how to record ethnicity. The study area includes Buglé, Ngöbe, and Campesino households, and a high proportion of multiethnic families, making this an important, and complex, issue. I presented my view of how I thought ethnicity should be recorded, and the local investigators agreed that it should be based on self-identification. We discussed many other issues related to culture, land use, and conservation. These conversations demonstrated the genuine interest of the local investigators in the work at hand and their desire to understand the research, and to do it well.

The census conducted by the local investigators collected information on age, sex, occupation, ethnicity, languages spoken, the location of secondary houses, and length of residence in the community among all households in the study area. Each investigator was responsible for visiting from between about 10 to 15 households in their own community. All but four households out of a total of roughly 100 agreed to participate in the census.[4] While administering the census, the local investigators invited villagers to a meeting to map community lands for the purpose of documenting their settlements and subsistence areas and collecting local place names.

During the first training workshop, I gave the local investigators general parameters on how to facilitate the sketch mapping process. The features to be included and the symbols used to represent them were not specified in advance, aside from the objective of including as a minimum, streams, agricultural areas, and hunting zones. The six community mapping sessions that took place in September 1999 were facilitated by the local investigators. I was present for most of the community mapping sessions, but only participated when it was necessary to clarify the objectives of the exercise.

The community mapping sessions each began with a questionnaire asking for the names of all of the places where villagers cultivate, raise cattle, fish, and hunt.[5] Upon completion of the questionnaire, villagers were then asked to gather around a table to draw a map of community lands on a large blank piece of paper using colored pencils. Blank sheets were chosen over drawing directly onto base maps for several reasons. First of all, the base maps have a lot of detail, including a coordinate grid, contour elevations, and land cover all of which can be overwhelming and confusing to people who are not familiar with topographic maps. Secondly, much of the information is incorrect – settlements are missing, many of the placenames are erroneous, and several locally important streams are missing. Moreover, the largest scale base maps available (1:50,000) allow little space to draw information at the level of detail that was desired. By drawing on large blank sheets, the participants were able to include much more detail, and place all important features themselves, without the confusion of unnecessary or incorrect information.[6]

Different people took turns drawing different parts of the map, and others helped locate features or ensure that all important places were included during the community mapping sessions. The local investigator facilitating the exercise then reviewed the questionnaire with the villagers to ensure that all of the toponyms were on the sketch map. Although there was considerable variation in the appearance of the maps that were produced in different communities, all contained considerable detail and demonstrated a clear understanding of scale and spatial relationships.[7]

A second, two-day workshop was held in Caloveborita in September 1999. The three objectives of this workshop were to review the census results and community mapping work, transfer toponyms from the sketch maps onto cartographic sheets, and provide training in how to administer hunting activity questionnaires. Together, the sketch maps that resulted from the community mapping sessions included about 200 unique placenames, and over 90 percent of these are not present on existing 1:50,000 topographic sheets. Given the limitations of the available base maps, which do not show many of the smaller streams in the region, as well as my own lack of familiarity with the region at that time, most of the toponyms from the community sketch maps could only be tentatively placed. To complete accurate base maps, I documented the location of dozens of small streams, houses, and other places with a GPS while accompanying villagers in their daily activities and during special trips with guides. A GPS, however, is not sufficient to do this type of work, especially in forested areas where a minimum number of satellite signals are often impossible to obtain. Frequently, locations can only be obtained after reconstructing the entire route of an excursion, plotting the path of the outing onto topographic maps using field notes and compass readings. The detailed base maps of the study area which resulted from the community mapping sessions and subsequent field mapping were essential for a core aspect of the research: documenting the spatial distribution of hunting yields through a participatory mapping process.

4.2.3 Participatory research on hunting activity

The local investigators and I reviewed the overall strategy and the content of the hunting activity questionnaire during the second workshop. These questionnaires were to be administered by the local investigators in their respective communities every week over a period of eight months. We made several modifications to a draft questionnaire that I had prepared, although the content did not change significantly. By the end of the workshop, all investigators understood its design and the logic well enough to be able to translate it and explain it to their fellow villagers.

During the first household visits conducted by the local investigators, a preliminary questionnaire was administrated to provide an objective basis for identifying and removing households that were not involved in hunting from the study group. In this questionnaire, each member of the household above the age of seven was asked what animal they had last caught (while hunting or otherwise), and how long ago that had been. Households which had not caught any game animals in the previous three months or so were removed from the study group. The majority of these households were Campesino families, although they are a minority in the region. It immediately became clear that hunting is much more important among the indigenous population, something that was stated repeatedly by local people during conversations. Results from this research show that hunting plays a negligible role in the subsistence activities of roughly 85 percent of Campesino households in the region. While most of these were excluded from the hunting activity study, five households in Quebrada Larga Arriba and Quebrada Tuza were retained in the interests of broadening participation in the study (at their request) and increasing goodwill among the Campesino population. Once these initial adjustments were made, 59 of the 100 households in the study area were selected for the hunting activity study, excluding households without hunters. These households then, are not a sample of the total population, but rather represent all households located in the Caloveborita region that are involved in hunting, with the exception of one household in Río Pedregoso that was removed from the hunting activity study when it was discovered that false information was being provided.[8]

Each local investigator became responsible for administering hunting activity questionnaires at between six to nine households. For the most part, they visited the same households every Sunday when people were most likely to be home. Although the questionnaire itself was written in Spanish, interviews were conducted in the language of the household (either Buglé, Ngöbe, or Spanish), except for questionnaires that I administered myself in Spanish among indigenous households when local investigators were not available to do the work due to illness or other reasons.

Towards the end of September 1999, a total of eight local investigators began to administer hunting activity questionnaires among 59 households. However, it became necessary to make several changes to the research team along the way. Two additional people were trained as local investigators to encourage greater community involvement in the study. This helped turn unenthusiastic informants into active participants in the research. Two more were later trained to administer the questionnaire in their own households because they were located at a great distance from the community, making it difficult to visit them. Mid-way through the research, a few of the local investigators wanted to leave the region to work on sugar plantations during the harvest season; another left the area to begin post-secondary studies. These people were either replaced by new local investigators, or I administered their questionnaires while they were away. By the end of the research, 18 different local people had administered questionnaires, although many only participated for short periods.

The hunting activity questionnaire was designed to collect information on the date and time of hunting trips, the technologies and strategies used, and all game captured. For each game animal captured, information was obtained on when it was caught, by whom, with what weapon, and in what type of habitat the animal was encountered. Interviewees were also asked the sex of the animal if known, and whether it was an adult or juvenile. For each animal captured, one of four hunting strategies was also specified (hunting trip, awaiting, traps, or opportunistic). These categories were chosen by myself in collaboration with the local investigators during the second workshop, after I had been engaged in participant observation for about two months and had a better understanding of the different ways game is captured. When administering the questionnaires, the local investigators also drew sketch maps showing the location of each "kill site" in relation to important rivers, houses, trails, and other features.[9] Data were also collected on fishing activity and the use of domestic animals. Every three or four weeks a small gift (usually a one-pound bags of sugar) was distributed to each participating household as a gesture of appreciation for their time and cooperation.

Local investigators required from about five to 30 minutes to administer each questionnaire, depending on the amount of information that had to be recorded. Together with walking time between houses and return visits to households where people were absent, the number of households that could be covered in a single day ranged from about five to eight. In some cases, the local investigator made arrangements to visit households at the same time every week when people agreed to be home.

The local investigators and I met during a third, one-day workshop in October 1999, again in Caloveborita (Table 4.1). The purpose of this workshop was to review each questionnaire for completeness and accuracy, and to evaluate how the work was proceeding. While reviewing their questionnaires, the local investigators were able to share their experiences and discuss several issues related to the work. For example, they shared their interactions with interviewees, how to record certain types of information, and logistical problems. The local investigators were especially interested in each others' sketch maps. After collectively evaluating and comparing maps, everyone came to appreciate the kind of detail that was necessary to portray precise locations. We met as a group again two weeks later to repeat the questionnaire review process one last time as a group during a fourth half-day workshop to ensure that all local investigators completely understood how to administer all aspects of the hunting activity questionnaire.

Given that reviewing dozens of questionnaires one by one in a large group is so time consuming, the local investigators subsequently met with me individually every two or three weeks to review their work. These meetings between myself and individual local investigators began with a careful review of the completed questionnaire. As with the first round of questionnaires, sometimes minor details were absent. Local investigators would often interview hunters informally, listen to their stories, ask questions in various sequences, and then fill in the questionnaire toward the end of the visit. So when details were absent from the questionnaire, the local investigators almost always remembered the information. If the local investigator was not sure of some missing information, he made a note to ask during the next visit.

At first, the level of detail and the style of the local investigators' maps varied considerably. Many contained enough information to easily pinpoint game kill sites while others required the delineation of additional features. If the sketch maps required further elaboration, this was easily done with my prompting; all of the local investigators know their surroundings intimately, and only needed to add features to communicate kill site locations to me. As the local investigators gained more experience, their maps became more and more detailed. Symbols for different features became more standardized.

The local investigators, because they have such intimate knowledge of the geography of their community's subsistence lands, were able to visualize precise locations of game kill sites when interviewing hunters, and then easily portray these sites on sketch maps based on their own mental maps. The challenge, then, was to accurately transfer these cognitive locations onto 1:50,000 cartographic sheets. During our meetings to review the questionnaires, the local investigators showed me their sketch maps, explaining the location of kill sites on them; we worked slowly and carefully to plot these locations with precision onto the base maps. One of the great advantages of doing this work in the Buglé homeland is that the terrain is heavily dissected and is covered by an extensive network of named streams. Together with various trails, secondary houses, and mountain ridges, it was possible to plot kill sites with an accuracy of about 100 to 400 meters depending on the area, which on a 1:50,000 scale map equals two to eight mm. I deemed this a quite acceptable margin of error considering the size of the study area (well over 100 square kilometers) and the mobility of game animals. Kill site locations portrayed on the sketch maps were often narrowed down and confirmed through a series questions such as, for example, "Was the monkey encountered while still climbing up the trail or was it at the crest, or on the other side of the hill?" From my own growing familiarity with the area gained through accompanying villagers during agricultural work, hunting trips, fishing trips and from field mapping with guides, it was frequently possible for local investigators to explain to me exact locations without even referring to the sketch map at all. In some cases, an approximate location was later revised after I visited the area myself. I also recorded the locations of dozens of kill sites in the field during hunting expeditions (either directly, using a GPS receiver, or through reconstructing hunting routes); these locations were later used to confirm the location of sites plotted during the participatory mapping process.

After eight months of participatory research, over 1,500 hunting activity questionnaires were administered, information on about 2,500 prey items was recorded, and almost 1,300 kill sites were recorded onto topographic base maps, each of these linked with information on the age and gender of the hunter, the date and time of day, the hunting strategy, the technology employed, and the habitat in which each animal was encountered. Given that the 59 households in the hunting activity study included virtually all of the active hunters in the five study villages, the results are representative of the game harvest of the entire population of the Río Caloveborita watershed.[10] The kill sites were later entered into a GIS for analysis as explained below.

4.3 Independent field research

In addition to the participatory research done in collaboration with local investigators, I was also engaged in several independent research activities while in the field. These included participant observation, interviews, and field mapping, as described below.

4.3.1 Participant observation

Participant observation was done in the study area throughout the duration of the field research. This method involves gathering information about a group by participating in the daily life of community members, and is one of the primary research approaches adopted by cultural geographers in rural settings in developing countries (Price and Lewis 1993:9). Close, prolonged interaction with members of the group that is being studied allows the researcher to observe people engaged in their normal activities, to see how they respond to different situations, to share conversations with local people in different contexts, and to experience typical situations first-hand (Eyles 1988b:197; P. Robinson 1998:422). Among the various styles of participant observation, the approach I used was that of an observer who interacts with local people, and who is accepted by them, but whose role as a researcher in the community is known from the onset (Eyles 1988a:8-9). I was clearly an outsider, but at the same time I was able to join in activities to gain insight into many – but certainly not all – aspects of local people's experiences. While participant observation does not generate rigorously objective, measurable results that are easily replicated or validated, it does allow the researcher to gain understanding of less tangible phenomena like values, intentions, meanings, beliefs, and local perceptions and knowledge through a combination of observation, questioning, and listening (Eyles 1988b:198; Robinson 1998:424; Stoddard 1982:117). Participant observation allowed me to learn many things about indigenous culture and the way of life in the Caloveborita region, and to gather qualitative ethnographic information to complement quantitative and spatial data in order to gain a richer understanding of subsistence patterns in general, and hunting in particular.

The participant observation I undertook among Buglé, Ngöbe, and Campesino people involved working alongside villagers in their various subsistence activities, participating in social gatherings and community meetings, and simply visiting with people while walking from place to place or during their leisure time. I took notes periodically throughout the day in small notebooks, and transcribed them to waterproof field books every second or third evening. Working alongside farmers in their fields helped introduce me to community life, while building rapport and friendships. Helping people in their daily tasks provides unique opportunities to ask questions about many aspects of their culture and subsistence activities. Accompanying farmers' in their fields, I also took advantage of the opportunity to conduct short interviews to document 90 farm histories focused on cropping and fallow cycles. Most local villagers demonstrated remarkable patience for my endless questions about topics that were of special interest to me, such as agricultural methods, land tenure, useful forest plants, animal behavior, and local history. Many seemed to truly appreciate my interest and were enthusiastic informants. After several months in the field, after I had learned more about Buglé culture and had developed closer relationships, I began asking people about their cosmological beliefs, legends, and rituals related to hunting success, although in this regard I barely scratched the surface.

4.3.2 Direct observation of hunting and fishing activity

Part of my time engaged in participant observation consisted of direct observation of hunting and fishing trips, which I did as frequently as possible. However, although hunting and fishing are common activities, they are not often planned very far in advance; the decision to go on a trip is also conditioned by weather, which is not reliable. As such, it helps to be in the right place at the right time to be able to accompany hunters and fishers, which is problematic where settlement is so dispersed. However, I let people know that I wanted to go as often as possible, and I was sent invitations to go on hunting trips on several occasions. During the field research, I was able to participate in a total of 20 hunting trips (two of these being overnight events of more than one day) and about 30 fishing trips.

While accompanying hunters, I recorded my observations (in small notebooks or with a small tape recorder) on the time of departure and return, the articles brought along, the techniques used, the routes taken, animals encountered, game caught, and all other relevant information. The hunting trips also provided opportunities to ask people about their understanding of animal behavior and diet, past hunting trips, forest plants, and other subjects. I also recorded GPS coordinates along the route, especially at house sites, boundaries between rain forest and agricultural lands, and of game kill sites whenever possible. The entire hunting trip was later reconstructed using the GPS points, compass readings, and other notes. In this way it was possible to plot the locations of all the sites where game was captured and later compare these known kill site locations with those that were communicated by the local investigators. In this way, I was able to use observations obtained through participant observation to confirm the accuracy and effectiveness of the participatory mapping process.

4.3.3 Mapping settlement and forest cover

The locations of primary and secondary houses and the boundaries between rain forest and agricultural areas were acquired with a GPS during the course of participant observation (Figure 3.3). In addition, I went on about 20 special outings with knowledgeable local guides were needed to collect additional GPS locations to complete the mapping of settlement and forest cover for the entire study area. Compass readings combined with my own sketch maps of forest cover from strategic points with a good view were also used. Over 200 points were recorded for primary and secondary houses (some were also mapped in relation to other features without GPS coordinates). Mapping the boundaries of rain forest was somewhat more difficult because of the large size of the study area and the complex, fragmented pattern of forest cover.[11] For the land cover map, I disregarded the smaller forest fragments with an area of less than roughly 10 hectares. The forest boundaries near the study villages were mapped directly and precisely. Some forest boundaries north of the study area were mapped with less precision, based on interviews, sketch maps made with local people, and recent settlement maps made by the Dirección de Estadísticas y Censo in Panama City.[12]

4.3.4 Interviews on game preferences and agricultural pests

I was not surprised to learn when accompanying hunters that the Buglé have varying preferences for different game animals which affect decisions about which animals to pursue when hunting. Hunters will pursue the animal that is more highly preferred if fresh tracks of two species are discovered, all other things being equal. Game preferences can also affect what weapons are used for different species. For example, a hunter may choose not to shoot a small bird in the canopy when a highly desired game animal in the area might be frightened off by the sound of the report. To better understand game preferences, I interviewed 33 hunters were interviewed (including three women). The interviewees were also asked to indicate which animals (excluding insects) inflict the greatest damage on several principal crops.

The interviews were conducted using plasiticized cards with illustrations of different animals. Thirty species were selected to include a broad sample including highly coveted species as well as smaller, but more frequently captured species. I also made an effort to represent a full range of animals in terms of body mass, from large mammals to small birds and reptiles. Although many more species are hunted in the region, a limit of 30 animals was chosen to keep the interview length within reasonable limits (about 30 minutes). Before beginning, the nature and purpose of the interview was explained, stressing that it was not the quality of the meat that I wanted them to rank, but rather the value of the entire animal as a prey item. The cards were then shuffled and placed before each interviewee in random order. He or she was then asked to choose which animal they would be most pleased to catch while hunting. Rankings were recorded on a special form and the flash cards were removed one at a time until all thirty animals were ranked. At the end of this part of the interview, each respondent was asked to indicate which animals most commonly feed on the seven primary crops grown in the region.

Toward the end of the field research, a group meeting was arranged with several key informants from different villages to review a long list of Spanish, Buglé, and Ngöbe terms for crop varieties, game species, and forest plants that were gathered during participant observation, informal interviews, and meetings with local investigators.

4.4 Compilation of quantitative data

The questionnaire data on hunting and fishing activity that was collected by the local investigators was entered directly into spreadsheets (MS Excel) upon my return to the University of Kansas. For each game animal captured, the scientific name was added, which was straightforward for the most important species. Spanish and Buglé terms for game species were compiled in the field so that I could assign the correct scientific name to each animal in the database. Local terms for game animals were collected in the field by showing hunters illustrations and photographs of animals, or by using physical specimens whenever they were available. When an animal term I did not recognize appeared on a questionnaire, I asked the local investigator describe it to me and then afterwards show it to me among field guide illustrations. I also did this periodically to confirm known animal terms.

However, assigning scientific names to many of the small bird species in the database was difficult. In some cases, I was never able to see a physical specimen myself to be absolutely certain about which local terms were used for which species. Moreover, local classifications are not completely congruent with scientific taxonomies. In several cases, a number of bird species are grouped into a single category and given a single name. This is true of both Campesino and Buglé ornithological taxonomies. Some species have more than one Buglé name, further complicating the identification. Also, children do not always know the names of the birds they catch.[13] Among the Ngöbe, many of whom were raised in villages on the drier, southern slope of the isthmus where wildlife composition is quite distinct, this was true of adults as well. To overcome this problem, several of the small bird species were grouped into a single genus or family for the purposes of compiling summary statistics. The vast majority of small birds that were captured could be identified to either the species or genus level. For fish species, which are more limited in number, local names were obtained using physical specimens and photographs taken for identification with the help of published keys (Bussing 1998).[14]

Weights were assigned to each species based on published average body mass figures (Dunning 1993; Eisenberg 1981; Robinson and Redford 1986; Stiles and Skutch 1989).[15] The sex of each animal was recorded by the local investigators on the questionnaires so that the appropriate weight could be assigned to bimorphic species. All juveniles that were captured were given half of this weight. Average body mass figures for reptiles were not available in the scientific literature, so for these I used measurements obtained in the field (using vertical spring scales), with the exception of a turtle and two small lizards for which estimates were made.[16] For the small bird species that were grouped into a single genus, averages of two or more species were used.[17] Once the scientific names and weights of all mammals, birds, and reptiles captured were assigned, hunting yields were tabulated according to species, order, hunter, gender, household, village, month, weapon, strategy, and habitat.[18]

The hunter who caught each prey item was recorded on the questionnaires, and hunter identification numbers were added to the spreadsheet database. In cases where two or more people were involved in the capture of a single prey item, the weight of the animal was divided between hunters. Calculating totals for different weapons required some generalization. For hunting with firearms, traps, the bow and arrow, and slingshots, the procedure was straightforward. All other weapons were grouped into one category, "other." This category is fairly large, because it is very difficult to separate the use of dogs, improvised spears, machetes, and other tools into distinct categories. For example, dogs are involved in many hunts that also rely on firearms. Animals are also trapped in their burrows by dogs and then dug out or smoked out of their hole and killed with a spear. Machetes are almost always used while hunting, if only to help clear the trail as the hunter pursues game. It is an important weapon to kill an animal that has been wounded, and is often the primary weapon used to make a kill of an animal captured by a dog. As a result it is not possible to calculating separate harvest totals of game caught using certain hunting tools. As such, game captured with dogs, machetes, axes, or a person's bare hands (a common way of obtaining a sloth or wood turtle) were all grouped into the "other" category.

4.5 GIS analysis of settlement, habitat, and hunting yields

A variety of spatial data layers were incorporated into a GIS database to produce maps, calculate land cover area values, and analyze the relationships between human settlement, habitat, and the distribution of game kill sites. The GIS analysis began with digitizing and generating spatial data layers, followed by spatial analysis and map production.

4.5.1 Creation of the river, settlement, and land cover data layers

Data entry began by digitizing streams from two 1:50,000 topographic maps published by Panama's Instituto Geográfico "Tommy Guardia" (Universal Transverse Mercator [UTM] coordinate system, North American Datum 1927). All permanent and intermittent streams in the study area and surrounding areas were digitized using a large, upright digitizing table and ArcInfo (8.0) GIS computer software. Streams were digitized from two separate topographic sheets, and then joined together into a single "coverage" (vector-based spatial data layer). Numerous additional tributaries in the study are that were mapped in the field were not added to the coverage in order to produce simpler, more readable final maps. This coverage, as well as all others, were projected into the UTM coordinate system.

The next spatial data layer that was created was a settlement coverage consisting of house sites. This coverage was generated automatically from a file of the UTM coordinates I collected using a GPS. Attribute information obtained from the census of the study area completed by the local investigators, including the name of the head of the household, household size, and ethnicity were then joined to the settlement points by means of unique identification numbers assigned to each residence.

The next data layer that was added to the GIS database was a land cover coverage, divided into three general land classes: forest, agricultural lands, and water. Forest cover was plotted onto 1:50,000 base maps using GPS coordinates, sketch maps, and compass readings collected in the field. Larger forest islands, and clearings within the forest were also mapped. Narrow strips of forest that are left along trails, and small forest fragments surrounded by agricultural lands were not included in the mapping because of their small size (generally less than five or ten hectares) relative to the entire study area. Forest cover near but outside of the study area was also mapped, but with less precision. After the land cover boundaries were compiled onto the two adjoining topographic sheets, they were digitized, joined together, projected into UTM coordinates, and edited.

4.5.2 Creating the game kill site data layer

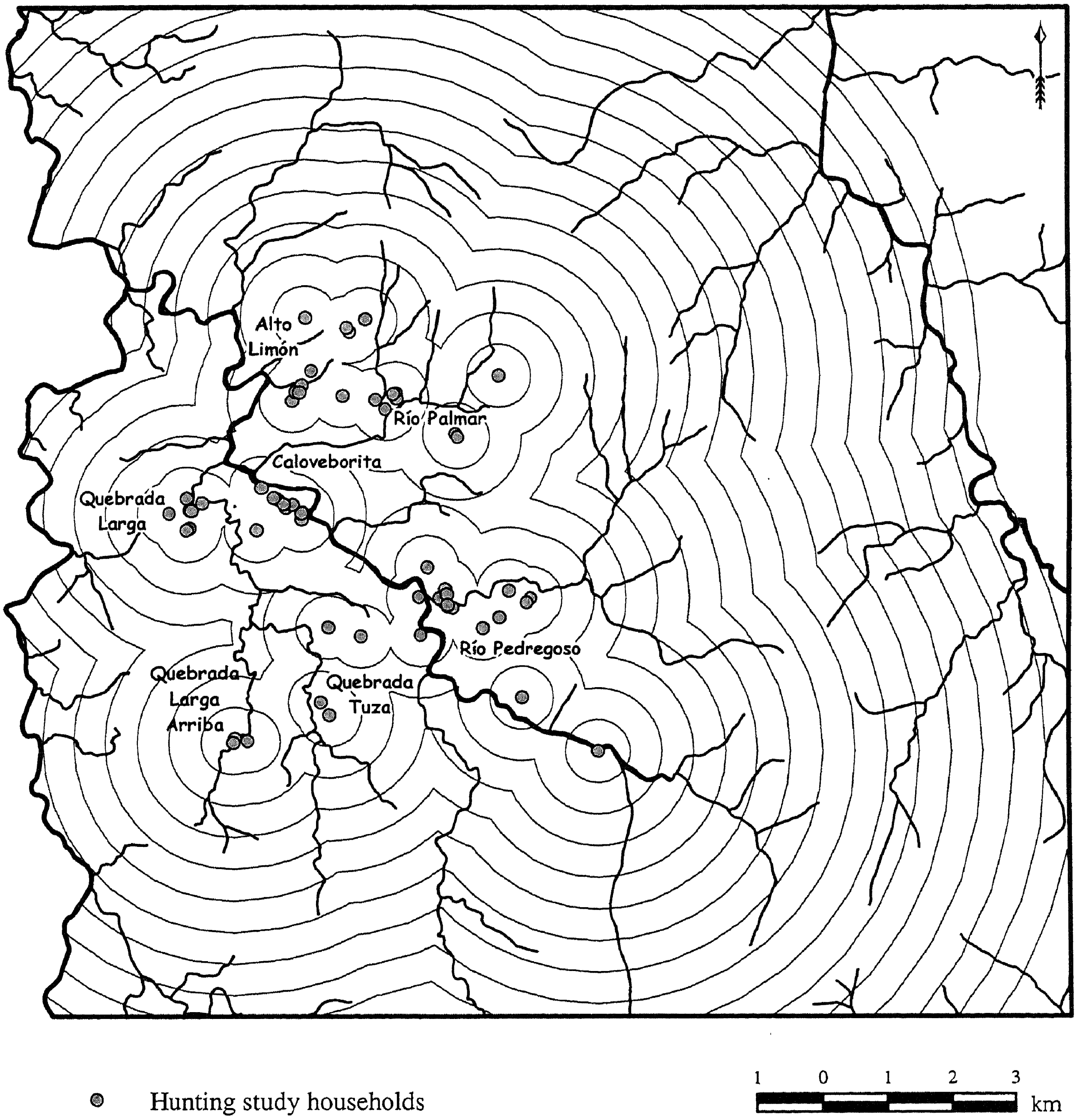
The spreadsheet containing the questionnaire data on all game animals captured served as the basis to create a new GIS data layer representing the spatial distribution of kill sites. First, small birds, crabs, and other species whose kill sites were not mapped were removed, leaving a total of 1,278 animals in the database. Each of these prey items was then assigned a unique identification number that were added to each kill site as they were digitized and added to the GIS coverage. In order to digitize the kill sites more efficiently and accurately, the two adjacent topographic maps representing the study area were scanned and georeferenced to provide a backdrop on the computer screen. After all of the kill sites were digitized, the unique identification numbers were used as a link to join the attribute information from the questionnaire results to the each point in the coverage. These attribute included the species name and order; the hunter, household, and name of the community; the gender of the hunter; the hunting strategy and technology used; and the time of day when the animal was encountered (day or night) and month in which it was caught.

4.5.3 Spatial analysis

One of the most significant results of the field research is the series of maps that were produced. Once the GIS database was complete, it was easy to generate a variety of maps showing the spatial relationships between indigenous subsistence and wildlife use. Kill sites were mapped (using ArcMap software) according to species, hunting strategy, weapon, gender, and community in relation to settlement patterns and land cover. Each of these maps tell a different story that can be read through careful interpretation.

The spatial distribution of kill sites was also analyzed to evaluate how distance affects hunting yields. One of the main hypotheses of the research was that certain species would be caught close to indigenous villages, while others would be caught in more distant areas. This hypothesis is tested in part simply by producing and comparing maps of kill sites for different species. I also decided to systematically measure hunting yields as a function of distance from indigenous settlement to show how far hunters need to travel to catch significant amounts of game. To do this, a series of "buffers" were made using the GIS software at 500 meter intervals around the primary house sites of hunters that participated in the study (Figure 4.1). Each buffer interval represents all areas found within a specified distance of these house sites. Individual house sites were chosen rather than village centers in order to better represent the dispersed nature of Buglé settlement. The amount of game captured within each buffer interval was calculated by overlaying the kill site spatial data layer with the buffer areas, and adding the weights associated with the kill sites falling within each buffer interval.

Figure 4.1. Buffer distance intervals around house sites in the Caloveborita region.



[1] These included the Regional Cacique and the President of the Regional Congress who are the two highest authorities representing indigenous communities in the Province of Veraguas, as well as the Secretary of International Relations of the General Congress which represents the entire combined Ngöbe and Buglé population.

[2] Residents from Río Palmar, Quebrada Larga, and Quebrada Larga Arriba were invited to the meeting in Caloveborita, which is a common practice for other meetings, such as those that are held to discuss school issues.

[3] One of the nominated investigators was an older man who could not read or write. In this case, another person was nominated to work as his secretary.

[4] These households were all headed by Campesinos who did not want to participate in the study because of my collaboration with and recognition of the indigenous leadership.

[5] This questionnaire was based on those used during participatory research mapping with indigenous groups in the Darién, Panama and the Honduran Mosquitia (Herlihy 2003; Herlihy and Leake 1997).

[6] The use of air photographs upon which villagers can draw community land use boundaries and other information is another promising participatory mapping method. Air photographs provide a spatially accurate base map, are engaging, and are easily interpreted by people of varying levels of education (Mather 2000).

[7] It is interesting to note that many places have both Buglé and Spanish names. At various times during the fieldwork, it was difficult to solicit indigenous placenames, in part because of what I perceived to be a widespread undervaluation of indigenous culture. When asked the name of a place or stream, Buglé villagers would sometimes tell me that they did not know its name, but then later tell me what they call it in their own language!

[8] Early in the study it was discovered that one respondent was lying about his hunting activity. The problem was revealed to one of the local investigators through conversation with friends and family members. The local investigators, because they are local residents and long-standing members of the community, are better able to know when false information is being provided.

[9] Early in the hunting activity research, it was decided to omit the small bird species from the sketch maps because it was taking an inordinate amount of time to map them all. Numerically, small birds such as orioles, tanagers, and manakins make up a large proportion of the game captured among the Buglé, although they do not represent a very significant amount of the total game caught by weight. Most are caught by children with slingshots in dooryard gardens and along trails near the home.

[10] Some members of the remaining 40 households of the region may have occasionally caught some game thereby increasing the yearly harvest, but the amounts would almost certainly be insignificant in comparison with the harvest of the participating households.

[11] Remotely sensed imagery would have been useful to corroborate field mapping and to gain more precise forest limits in outlying areas outside of the subsistence zone of the study population. However, for the purpose of this study, very recent land cover data would be necessary, and good quality imagery with a suitable resolution was prohibitively expensive.

[12] These 1:50,000 scale maps were compiled by the Dirección de Estadísticas y Censo based on field work conducted in 1998. They indicate, fairly accurately, the location of all house sites belonging to the hamlets and villages of northern Veraguas.

[13] 43 birds were recorded simply as "*pajaro*" and not included in the tabulations.

[14] Dr. Richard Cooke, at the Smithsonian Tropical Research Institute generously assisted me in the identification of fish species.

[15] For the body mass of birds, Dunning (1993) was the preferred source, but a few estimates were taken from Stiles and Skutch (1989) as well. For mammals, Robinson and Redford (1986) was likewise favored over Eisenberg (1981).

[16] Dr. William Duellman, Curator of Herpetology at the University of Kansas Natural History Museum, shared his expert advice to make these estimates. The three species for which estimates were made (*Kinosternon leucostomun*, *Lepidophyma flavimaculatum*, and *Corytophanes cristatus*), are small prey items that are not caught frequently, and make up an extremely small (less than one percent) contribution to the total hunting yield.

[17] Often these averages were of just two species with very similar weights. In other cases, an average of several birds that share a common local name were averaged. The most problematic group to identify was the hummingbird family, Trochilidae. Over 50 species are represented in Panama (Ridgely and Gwynne 1989), with differences in coloration between males and females. The Buglé and Spanish terms used are usually general, and specific names are not consistently applied. As such, all hummingbirds were grouped into a single category and an estimate of 5 grams for each individual bird was used, based on the average body mass of the most common species.

[18] Most totals were rounded to the nearest kilogram, and percentages to the nearest integer. It should be kept in mind when evaluating the quantitative data that these relatively precise estimates are subject to a small margin of error due primarily to the fact that average published weights were used rather than actual weights.

5. Contemporary Lifeways of the Buglé

Despite centuries of disruption and change, the Buglé on the northern slopes of western Panama practice a way of life with innumerable connections to an ancient past. They speak their native language, depend on a traditional form of agriculture, and maintain an intimate relationship with their natural surroundings that has been passed on generation after generation. As their relative isolation continues to wane, and exogenous ideas, technologies, and economies are introduced, the Buglé will face growing threats to their survival as a distinct people. Their ability to adjust successfully to change will be largely dependent on whether or not they are able to maintain their self-reliance through the sustainable use of their natural resources. This chapter describes how the Buglé in the Caloveborita region farm, use the forest, and earn money – in other words, how they make a living. A detailed overview is provided in part because it is not available elsewhere, but more importantly because hunting patterns are conditioned either directly or indirectly by all of these activities. In addition, habitat modification through shifting cultivation has special implications for numerous game species and is one of the key elements of the relationships between indigenous peoples and wildlife in neotropical rain forest environments. This overview, however, should be considered tentative, and based on observations made almost entirely in the Caloveborita watershed. In other areas, environmental conditions, population density, land availability, wage earning opportunities, and relations with other ethnic groups may be different, leading to distinct economic orientations.

5.1 Land tenure

The usufruct land tenure system among the Buglé is similar to others found among indigenous shifting cultivators elsewhere in the humid neotropics. Once a farmer clears a new field from the forest, that plot of land is not available to anyone else as long as he or she continues to use it. Although these lands are not "owned," exclusive rights to use them are retained even after the field is left fallow and is gradually replaced by secondary forest. Fallow lands may be inherited by both sons and daughters, but the former is much more common, as it is expected that a daughter will be provided for by a husband with access to his own lands acquired through inheritance or his own work. Yet, in the Caloveborita region, which experiences in-migration of young adult males seeking new areas to farm, new settlers often marry a daughter of an established family and are given rights to use land belonging to the bride's father. Under the customary rules of land tenure, any forest area is available for clearing, but in practice there are exceptions. Forest products for house construction are especially valuable and often scarce, and many individuals claim small, isolated forest lots as private reserves for their own use. Sometimes neighbors agree to divide a piece of forest that is surrounded by their farmland for their respective use. In some cases, farmers deliberately clear new farms around a forest stand over time, enclosing it within their agricultural lands to consolidate their "ownership" of the reserve.

Buglé men feel a responsibility to their children to provide them with lands for future use, and sometimes invest considerable effort into clearing land over many years in order to accumulate large areas of secondary forest to pass down to their sons. A person's lands, however, are not always divided by his heirs, but are sometimes held in common by all descendants. Fallows are used as needed, and individual plots can pass from one brother to another. When there are not sufficient lands for all heirs, older brothers may lay claim to all of the inherited lands, leaving younger brothers no recourse but to establish new clearings for themselves. This is especially common where polygamy has resulted a large number of heirs.

Family sizes among the Buglé are large, and under normal circumstances all fallows are eventually used by a farmer or his children, so that agricultural lands are rarely abandoned. This is even true when people move to another community. The Buglé are quite mobile, and those who have limited access to inherited lands are especially prone to move once or more during their lifetime. For example, several families who now live in the Caloveborita region continue to return to villages where used to live to harvest and replant crops. Alternatively, they may allow relatives to use their lands with the understanding that if they should return, these lands would become available to them again. However, there are situations where fallows are completely abandoned, mainly when a family moves out of the region to a distant location. In these cases, two things may occur. Firstly, the fallow may become very old and someone else may begin to use it. Once a fallow reaches the age of about 20 or 25 years, and there is no indication that the person who cleared the land will return, the fallow may be used by another person. Sometimes a person will make efforts to consult the original caretaker to seek permission. Alternatively, a farmer may try to sell his farmland to someone else in the village for a small sum before he leaves.

In the Caloveborita region, farmland that is closer to village sites is preferred, primarily because the Buglé place a high value on the education of their children. Working in areas far from school requires either that their children walk great distances to attend class, or that the farmer must travel significant distances to active gardens.[1] Families that have a long history of residence in the region arrived when lands were more abundant, and tend to have sufficient lands close to the village centers. In the vicinity of Caloveborita there is no longer any forested land nearby that is available for agriculture. The farmland is dissected by a complex network of invisible boundaries between the lands of different families. Families that arrived later, and men who have not inherited land, tend to have farms in areas that are more distant from the village. People seeking new land tend to choose locations that are somewhat removed from other farms in order to avoid conflicts in the future when lands may become scarce – this is a concern for many farmers, especially for those who left other communities because of land conflicts. Farmers clearing land in distant areas usually build secondary residences in these locations, where family members spend short periods by themselves to do agricultural work, and where the entire household stays during school vacations.

Residents in the Caloveborita region commonly state that land should not be bought and sold, but that permanent crops such as peach palms, coffee bushes, orange trees are negotiable. If someone wants to cultivate a piece of land that belongs to someone else, the plot may be exchanged for a modest sum that takes into account the value of the tree crops found there. The going rate at the time of the research was $5 per tree or palm,[2] which represents about two days of wage earnings. Or, an area of fallow with some fruit trees, for example, may be exchanged for a small pig. Pastures that have been planted with introduced grasses are considered to be improved land are may also be sold. However, although in principle the land itself is not considered private property and can not be sold, in practice fallow lands without fruit trees or other permanent crops are occasionally sold between neighbors, although efforts may be made to keep the transaction private so as to avoid criticism from the community.

The Buglé are in general strongly opposed to the sale of lands, especially to outsiders. A primary fear is that outsiders, or local Campesino professionals (i.e., teachers), are the only ones with the economic resources to purchase lands, and that they will be able to gradually buy up vast amounts of land so that eventually the indigenous families will have serious land shortages. This issue has been especially prominent over the last fifteen or more years because of the struggle for the establishment of the Ngöbe-Buglé Comarca, which in fact included a large part of northern Veraguas in at least one draft proposal. The indigenous population in northern Veraguas, however, continues to demand that the territorial limits promulgated in 1997 be amended to include northern Veraguas. This situation has not only produced serious tensions between the Campesinos and the Buglé, but also complicates land tenure conflicts. If a dispute can not be resolved with the help of friends and neighbors, the Buglé seek out local or regional indigenous authorities. This leader may then visit the area in dispute and help resolve the conflict. However, complaints may also be made through "civilian" government channels (to a *Corregidor*, *Representante*, or *Alcalde*). This is done by Campesinos who do not recognize the authority of the indigenous organization outside of the legal boundaries of the comarca.

In the last several years, there have been a few isolated cases when outsiders from Santa Fe and other areas south of the central cordillera have purchased land from local residents for cattle pastures. In all cases, this has led to organized opposition from indigenous authorities. Pressure on the newcomers to leave is mounted through visits by indigenous leaders and formal resolutions drafted at annual congresses. So far, the indigenous federation has been successful in ejecting colonists from "*afuera*" ("outside" of the region), but now that the limits of the Ngöbe-Buglé Comarca have been defined, their power to defend against such invasions in northern Veraguas has been severely undermined.

5.2 *Agriculture*

The mainstay of Buglé subsistence, as with virtually all indigenous peoples residing in the rain forest regions of the neotropics, is shifting cultivation,[3] also known as swidden agriculture. In general terms, shifting cultivation as practiced by the Buglé may be characterized as a form of rotational agriculture with heavy reliance on reciprocal work parties for clearing, mulching of felled biomass, and the use of wide variety of staple crops. It is noteworthy that farmers in the Caloveborita and surrounding regions rarely burn their fields before planting, but rather let the cleared vegetation slowly decay in the field – a practice known as "slash-and-mulch." This has implications for agricultural productivity over the long term because it has different impacts on soil properties over time. The Buglé make use of seven primary crops: maize (*maíz* in Spanish), rice (*arroz*), bananas (*guineos*), yuca, yams (*ñame*), dasheen (*sepa*), and the peach palm (*pifá*) (Table 5.1). All of these are staples of more or less equal importance, although some households tend to plant certain crops in greater quantities than others. Additional crops that are interplanted with these or planted separately include coffee (*café*), otoe, plantains (*plátanos*), beans (*frijoles*), sugar cane (*caña de azucar*), and oranges (*naranjas*). Many other cultivars are found in the dooryard orchard-gardens surrounding the home.

Agricultural work is done by both men and women. Both men and women plant, weed, and harvest crops, although women tend to do more of the weeding and harvesting which in the case of root crops, occurs on almost a daily basis. The only task that is reserved almost exclusively for men is clearing fields. Most new fields, whether they are made from cutting down young fallows, secondary forest, or mature rain forest, are cleared by communal work parties, called *juntas* (also called *cambio de mano* elsewhere). A farmer's brothers, brothers-in-law, friends, and neighbors may all be invited. For large *juntas* that are organized to clear large tracts of land, up to 25 people may be invited. Smaller *juntas* of five or six men are more typical. In some cases, a group of farmers agree to work together clearing a different person's plot each day for an entire week or so.

A farmer planning a *junta* to clear a new field begins by cutting and pressing sugar cane, extracting the juice and placing it in plastic containers, and waiting for several days

Table 5.1. Primary and secondary crops planted by the Buglé.

Spanish name	***Buglé name***	***Scientific name***
Primary crops		
maíz	aú	*Zea mays*
arroz	aró	*Oryza sativa*
ñame	haña	*Dioscorea* spp.
ñame blanco	haña hutre	*D. rotundata*
ñame guacajó	haña guakahó	*D. alata*
ñame amarillo	haña kalorín	*D. cayenensis*
ñampí	haña	*D. trifida*
sepa	hirŏ	*Colocasia esculenta*
yuca	i	*Manihot esculenta*
guineo	bla	*Musa* spp.
pifá (pifbá)	bibá	*Bactris gasipaes*
Other important crops planted in fields, dooryard gardens, and pastures		
piña		*Ananas comosus*
guanabana	guanabo	*Annona muricata*
fruta de pan, árbol de pan	pan, pâglia	*Artocarpus altilis*
achiote	galá	*Bixa orellana*
naranja (dulce)	nâră	*Citrus sinensis*
limón	limó	*C. aurantifolia*
naranja japonesa	nâră haponesa	*C. aurantium*?
limón chino	limó chino	*C. limon*?
limón limo	limó limo	*Citrus* sp.
frijol de palo	poroto	*Cajanus cajan?*
ají	cheúkwa	*Capsicum* sp.
papaya		*Carica papaya*
sandía		*Citrullus lanatus*
coco		*Cocos nucifera*
café	kafé	*Coffea canephora*
calabazo / tutumba	hogdá (hogé)	*Crescentia cujete*
pepino	pepino	*Cucumis sativus*
uyamá (zapayo)	erúmli (?)	*Curcurbita moschata*
membrillo	tumá	*Gustavia superba*
ratana		*Ischaemum indicum?*
calabazo de bejuco	numá	*Lagenaria siceraria*
tomate		*Lycopersicon esculentum*
plátano	bla, kwerí	*Musa* sp.
gramalote		*Paspalum dilatatum?*
maracuyá		*Passiflora edulis*
frijol de bejuco	skiú giskale	*Phaseolus vulgaris*
guayaba	uré	*Psidium guajava*
caña de azucar	eské	*Saccharum* spp.
pera		*Syzygium malaccense*
cacao	ku	*Theobroma cacao*
cacao chibú	ku chibú	*T. bicolor*
otoe	hirŏ	*Xanthosoma sagittifolium*
jenjimbre	dáikwacho	*Zingiber officinale*
trigo		?
ñajú		?

until it ferments sufficiently. This *guarapo* is the most important item offered in exchange for the labor of the *junta* participants, although fermented bananas or maize may be prepared instead. Often, a meal is also served for the group after the day's work is done. Notwithstanding the fact that food and drink are provided to the participants, this is a reciprocal system, and it is expected that the host of a *junta* can be counted on to work for the participants at a later date. In the case of female-headed households, women also clear fields, but may similarly organize a *junta* consisting primarily of her male relatives.

It is possible to identify four farm types, or cultivation systems, found in the Caloveborita region which are described below, although in reality there is considerable variation in the combination of crops that are chosen and the methods and cycles of cultivation, leading to a degree of overlap between these heuristic categories.[4] Three or four cultivated plots are initiated every year by each household on average, and remain productive for about two to five years depending on the quality of the soil, the types of crops planted, and the amount of weeding that is done to maintain productivity. Households usually have several active gardens in different stages of cultivation at any given point in time and agricultural work is done throughout the year.

5.2.1 *Maíz chiquito* cultivation

One of the most important and common farm types is the *maíz chiquito* plot. *Maíz chiquito* is a local – and likely ancient – variety of maize with small cobs (~ 10 to 15 cm long) and small yellow and dark purple (and sometimes reddish) kernels. Primary forest or secondary forest (of at least five, but averaging about eight years) is cleared for the crop, which most families plant once per year. Field sizes for *maíz chiquito* are typically among the largest, ranging up to about four or five hectares. The field is initiated by clearing the understory with machetes and planting secondary crops in some portions of the plot, usually at low densities. The combination of secondary crops planted varies, but most commonly includes bananas, yams, yuca, and dasheen. Then, *maíz chiquito* seeds are broadcast over the felled underbrush, after which tall trees and palms are cut down with axes. Some wild species that provide firewood, lumber, or house materials are occasionally spared, including *cedro* (*Cedrela odorata*), *bateo* (*Carpa guianensis*), or *guayacán* (*Tabebuya* sp.?), as well as the *gira* (*Socratea exhorrhiza*), and *palma real* (*Attalea butyracea*) palms. Frequently, however, trees and palms that are identified for future use are knocked down by other falling trees or pulled down by vines that weave through the forest canopy. Once the maize is sown, the field is not burned –burning is usually not possible because of the abundant rains that fall during the period when these fields are prepared. Unlike some of the other principal crops grown in the region, *maíz chiquito* has a definite seasonal cycle, although there is considerable latitude as to when new fields are initiated. Sowing occurs as early as September and continues until January, and this slow-growing variety is harvested about five months later, after it has matured and dried in the field on the stalk.

The maize plants rise up through the decomposing vegetation with the help of weeding which is done once or twice during the growing period. When it has matured, some cobs are harvested for immediate consumption, but most of the maize is left to dry in the field. Several forest animals raid the maize crop. Six species in particular stand out as the most significant pests, as identified during interviews with local farmers.[5] These are the blue-headed parrot (*Pionus menstruus*), the coati (*Nasua narica*), the paca (*Agouti paca*), the collared peccary (*Tayassu tajacu*), the red-tailed squirrel (*Sciurus granatensis*), and the great-tailed grackle (*Cassidix mexicanus*), a bird that has become increasingly abundant in Panama's principal cities and other parts of the country (Ridgely and Gwynne 1989:428). Some farmers build temporary shelters in their fields where they stay for a week or two to guard their field from these pests. Alternatively, they may construct simple scarecrows, visit the fields before dawn or after nightfall to wait in hiding for game animals, or make small fires in their fields periodically to keep animal pests away. After the harvest, the secondary root crops and bananas interplanted in the field continue to grow and may persist for several years if periodic weeding and replanting occur.

Among the Buglé, maize is consumed primarily in the form of *chicheme*, a corn porridge made from soaking, straining, boiling and grinding the maize. Maize is also fermented, and *chicha de maíz* is a common drink after the harvest. Young, tender maize is also roasted over a fire, and thick tortilla cakes are made.

5.2.2 "*Verduras*" cultivation

A second farm type that is common among the Buglé consists primarily of bananas, yams, dasheen, and yuca – and does not include maize or any other grains. These farms are known locally as a "*verduras*" plot. Plantains and otoe are also sometimes planted, and Campesino farmers often plant *uyamá* (*Curcurbita moschata*) in these farms. Again, fallows of at least five years are used, although primary forest plots are also cleared frequently in part because they are recognized as more fertile (in particular for dasheen and banana production). Parts of the field may also be used to plant sugar cane, peach palms, or a few fruit trees. As with the *maíz chiquito* farm, field preparation begins with clearing the understory. The principal crops are then interplanted beneath the taller trees and palms before taller trees and palms are cut down. Again, the field is not burned – the cleared vegetation is left to decompose on the ground as the crops grow. Weeding is done two or three times during the growing period before the first harvest. A *verduras* plot can be planted in virtually any month.

Harvesting begins after about eight months to a year, depending on the crop. Only small quantities are harvested at a time as they are needed for home consumption. Root crops are better left in the field where they continue to grow and do not spoil. "*Buscando verduras*" is thus an activity that takes place every two or three days as stores in the home are depleted. When harvesting, new shoots and rhizomes are removed and replanted in the same field. Weeding is also done frequently to extend the life of the farm. For example, when *ñame guacajó* (*Dioscorea alata*) is harvested, part of the deep edible tuber is cut off and replanted nearby. Small axillary tubers (those that grow directly on the climbing vine) can also develop into new plants, sometimes in new locations where they have been deposited by floodwaters. In this way, *ñame guacajó* can persist in an area for many years without much effort on the part of the farmer. With periodic weeding and replanting, bananas and other root crops can continue to produce for up to four or five years (or even longer in the case of bananas). As a field gradually reverts to fallow, the planting stock from older farms is eventually transplanted to a new farm. Families plant new *verduras* farms every year, and as the harvest of one farm declines, another comes into production. As with other farms, peach palms and fruit trees are commonly planted in the fallow after the main harvest.

5.2.3 Rice cultivation

Rice is a highly valued crop in the Caloveborita region. Unlike all other principal crops, it is the only one for which the burning of a cleared field is necessary. A local variety, called *arroz colorado* (**"aró dabere"** in Buglé) is the preferred type, for both its flavor and resistance to a variety of pests (due in part to thick seed husks that seem to deter some birds) Secondary forest is preferred over mature rain forest for rice farms because the felled biomass dries more quickly, resulting in a greater probability of an effective burn. The undergrowth is cleared first, and secondary crops (dasheen, bananas, yams, and yuca) may be planted before taller trees and palms are cut down. These crops are not damaged by fire allowing them to re-sprout after a fire. In such a humid environment, the burning of the field is never certain and almost always variable; some patches of the field are burned more thoroughly than others. A good burn is important to obtain a clean planting surface and reduce the need for weeding, and also to add nutrients to the soil. Farmers hope for at least two or three weeks of dry, sunny weather before setting fire to the field. Sustained dry weather occurs most frequently in March and April. As the lifeless vegetation dries, the farmer waits as long as he feels he can without risking rain. He then chooses a (preferably windy) day to set fire to the field. Next, the rice is planted. If the field has only burned partially, rice planting is concentrated in those areas where combustion was most complete. Additional crops that are commonly planted in rice fields are an unidentified grain known in the region as *trigo*, beans, and a short bush known as *ñajú* (unidentified) that produces a pod of small, reddish seeds that are made into a beverage. If planted in March, the rice is ready to harvest in June or July. After the rice harvest, additional root crops and bananas may be planted to take advantage of the effort invested in the initial clearing of the field.

Birds represent the greatest threat to the rice harvest. The worst pests, according to local people, are the blue-black grassquit (*Volatinia jacarina*) and the blue ground dove (*Claravis pretiosa*), followed by many other small birds that feed on the ripening grains.[6] Rats and other small rodents were not mentioned as important pests by Buglé interviewees.

People visit their rice fields frequently just before harvest to scare the birds away with slingshots, which happens in other parts of Central America as well (Mathewson 1984:97). A small trap is also used to catch ground doves. It consists of a pyramid-shaped box made of a lattice of sticks that falls on the bird when it approaches to feed on the bait that is placed underneath.

Rice production is one of the more tentative subsistence activities practiced by the Buglé. The dry season on the Caribbean slope of western Panama is very short, unreliable, and unpredictable. One to three weeks of clear, dry weather usually occurs around March or April, and dry, sunny periods may also occur around October. Despite the fact that the arrival of the dry season is uncertain, the Buglé clear fields in advance with the hope that they can burn the fallen vegetation to initiate a new rice farm. The problem, however, is that in addition to the uncertainly of whether or not a dry season will arrive, the timing of the brief period of sunny weather is also critical. If a farmer clears a field too early, weedy vegetation will become too thick, preventing a good burn. If the clearing is made too late, there is insufficient time for the vegetation to dry. Buglé farmers recognize that burning a field increases the yields of other crops, but as there is only one opportunity for burning a field each year, a burned field is dedicated primarily to the highly valued rice crop.

One of the added problems that occurs when a dry season does not arrive, is that rice seed becomes unviable after about one year, which means that planting stock must be obtained from the previous year only. Other varieties of rice are available outside of the region, but the preferred local variety is only planted by the Buglé and their neighbors. In the early months of 2000, many farmers did not have access to viable rice seeds for planting because they had not been able to grow rice the previous season – abundant rains fell throughout the period when dry conditions were expected. A great number of farmers lost a considerable amount of time and effort clearing fields for rice that resulted in weedy fields with only a few secondary crops. Thus, in 2000, rice seed was very scarce. Some farmers undertook long trips on foot to see if they could acquire seeds from relatives in other areas, and a few were able to buy seed from the rare few who had been able to burn fields a few months beforehand during an unexpected period of dry weather. Others had planted small areas of rice in laboriously weeded areas in order to acquire a small store of new planting stock for the following year.

5.2.4 *Maíz grande* cultivation

A fourth type of farm that is found in the region is the *maíz grande* plot. The term *maíz grande* encompasses several larger, introduced varieties of maize that can be purchased in towns outside of the region. *Maíz grande* is planted primarily in large fields as a monocrop, although as always, a few bananas and root crops may be planted in the same field. The crop requires more fertile alluvial soils and is planted almost exclusively in the "*bajos*" – the narrow floodplains on either side of the larger rivers that are usually inundated at least once per year. These areas, however, have a limited distribution and only a small number of families have access to them, primarily the descendants of the first Campesino families who were to first to farm in the Caloveborita valley.

Very young fallows are used to plant *maíz grande*. Weedy vegetation that is about one or two years old, consisting primarily of grasses, vines, and low plants, is cleared and then chopped into finer material. Typically, large *juntas* of 20 or more men participate in this initial clearing; well over 50 liters of *guarapo* can be consumed during these events. Afterwards, the farmer creates small openings in the blanket of cut vegetation and a few maize seeds are dropped into a shallow hole surrounded by bare ground. The crop is planted at two different times of the year, around January and July, and requires about four months to mature. Weeding is done about six weeks after planting. In addition to animal pests, these fields are also subject to flood damage.

5.2.5 Fallow periods

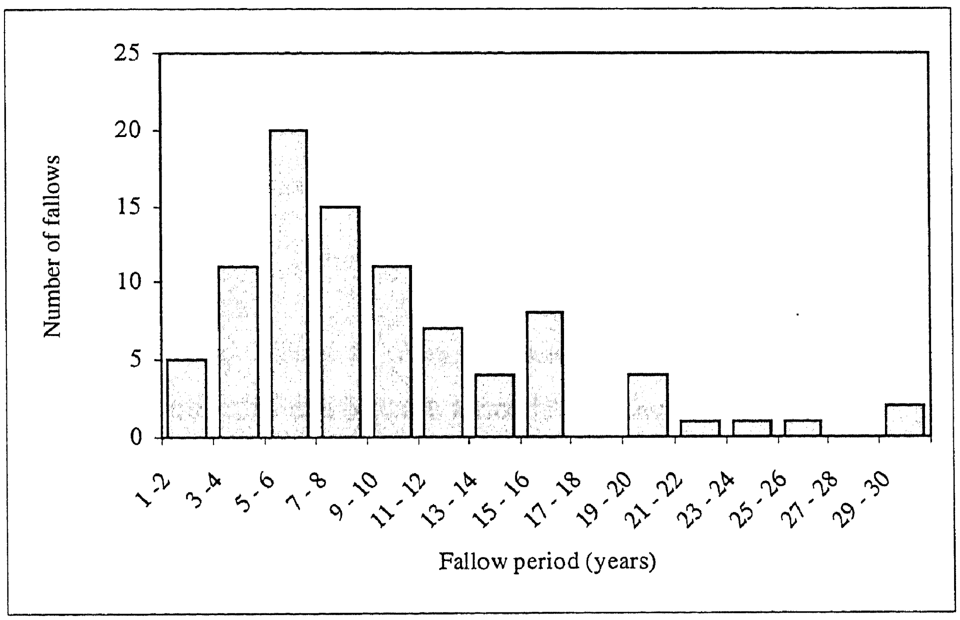
The length of fallows maintained by shifting cultivators before using them again for new farms is an important parameter affecting the agricultural productivity over the long term. Average fallow periods can also provide some indication of whether or not arable land is scarce. Longer fallows that allow soil fertility to regenerate are possible when farmers have access to sufficient amounts of farmland. Short fallow periods, on the other hand, may be symptomatic of increased population pressure which prevents farmers from allowing their fields to recuperate sufficiently, leading to declining yields and soil degradation. Measuring the average fallow period, however, can obscure a more complex situation. In the Caloveborita region, the length of fallows is conditioned by several factors, including the farm type, family land holdings, and the location of the field, all of which induce a great deal of variation in fallow cycles. Moreover, field boundaries are very dynamic – plots are repeatedly divided into different parts for different uses, and additional small clearings are added to existing ones, leading to complicated patterns of cultivation and fallow over space and time.

As mentioned above, when planting in the more fertile floodplains, fallows are very short, usually less than two years. Here, long periods of recovery are not required because frequent flooding replenishes soil fertility through the deposition of nutrient rich sediments. Conversely, fields that are located far away from the village, requiring more investments in traveling to the site, tend to be left in fallow for longer periods, regardless of whether or not a sufficient period of rest has been attained. Fallow periods are also affected by household land holdings, which are far from uniform. Again, families that settled in the area earlier tend to have much more land (except when land holdings are highly fragmented due to inheritance among many heirs). More recent arrivals may preferentially clear mature rain forest in a more remote area, instead of using available secondary forest, as a way of assuring that their children will have sufficient lands in the future.

Notwithstanding the many factors that influence the rotation of gardens and secondary vegetation, the ages of most fallows used by the Buglé range from about four to 12 years. The average fallow period, based on 90 farm history interviews, is nine years (Figure 5.1).[7] The general consensus among local farmers seems to be that one should wait at least five or six years before using secondary forest for a new farm so that it will be productive. These fallow periods may seem rather short, but it should be kept in mind that direct comparisons with other shifting cultivators who burn cleared fields are probably not very appropriate. Burning results in losses of nutrients in the smoke, as well as changes in soil structure that do not occur with Buglé cultivation which relies primarily on mulching rather than burning.

Two broad categories of secondary growth are recognized by people in the Calovebora region based on the structure of the vegetation: short fallow (*rastrojo bajo*), and tall fallow (*rastrojo alto*). Short fallows are characterized by thick vegetation dominated by vines, short heliophitic plants, and slender saplings that make walking through the vegetation without a machete virtually impossible. The height of a short fallow reaches up to about three or four meters, and the largest saplings have a diameter at breast height of about 5 cm. Tall fallow consists of vegetation with a fairly thick ground cover and a well developed understory, but with an emergent canopy that reaches at least four or five meters. Depending on the site, a short fallow grades into a tall fallow after about five years, when the dominant trees gain a diameter at breast height of about 20 cm.

Figure 5.1. Length of fallows in the Río Caloveborita watershed (n = 90).



5.2.6 The peach palm

The peach palm (commonly known as *pejibaye* in most of Central America) is an especially important crop that is cultivated by indigenous peoples of the humid neotropics because of its extraordinary productivity and high concentrations of vegetable oils and proteins (Clement and Mora Urpí 1987 305-306; Popenoe 1921:157). This is particularly true on the northern slope of western Panama, where it is planted in large numbers by the Buglé, Ngöbe, and Teribe (Gordon 1982:75). As mentioned earlier, it is one of the seven primary crops used in the Caloveborita watershed, where it is planted in dooryard gardens, cared for in fallows, and planted in separate orchards of up to 100 palms or more. Even one or two dozen peach palms make a significant contribution to a family's diet – one palm produces several bunches of fruit per year under good conditions, with a combined weight of well over 25 kg. Two distinct varieties are commonly recognized, based mainly on differences in the color (but also size) of the fruit, which ranges from yellow to a reddish orange. **Bibá hutre** ("white peach palm") and **bibá dabere** ("red peach palm") are the two types most frequently distinguished. The individual fruits are round, tapering to a point, and range from about four to seven cm in length.

The most common cultivation method consists of planting a number of seeds in a field as it reverts to a fallow, with subsequent weeding to protect juvenile plants. Sometimes, just a few scattered palms are planted, and in other cases 20 to 50 or more are planted in larger stands. It is also common to see several of these palms planted near the home in dooryard orchard gardens and at former house sites. The palm begins to bear fruit after about five years.

Some farmers deliberately plant the peach palm in larger quantities in certain areas to provide opportunities to catch game animals that feed on the fruit. A great diversity of birds eat the fruit as it matures, most importantly the blue-headed parrot (*Pionus menstruus*), the two toucans found in the region (*Ramphastos swainsonni* and *R.. sulfuratus*), the collared aracari (*Pteroglossus torquatus*), the gray-headed chachalaca (*Ortalis cinereiceps*), and the crested guan (*Penelope purpurascens*), as well as the red-tailed squirrel (*Sciurus granatensis*). Local people also note that animals such as the collared peccary, the paca, the agouti, and the brocket deer feed on fruits that fall to the ground. Extra peach palms are also planted to feed to pigs. These animals can gain a lot of weight during the main harvest season, after which time they can be sold for a better price.

The peach palm has two main harvest seasons. The primary season is from August to October, and a smaller harvest sometimes occurs around March or April, the latter being dependent primarily on rainfall patterns according to local people. Given that the trunk of the palm is covered by long, sharp spines, special efforts are needed to harvest the fruit. Long poles are fitted with downward pointing hooks made from tree branches or machetes to reach and break the stem of the raceme. For especially tall palms, a person climbs up a neighboring tree for a better reach. Sometimes accompanying trees are planted or left standing beside a peach palm expressly for this reason. A simple scaffolding, or *talanca*, may also be constructed to gain access to the fruit. Once harvested, the fruit is boiled, peeled, and eaten with salt. The fruits are an especially convenient food to eat away from the home as a mid-day meal when working in agricultural fields or during hunting trips. The boiled fruits are also ground into a paste and mixed with water to make a *chicha fresca* (unfermented) which is very popular.

5.2.7 Other forms of cultivation

Certain other crops are also planted by the Buglé in separate plots. Several families have coffee orchards of up to 200 or more bushes for household consumption and sale in the community. Small orange orchards for home consumption are also common. At least six varieties of sugar cane are also planted in separate plots. Yuca is also occasionally monocropped in small fields close to the home (where problems with terrestrial animal pests are less likely to occur), where it produces well in the absence of shading from other plants.

Dooryard gardens are found around virtually every house in the region, although they vary considerably in size and character. These diverse orchards contain useful wild trees and palms that are spared during the initial clearings for useful products, to attract birds and other animals, for shade, or simply because they are pleasing to the eye. Some of the more common of these species are the *gira* (*Socratea exhorrhiza*) and *palma real* (*Attalea butyracea*) palms, and trees like *membrillo* (*Gustavia superba*), *cerillo* (*Symphonia globulifera*), or *panama* (*Sterculia apetala*), but many other species are also commonly spared when they are present. Planted fruit trees and other crops include citrus trees, *pera*, *fruta de pan* (breadfruit), peach palms, coconut palms, papaya, *calabazo*, *achiote*, coffee bushes, *cacao* and its relative *cacao chibú*, *ají*, bananas, pineapple, and a variety of ornamental plants (see Table 5.1). Some people have begun to plant small patches of tomatoes and cucumbers. Guava trees are also very common in dooryard gardens and in pastures surrounding villages where seeds are dispersed by pigs and cattle.

5.3 Animal husbandry

The Buglé raise a number of domestic animals on a limited scale for both personal consumption and for sale. Animals are owned individually by both men and women, as well as by children. Chickens are by far the most common fowl, valued for both meat and eggs. They are fed grain, when available, and table scraps. Hens and roosters are often kept in small, rustic coops at night for protection against the larger opossums (*Didelphis marsupialis* and *Philander opussum*) and smaller wild cats (*Leopardus* spp.). During the day, chickens wander around the yard in search of food, and are occasionally captured by eagles and other birds of prey, as well as jaguarundis (*Herpailurus yaguarondi*) and tayras (*Eira barbara*). Many households also raise muscovy ducks (*Cairina moschata*), and occasionally house pigeons (*Columba livia*), guinea fowl (*Numida meleagris*), and geese (*Anser* sp.). In 1999, a small chicken farming project was initiated in Río Pedregoso with some external funding, with the aim of contributing to economic development, improving the local diet, and reducing dependence on wild animals for food.

Pigs are raised for both home use and sale within and outside of the region. They are slaughtered only very occasionally for home use or for a large *junta*. Piglets are sold more frequently within the area for raising, but adults are also sold for community events such as national celebrations hosted by a school or for an "*actividad*" – a social gathering where food and beverages are sold to raise money for a local organization (most often a sports club or church). Within the community, neighbors may "loan" an adult male to someone with a female to produce offspring which are then shared. Unlike crops surpluses, which are heavy to carry and have low values, pigs can be easily walked to buyers in Santa Fe where a large one may sell for $50.

Pigs have been banned from the village center of Caloveborita for health reasons. In the other villages of the study area, however, they wander freely and occasionally enter agricultural fields where they can cause considerable damage – some fields near settlements have actually been abandoned to prevent further crop losses from errant swine. Many people prefer to keep pigs at secondary house sites where they may be kept in small enclosures. Occasionally pigs are killed by jaguars (*Panthera onca*) or pumas (*Puma concolor*).

Cattle raising is also practiced by the Buglé on a limited scale, mainly for sale or as an investment. Most families in the study area do not own cattle, due to prohibitive costs and the amount of labor required to establish and maintain pastures. The majority of households that do raise cattle have at most three or four animals. Only two households had more than 10 at the time of the study. A one-year-old calf costs roughly $150, which represents about two months of wage labor. The main variety found in the area is a small, local "*criollo*" breed, although some people have recently acquired larger zebu and milk-producing hybrids. The only people in the region who own larger numbers of cattle are teachers or others who earn regular salaries that can be used to buy animals and hire laborers. An alarming recent trend is the renting of pastures to outsiders. This has not yet occurred in the Caloveborita region, although local people have been approached by cattle owners from Santa Fe and elsewhere. However, at least one large ranch to the north has been cleared for cattle that are brought in the area and later taken out after they have grown. This is especially worrisome because of the potential impact on the forest under a system whereby "free" forest areas can be cleared by hired hands. Already this is occurring rapidly in the cordillera south of the study area along the main trail to Santa Fe.

Pastures are cleared from old farms and planted with suitable grasses. The most common species is *ratana* (unidentified), a fast-growing, spreading plant that is transplanted from existing pastures or sown with seeds that are either bought or gathered by hand. Pastures require frequent weeding to favor the growth of nutritious plants. "*Picando potrero*" is thus a fairly common local source of wage earnings. Cattle owners typically have two or three pastures that are rotated. Barbed-wire and natural fences are placed around the pasture, but animals often escape and feed on growing crops, which can cause significant damage if they are not discovered quickly, resulting in complaints and conflicts between neighbors.

A community cattle raising project was founded in the early 1970s in Caloveborita with a small grant provided by the Torrijos government, which donated modest sums to several communities in the region for development projects of their choice. This initiative, representing the first community project sponsored by an outside agency, required new forms of organization and cooperation and floundered for many years, but has survived to the present as a cooperative enterprise with over 20 head of cattle belonging to a limited number of members.

5.4 Fishing

Fishing is a convenient and reliable source of food in the Caloveborita region. Rivers of sufficient size to harbor preferred fish species are numerous, and most people have the option of walking only a short distance to a good fishing spot. Fishers may also invest more time walking a few hours to special areas with abundant fish resources and almost always return home with a worthwhile catch.

The most common method is spear fishing, which is practiced boys and adult men, although some young women also occasionally pursue this activity as well. The two necessary pieces of equipment are a diving mask and a spear. Masks are store-bought but spears are made from a shaft of palm wood about 1.5 m long. A barbed metal point is fitted to the striking end of the spear and attached with a long string wrapped tightly around the base of the point. A loop of thick elastic tubing is fastened to the other end of the spear. To "arm" the spear, the diver places the tubing between the thumb and forefinger, stretches it toward the point, and then grips the spear shaft. When striking at a fish underwater, the diver simultaneously lunges his arm and loosens his grip on the shaft of the spear so that it is propelled forward explosively with the release of elastic tension.

Two or more divers often work together to improve their chances of catching their prey. When a wary fish attempts to elude one person, it can be driven toward the other diver. Buglé divers are excellent swimmers, and even the fastest, most agile species can be caught in this way. Large pools are preferred locations for spear diving, but fishers also slowly work their way up stretches of rapids in shallows, where they find fish at rest amid the stones. Spear diving takes place both during the day, and at night with the use of inexpensive, watertight flashlights.

Another method, less common but still important, especially for women, consists of fishing with a line and hook. Insects, small shrimp, or some other form of bait is attached to the hook and cast from the river bank or a canoe. Line fishing is not as rewarding as spear diving, but almost anyone can participate, and it remains a good way to catch small fish. In the dry season, shrimp can be caught in large quantities by making a "*sequía*." This involves moving stones of a drying stream bed to make canals that redirect water to one side of the channel, draining sections of the river channel. Shrimp are collected from the small puddles and damp depressions where they have been trapped amid the stones of the drained stream bed. These *sequías* are group projects that are maintained by several people (usually women and children) who may harvest several kilograms of shrimp over two or three days.

Fish poisons derived from wild plants are used infrequently, but were probably more common in the past. A vine and a small tree (both unidentified) are the two most important sources. To prepare the poison, the vine is crushed and put into a container of water to soak. The procedure is the same when using the tree, except that only the leaves are used. The toxic liquid is then poured into a pool of a stream, and when it begins to take effect, fish become stunned and are easily collected from the surface of the water. This method, although apparently quite effective, appears to have come into disuse because of widespread criticism that it results in the loss of too many fish, especially small fish that would otherwise contribute to future stocks. Many people told me that they do not use poisons because they are destructive, and that the indigenous authorities have prohibited their use.

Two special riverine resources in the Caloveborita region are the *tití* fish (*Sicydium* sp.) and a snail. The *chelelé* snail (*Neritina clenchi*) is collected by hand from the faster sections of larger streams. This and closely related species spawn larvae that are carried to the sea and develop into juveniles which migrate back upstream (Dillon 2000:103). Their distribution in streams is patchy, but when a localized abundance is discovered, a person with a mask can collect several dozen snails in an hour or two. The *tití* is a small, diadromous species that travels upstream from the ocean in large migrations at certain times of the year. The frequency and timing of migrations is unpredictable, but older people say that the availability of this species has declined dramatically in the last two or three decades. The fish, which is only about three or four centimeters long at this stage in its life cycle, has a circular protrusion on its underside (something like a small suction cup) that it uses to cling to rocks as it makes its way up rapids and waterfalls. At special sites along the Río Caloveborita and some of its tributaries where there are vertical or near-vertical rock surfaces, hundreds of these fish accumulate on the stones where they can be easily scooped off into a net or basket. Once they have been removed, one can simply wait an hour or so for more to accumulate on the same surface. The fish are boiled or added to a soup, but the major part of the catch is usually wrapped in leaves and smoked over a fire.

The main riverine species consumed by the Buglé and their neighbors include about 10 fish, a river lobster, small shrimps and crabs, the *chelelé* snail, and two turtles (Table 5.2).

5.5 *Use of forest plants*

The Buglé make use of a large variety of forest products to meet many of their basic needs, and they have an extensive knowledge of the ecology, distributions, and special properties of a diversity of wild plants. Of the native flora, the most important species are probably those used for house construction. Homes are constructed entirely of local forest materials – nails are sometimes purchased, but for most people this represents an expensive and unnecessary drain on scare cash resources. Forest products are also used for medicine, food, building canoes, and the manufacture of innumerable household items.

5.5.1 House materials

The traditional Buglé house is a round structure with a short exterior wall and a large conical roof supported by a central pole. Although the round house is still built occasionally, and is considered ideal for certain ceremonies, almost all of the houses that are built by the Buglé today are rectangular structures. Homes are a variety of sizes and styles, depending on the builder and the size of the household, but typically consist of a raised

Table 5.2. Aquatic species caught in the Río Caloveborita watershed, 1999 – 2000.

Scientific name	Family	Buglé name	Spanish name
Fish			
Agonostomus monticola	Mugilidae	gubá, gugbá	dajao
Anguilla rostuata	Anguillidae	nuêgiáya	anguila, morena
Astatheros bussingi	Cichlidae	bukésoli	mojarra, chogarra
Centropomus sp.	Centropomidae	?	robalo
Gobiomorus dormitor	Eleotridae	ñulí, toma	guabina
Joturus pichardi	Mugilidae	ñwé kweria, (ñwé) tîti	boca chica
Pomadasys crocro	Haemulidae	mnaú	ronco, roncador
Rhamdia guatemaltensis	Pimelodidae	eskébita	barbú
Sicydium sp.	Gobidae	balú	tití, chupalá
unidentified (≥ 2 spp.)	Characidae	hibakwa	sardinas
Reptiles, molluscs, and crustaceans			
Chelydra serpentium	Chelydridae	gubi makwa	morrocoy
Kinosternon leucostomun	Kinosternidae	gubi terékwa	tapaculo
Neritina clenchi	Neritidae	higbí	chelelé
Procambarus sp.?	Cambaridae	chugwa siblí	camaron de peña
unidentified shrimp	Paleamonidae	chugwa	camarones
unidentified crabs	Pseudothelphusidae, Gercarcinidae?	huchi	cangrejos

* Identifications were made using Busing 1998 and with the generous assistance of Richard Cooke at the Smithsonian Tropical Research Institute.

platform about one meter above the ground, an enclosed room for sleeping that occupies a portion of the floor space, and a two-sided pitched roof. Usually, one or two full sides of the house are open, without walls or with only a short wall rising two or three feet from the floor. A high, upper platform is also constructed within the house for storing grains and other items. Kitchens are usually built at ground level, adjacent to the main structure, and covered by an extension of the main roof. Cooking is done on a table lined with a thick layer of clay. Pots are placed on an arrangement of large stones that hold them above the fire.

When building a new house (which can take place fairly rapidly or over a period of a few months), the first stage is to erect the main support posts. The heartwood of *palo frío*

(*Dipteryx panamensis*) is used exclusively for this purpose given that it is exceptionally strong wood that is resistant against both termites above the ground, and rotting below ground. The posts, which may last three or four decades despite the warm, humid climate, can be used for several homes in succession. The wood is considered necessary for a new house, and it is so highly valued that it is the virtually the only type of unfinished wood that is bought and sold in the region.[8] A large variety of other tree species supply cross beams that support the floor and the roof of the house.

Walls and floors are made from two similar forest palms that are abundant in the region, the *gira* or **bukwa** palm (*Socratea exhorrhiza*), and the very similar *jirote* or palm (*Socratea* sp.?). The trunks are split and flattened with an axe into planks with a width of up to about 75 cm. The planks are lain across the floor, with the outer surface upward, providing a smooth, durable surface. The split palm trunks are also used for walls. Thatch is made from the fronds of the *palma real* or **uga** palm (*Attalea butyracea*). Leaves are split down the central rib and fitted in several overlapping rows to the roof support beams. The strong, pliable liana known as *bejuco real* (unidentified) is used for tying together the posts and beams of the structure, while the less resistant *bejuco verde* (*Cydista* sp.?) is used for attaching the thatch. The *bejuco real* is one of the important wild plant species that has become especially scarce in the region.

5.5.2 Wild plant foods

Wild plant foods are frequently gathered in small quantities while people are engaged in other activities. One of the more important of these is the **gibagwa** liana (*Gnetum leyboldii*?) that weaves through the upper canopy and periodically drops cylindrical nuts (about 2 cm long). The nuts are collected from the ground, and roasted. Another wild food comes from the *cucharo* tree (unidentified) that drops large pods that contain about 15 to 30 individual edible nuts that are also roasted. A few wild cacao species are also found in the forests of northern Veraguas, whose seeds are collected to roast, grind, and made into a hot drink. Some species are thought to have special powers and are consumed during some ritual ceremonies.

A more significant wild plant food is found in young fallows and other clearings with abundant sunlight. One of these is a wild fern (*Ctenitis sloanei*). The top 10 to 20 cm of the immature, curled leaves are snapped off of the upper part of the plant and cooked briefly, and added to the main meal. These plants are often abundant in young fallows and are probably the most common wild plant food eaten by the Buglé. Several other leafy greens that grow in sunny clearings are also eaten.

5.5.3 Canoes

The main form of transportation in the Caloveborita region is walking. This is not surprising given that even the largest rivers in the area have numerous shallow sections that make river navigation difficult. Moreover, precipitation events are often very intense, leading to brief, but dangerous surges in river depth and flow velocity. Small dugout canoes are sometimes made, however, to go fishing or to carry agricultural produce downstream. Canoes are especially useful for farmers who have fields along the upper Caloveborita and its larger tributaries. Most families, however, do not own a canoe.

Several people in the study area, however, take advantage of the availability of large forest trees to construct semi-refined dugout canoes for sale. The tropical cedar (*Cedrela odorata*) is the tree of choice, and local people distinguish between different varieties based on the color and properties of the wood. One of the older residents in the study area said that he made canoes occasionally in his youth to earn money, and a few mestizo families downstream from the mouth of the Río Caloveborita (in a community called Guazarito) have specialized in this economic activity for many years. They continue to act as middlemen for some of the indigenous residents who have learned the trade. Most of the trees that are extracted at present come from the headwater areas of the Guazarito, Caloveborita, and Pedregoso rivers.

A suitable tree is identified based on its size and location, as well as its solidity, which can be inferred by the sound made by pounding it with the back of an axe. Once a buyer has been found, the tree is cut down, and the builder shapes the canoe, sometimes with hired help. In some cases, two men make arrangements to share the work, expenses, and profits. The canoes that are made are sold primarily to buyers on the north coast where the sides of the craft are heightened with additional planks so that the canoe is sea worthy. There is great demand for large canoes, and prices increase substantially with the size of the craft. Canoes of more than 10 meters are not uncommon and the preliminary work may be done intermittently for several months. However, bringing the rough-hewn canoe into the village for further refinement can be a tremendous endeavor when the tree is especially large. First of all, a large path through the forest down to the closest river needs to be cleared. Then a *junta* is organized and up to 20 or more men are sought. Obtaining a sufficient number of helpers is essential, for if the canoe can not be moved, the owner can lose a significant investment in the food and drink prepared for the event. In at least one instance during my field work, a local Buglé man organized three *juntas* to remove a roughly 20-meter canoe. In each case, the men failed to move it due to its tremendous weight. When the canoe was finally moved during a subsequent attempt, it slid out of control down a steep slope and was damaged when it collided with a large boulder.

5.5.4 Household items

Another important forest liana used in the region is the *jaba* (unidentified) that is used to make large baskets that are carried on a person's back. These *motetes* are used almost daily for transporting harvested crops, as well as planting stock or any other heavy load. (For especially heavy loads, a tump line may also be used.) The strong, flat strips of material that are used to weave the basket are removed from the center of the thick vine (about 5 cm in diameter). Roughly 20 meters of vine are needed to make a basket, which is woven loosely with large holes between the strips of vine. Under regular use, these baskets last about four to six months before they need to be repaired or replaced.

Another important source of fiber is the *pita* or **iké** plant (*Aechmea magdalenae*). The plant is a large, succulent agave-like species that grows to a height of about 2 meters. In addition to the wild variety, another cultivated variety is planted near the home for its fiber, or as a natural fence – sharp spines on the edges of the leaves are effective at containing cattle when the plants are closely spaced. Local people indicate, however, that the wild variety (which is distinguished primarily by a lack of lengthwise white stripes on the leaves) produces stronger fiber. The long, fleshy leaves are cut from the plant, and the fibers are removed from the inner portion of the outer skin, washed, and then hung to dry. The fiber is spun into a thread which is used for repairing clothes, and making bowstrings, bags, and other items.

It is common throughout much of rural Panama to see men wearing the distinctive wide-brimmed, woven hats. While it is difficult to ascertain whether weaving hats has Central American origins or weather it was introduced from elsewhere, weavers in northern Veraguas are emphatic that it is a local indigenous tradition that has spread to the rest of the country. Simple hats are worn to ward off the sun when working in the fields, and finely crafted hats are worn for special occasions. On the humid, Caribbean slope of western Panama, the fiber that is used to make the hats comes from the *palma de hilar* (literally, the "weaving palm,") or **bdagá** palm (tall, spiny unidentified palm – not the more widely used *Carludovica palmate*). The outer skin of the frond leaflets is removed, and a thin strip of material is pulled free and cut into long, slender bands suitable for weaving. The fiber is soaked in water, and then hung to dry. The fiber has a light, straw color, but can be dyed black in order to weave patterns into the hat. The dying process involves crushing the leaves of the *hoja de teñir* or **iká** plant (unidentified) and cooking them in a large pot of water, in which the fiber is submerged. Afterwards, the fiber is removed and packed into a special dark clay and buried for a couple of days. When removed and washed, the fibers have taken on a shiny, black color.

Five strips of fiber are woven into long, flat bands about one centimeter wide. These bands in turn are sewn in a circular pattern around a wooden mold to form the body of the hat, before the brim is added. The hats are made with great care so that they are water-tight. Many men in the region are proficient in making hats, and they are sold locally as well as outside of the region. One Campesino family in Playita (a hamlet south of the study area near El Guabal) in fact specializes in the manufacture of these hats and sells them periodically at artisan fairs in district and provincial centers.

Forest products are also used to make innumerable miscellaneous household items, including serving platters, cutting boards, brooms, axe handles, and furniture. An aromatic sap is also harvested from the *caraña* tree (*Trattinnickia aspera*) and burned for ritual purposes, as well as to repel insects. Most adults are knowledgeable of a number of wild plant medicines for treating common ailments, and specialists provide recipes for treatments that require many additional species. Many medicinal plants were pointed out to me during the field research, but even a very preliminary inventory of the numerous plants used would require a considerable research effort (see Duke 1986).

5.6 Earning money

Buglé livelihood is based on subsistence activities rather than a cash economy. They consume almost all of the food they produce and they produce almost all of the food they consume. Nevertheless, money is an essential element of the local economy. Money is required to buy staple items such as salt, sugar, and cooking oil, as well as machetes, axe heads, boots, pots, clothes, and so on. The Buglé and their neighbors engage in a diverse variety of activities to earn money that can be divided into three main categories: wage labor, the sale of domestic animals, and the sale of artisanry. Some use of forest products for commercial purposes does exist, but makes a negligible contribution to household income and appears to have an equally minor potential impact on wild species.

With regards to wage labor, at times men work when a need for cash arises, for example when someone falls ill and medicines are needed, or at the beginning of the school year when their children need basic supplies. At other times, men leave the region for a few days, weeks, or months to earn more significant amounts of money. Locally, the most common type of wage work is weeding pastures. Occasionally, a teacher or someone else with a steady source of income may hire someone to prepare or weed agricultural fields, but this is rare. Work can also be found on coffee farms near Santa Fe, although this source of income is not nearly as important as it was in former times according to older residents. The standard wage for a day's work is $3 per day, unless a meal is provided, in which case only $2 is given.

A much more significant source of income for the Buglé is seasonal work cutting sugar cane on the large plantations in the provinces of Veraguas, Coclé, and Herrera between late January and early May, the dry season on the Pacific slope of western Panama. During the 2000 harvest, there were five large companies that sought workers to cut cane, as well as many small, independent producers that sell their crop to one of these firms. Most Buglé men from the Caloveborita region have worked for more than one company, and may even switch from one to another in the middle of the harvest season seeking better pay or better living conditions. Sugar producing companies actively recruit indigenous laborers from the relatively remote communities north of the continental divide by placing announcements on radio stations to indicate when the work will begin and when free transportation from Santa Fe to the plantation will be available. However, both indigenous and mestizo laborers cut cane. Workers can work for a week, a month, or for the whole season depending on their cash needs. Usually only adult males leave the Caloveborita region seeking work, but many bring sons to help. Workers are paid according to the amount of cane that is harvested, so even a child can make a contribution. It is exceptional that an entire family goes to the plantation, but it does occur.

The Buglé are drawn to work on the plantations for the relatively large amounts of money that can be earned. The working days are long, but a man in good condition usually earns somewhere between $6 and $8 per day. Even with the costs of purchasing food away from the home, this represents a much greater income than can be earned in the Caloveborita region. Most people, however, usually only work as much as they need to so that they can return home and resume farming, unless they are planning a large purchase such as a steer or a rifle.

Another common source of money in the Caloveborita region is the sale of domestic animals. As already mentioned, chickens and pigs are sold locally for relatively small sums, and large animals are sometimes sold to raise money for community organizations. Pigs and cattle are also walked to Santa Fe for sale. As noted above, a large pig can garner $50, and a bull can bring $250. Crop surpluses are rarely sold because there is little demand in the region and they are difficult to transport.[9]

In addition to the palm-fiber hats made by Buglé men, women weave small bags called *chacaras* made with **iké** fiber, a craft that was apparently learned from the Ngöbe

(Herrera and González 1964:59). However, the sale of these items is not widespread, and represents a minor source of income.

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[1] In the village of Río Pedregoso, some community members are actively encouraging new settlers to move there so that they community will grow to strengthen their argument with provincial authorities that a new school is needed for a growing population. This has created tensions, because other community members are resistant to inviting new settlers who would need to be offered their own agricultural lands. A significant number of residents in Caloveborita are adamantly opposed to the establishment of a new school in Pedregoso because it would result in reduced enrollment at the school there, which would decrease the chances of obtaining additional teachers.

[2] All monetary values are given in US dollars, the official currency of Panama.

[3] I deliberately avoid using the term "slash-and-burn" agriculture for two reasons. Firstly, the slashing of standing vegetation and subsequent burning of the biomass represents only the initial step in the farm cycle, and neglects the most important aspect of the traditional indigenous system, which is that fields are shifted to new sites every few years as productivity declines, leaving the old field in fallow so that it "rests" and can be used again in the future. The term "slash-and-burn" has also become associated with the more destructive frontier agriculture by non-native colonists who often sell their abandoned plots after only a few years of cultivation to cattle ranchers as they clear new plots in the forest, creating a colonization front that is quite distinct from the more sustainable rotational system. Secondly, "slash-and-burn" as a concept is more narrow term that does not include rotational agriculture that does not involve burning – known also as "slash-and-mulch – which is the predominant cultivation method among the Buglé,.

[4] The farm archetypes described here became discernible after reviewing about 90 farm histories.

[5] 33 men and women were asked to name the most significant animal pests that cause damage to each of the seven primary crops grown in the region. The most important pests were identified simply by the frequency with which they were identified by the interviewees. While it is not a precise quantitative method of assessing the relative amounts of crop losses attributable to each species, it does indicate which animals are the most important pests. Although a great number of species were often identified, there was a considerable amount of agreement between interviewees as to which animals are the most destructive.

[6] One man told me that he lost almost all of his rice crop in just a few days when heavy rains prevented him from crossing the river to protect his field. This statement was not verified, but is indicative of the tremendous damage a flock of these birds can do.

[7] While the fields chosen for conducting the farm histories were not obtained through a random sample, efforts were made to include a wide range of farms in different stages of production belonging to different families throughout the agricultural zones of the study area. While the farm histories do not provide a precise average fallow periods that can be extrapolated to the entire study area, the results clearly show the common lengths of fallow periods and the considerable variation in the length of Buglé fallows.

[8] Before they became somewhat scarce, these trees were frequently cut down and left to rot when clearing forested land for cultivation. Remarkably, some of these trees are still occasionally recovered from agricultural areas after lying on the ground for many years – a testament to their durability.

[9] The exception is the sale of small quantities of certain preferred vegetables to schoolteachers, mainly those who live in Río Luís.

6. Hunting Among the Buglé

Hunting makes a significant contribution to the diet of the Buglé and is at the same time part of an ancient tradition that is an integral part of their culture. Many hunting strategies and methods are employed, and almost every member of the community participates to some degree, although men are the primary protagonists. By examining what, how, and where the Buglé capture game, it becomes evident that hunting is but one component of a dynamic, diversified subsistence strategy, and way of life that is intimately connected with the physical environment in which they live. Because hunting represents such an immediate and readily identifiable interaction between people and their natural surroundings, it is a subject that highlights the dynamic interplay between culture and ecology as two intimately connected and mutually interdependent elements of rain forest regions.

This chapter provides an ethnographic account of hunting as practiced by the Buglé, followed by quantitative results of research on hunting activity that was done using participatory methods over an eight month period.[1]

6.1 Hunting strategies

Hunting among the Buglé is an occasional activity practiced exclusively for subsistence. Hunting is a predominantly male activity, with men accounting for 94 percent of the total harvest during the eight months when hunting activity questionnaires were administered by local investigators. Several strategies are employed, the most common being hunting trips that consist of expeditions dedicated specifically to tracking, pursuing, and capturing game, and which usually occur in mature rain forest. The three other main hunting strategies used by the Buglé are "awaiting" game, the use of traps, and opportunistic hunting, as discussed below.

People go on hunting trips when they have free time, which is often limited by the demands of agricultural work such as clearing fields, planting, or harvesting crops. Hunting usually consists of an expedition of a day or less in areas within four or five kilometers of the home. Most hunting occurs during the day, but some people go at night with flashlights in search of the eyeshine of nocturnal species. Hunters leave their house in the early morning by themselves or in a small group (or sometimes later, after rainfall abates), and travel along trails leading into the forest, where they listen for signs of animal activity and scan the forest floor and canopy for game. Hunters are attuned to even very faint tracks, sounds, signs of animal foraging (such as fallen fruit, the presence of seed husks, eaten leaves, or damaged branches or plant stems), and smells that are associated with different species. Boys often accompany their fathers, uncles, or grandfathers on hunting trips, giving them opportunities to make their own observations on animal behavior and ecology, and learn how to hunt effectively. They are valued companions at least in part because they help sight furtive animals and can seek help in case of an accident (for example, a snake bite). Boys also catch birds and other small game on their own with slingshots.

Most hunting trips can be characterized as general searches for any type of game, although hunters may be hoping or expecting to encounter a specific preferred species. This expectation may derive from a number of different factors. They may have noticed or have been told by a neighbor or relative that there are certain tracks in a particular area, or it may be the fruiting time of a tree that is concentrated in special areas. The Buglé also associate their chances of encountering different wildlife species with weather patterns, the calls of certain birds, and dreams. This is true of both preferred game items as well as species that are not considered edible, such as poisonous snakes. A wide variety of game may be encountered during the trip, and hunters will pursue almost any medium-sized or large game animal when encountered. Small game, however, may be ignored when a hunter is hoping for a better catch.

Directed searches that target a specific species also occur. One example is the pursuit of collared peccaries. Small groups of collared peccaries forage in gardens and can cause substantial crop losses when they raid the same farm repeatedly. In response, a hunting party may be formed, consisting of several men and as many dogs as possible, from perhaps four to eight in total. The party proceeds to the area where the peccaries have been detected, and the dogs soon flush them and begin the chase. The hunters follow in one or more groups, trying to keep up while calling out frequently to signal to the others the direction of the chase, and ostensibly to encourage the dogs. The pursuit is arduous, requiring that one cross small streams, traverse steep banks, and pass through overgrown fallows and forest underbrush at high speeds for up to an hour or more. Unless the peccary escapes, it will eventually stop running and turn to face the dogs. Hunters are motivated to arrive to the scene quickly to kill the animal before it wounds a dog, which is common.

Another directed hunting trip occurs when evidence of a tapir is discovered. This animal is highly valued for its large size, and when its tracks are seen, a hunting party will be organized quickly to track and pursue the animal. Once fresh tracks are encountered, the hunting party may separate into two groups. One group continues to actively track the tapir, which can be painstaking because the animal frequently uses small streams as paths, thereby interrupting the trail of footprints, while others wait in hiding at a strategic location. According to the Buglé, when the tapir detects a hunter, it will often use the same path by which it arrived to return to the deep forest. A similar hunting party is formed after discovering evidence of white-lipped peccaries, another large mammal that travels in large herds, leaving behind a wake of disturbance that is easy to follow. Several can be captured in one encounter, but there is a risk of injury. These animals frequently attack pursuers, using their long incisors as a weapon – local people enjoy recounting stories about dangerous encounters with an incensed herd.[2]

Hunters use established trails, but deviate from them to track and pursue game that can be heard in the distance or that have left visible footprints leading into adjacent areas, or when taking a circular route that will bring them home more directly. Trails consist of narrow paths through the natural vegetation, free of intervening branches and vines, and tend to follow interfluvial ridges and crests between larger watersheds. In tall forest where there is little understory, they can be difficult to discern, and are in fact often not restricted to a single path but are rather a general direction. Men use a single hunting trail repeatedly, especially if they continue to catch game in the vicinity. In this warm, humid environment trail maintenance is required periodically, which is done by clearing vegetation with a machete. Hunters also dedicate themselves occasionally to a thorough, noisy clearing of a trail for later expeditions. If a trail is not used for a long period, it is gradually recovered by the forest and disappears, and is either abandoned completely or cut anew at some later time.

New trails are cleared in areas where hunters expect to find more abundant game in areas that have not been used for some time. Again, hunters do not stay exclusively on trails, but search for game off of the trail when following animal signs, crossing over to another trail, or taking a more direct route home. As such, the areas used most intensively by the Buglé are continually shifting with the appearance and decline of different hunting trails, but virtually every part of the hunting zone is used during any given year, even if only rarely.

It does not appear that there are cultural prohibitions that prevent indigenous hunters from using specific areas in the Caloveborita region, although the existence of such zones elsewhere is recognized. Several hunters told me that there are "dangerous" areas where you should not hunt, but all of the specific places that local residents revealed to me are quite distant from the study area. One speculative explanation for this could be that as an area of recent colonization, there was no existing lore or identification of taboo areas in the Caloveborita and Guázaro watersheds, and that none have developed since the arrival of the first Buglé settlers some 50 years ago.

The Buglé prefer to hunt when it is not raining, and may cut their trip short with the onset of sudden downpours, which in most months are an almost daily occurrence. Hunters prefer fair weather for several reasons. They say that dogs are less effective at tracking prey and that it is more difficult to hear or see animals when it is raining. Another concern, depending on the location of the hunt, may be the sudden and sometimes prolonged increase in river discharge that makes fording even small streams dangerous or impossible. If a hunter is not careful, he may become trapped on the far side of a river so that he is unable to return home until it subsides. People also told me that hunting when it rains is "sad" and unpleasant. Alternatively, when people have more free time and it appears that the weather may be fair for a few days, hunters make extended hunting trips to distant forest areas where they will hunt and possibly fish for two or three days, bringing some provisions with them and sleeping in lean-to shelters. Women may also participate in these expeditions and prepare food at the camp site.

Another second hunting strategy consists of patiently "awaiting" game animals in gardens where they have been foraging.[3] During their daily work activities, farmers take note of fresh animal tracks and evidence of recent crop predation. Yuca, yams, taro, peach palm fruit, and maize are all commonly eaten by a variety of wildlife. The fruit of *membrillo* trees (*Gustavia* sp.), which are common in secondary forests, also attract game. When the Buglé encounter evidence that preferred game species have been foraging in their gardens, they know that there is a good chance that the animal will return. Sometimes piles of food are prepared for them and left in the same spot several times so that the animal will be more likely to come back and be less wary. Some hunters await game in mature forest as well, although this is much less common. To prepare for awaiting game, hunters will either build provisional scaffolding in a nearby tree or create a small enclosure by inserting a fence of leaves – usually palm fronds – into the ground where they will later lie in wait.

Awaiting game in garden areas is done primarily at night. Lone hunters go to the spot where they expect to encounter game in the late afternoon or early evening, armed with a flashlight and either a firearm or a bow and arrows.[4] Sometimes an animal arrives within an hour, but on other occasions, a person will wait for several hours before an animal arrives, or until he gives up. Swarms of mosquitoes or rain may lead to an early end of the waiting. When an animal arrives, the hunter turns on his flashlight (which is usually tied to his head), takes aim, and fires.

Another form of awaiting consists of catching birds using a sticky latex from the *olivo* or **nwískiro** tree (*Ecclinusa guianensis*?). This white, gummy, elastic latex is collected from the tree a day or two after incisions are made in the trunk. It is wrapped around the thin stem of a palm leaf or some other small stick about 10 to 15 cm long. This stem is then mounted at the end of a thin, light pole about one and a half to two meters long. The pole is then raised into a fruiting or flowering tree that attracts birds. When a bird arrives, the hunter taps the wings of the bird with the *olivo* sap, which pulls off its feathers so that it can no longer fly properly. This method is used primarily by boys, although adults sometimes participate as well. Alternatively, the *olivo* latex can be applied to several small sticks that are attached near a fruit or flower that is known to attract birds. This often takes place in dooryard gardens near the home. *Pera* (*Syzygium malaccense*) fruits and banana and other flowers that attract hummingbirds are commonly used.

A third strategy for capturing game is the use of traps. The most common trap is a rock-fall trap that is constructed along narrow trails used by terrestrial animals (or sometimes at the entrance of a burrow). The trap consists of two short fences of closely spaced sticks inserted vertically into the ground on either side of the animal trail. A log is hung above and between these two short fences, and heavy rocks are placed on top of the log. When an animal passes through the trap, it trips a release and the log and stones fall and crush the prey.

The "*trinchera*" is a trap for catching terrestrial birds that forage in mature rain forest. Unlike hunting trips and the use of the rock-fall trap, the *trinchera* is commonly made by women, and is in fact the most important method used by women to catch game. 65 percent of all game caught using a *trinchera* is caught by women. The *trinchera* consists of a long fence of palm leaves inserted into the forest floor that can reach lengths of 100 to 300 meters or more. Narrow openings in the fence are made at intervals of about 1.5 to 3 meters, and armed with snares placed around the opening a short distance above the ground. A bird that attempts to cross to the other side of the fence will likely get its head caught in the noose which is tied to a nearby sapling. It its struggle to free itself, the snare tightens around its neck. Caretakers check their *trinchera* regularly and several animals may be caught after a week or two before the trap is abandoned. The *trinchera* must be visited frequently so that animals that become trapped are not eaten by predators or die and start to decompose.

An additional trap that is used occasionally is a snare tied to spring mechanism which is used to catch terrestrial mammals. A noose is placed along an animal trail where the fresh tracks of a paca, collared peccary, or some other animal – even a small felid – have been encountered. The noose is attached to a bent sapling, and when the animal passes through the noose and trips a release, it is caught in the snare and lifted into the air. Another trap is the "*chinchorro*," which consists of a conical net that is placed at the entrance of a burrow – most often a armadillo burrow. As the animal exits the burrow, it kicks soil and loose vegetation behind it and becomes trapped in the narrow end of the net.

A fourth hunting strategy among the Buglé (in addition to hunting trips, awaiting, and the use of traps) is what is best called "opportunistic" hunting. This consists of obtaining game while involved in some other activity, such as clearing fields, weeding, collecting medicinal plants in the forest, or simply walking from one place to another. A great diversity of wildlife is found in the vicinity of settlement and work areas, and the Buglé often encounter game – especially small game – during their daily activities. The Buglé are well aware of the possibilities of encountering game at almost any moment, and carry weapons or bring dogs with them when they go to work in their agricultural fields. Birds in particular are ubiquitous: they are found along trails, in agricultural fields, and in isolated trees in pastures. Visiting birds are even spotted and killed in dooryard gardens in the immediate vicinity of houses. In agricultural areas, armadillos, agoutis, and deer may be flushed by hunting dogs, and all work is interrupted to take up the chase, which may result in spending an hour or so digging an animal out of its burrow, or forcing it out with smoke. When clearing large trees to make a new field, sloths and kinkajous located in the upper canopy may become an unexpected meal. The neotropical wood turtle is a good example of an animal that can be caught unexpectedly while walking along trails.

6.2 *Hunting technologies*

The primary technologies used during hunting trips are firearms, the bow and arrow, hunting dogs, and slingshots, as well as machetes and improvised spears that are frequently involved in the kill even if they are not the primary weapon. Firearms are the weapon of choice among the Buglé for obtaining preferred game species while hunting. People who do not catch very much game usually say that they do not go hunting because they do not own a rifle, despite the fact that alternative technologies are widely used. The firearms that are used in the region are rifles (0.22 caliber) and to a lesser extent shotguns (10-gauge), both of which are purchased secondhand in the area, or in Santa Fe and other towns. The rifles used are often several decades old, but still function, although they are usually not very reliable. Rifles often misfire, or will not function at all, and hunters lose their prey. Accuracy is another problem, but minor sighting errors can be adjusted after gauging offset by shooting at a test target. Local people are adept at repairing faulty loading and firing mechanisms, and replicating new wooden stocks when old ones have been damaged. Shotguns that are found in the area are even older, apparently dating back to the Guerra de los Mil Días conflict a century ago. An average price for a second hand rifle is roughly $150, the equivalent of perhaps seven or eight weeks of wage labor, which is prohibitive for most households – only about one in five households own a firearm. Ammunition is also expensive in this cash scarce region. Locally, each bullet costs about $0.15, and in Santa Fe a box of 50 bullets were sold for about $5 at the time of the field research. Shotgun shells were $1 apiece. This of course limits the use of firearms for small game, but rifles are still used for small animals such as squirrels and toucans.

Bows and arrows are made and used exclusively by the Buglé, although not by all households. Among the 40 most active hunters in the study area, only 12 use a bow and arrow at least occasionally. The arrow itself is made from a special variety of "*caña blanca*" (*Gynerium* sp.?), called "**eskegda dabé**" after the reddish color of the stem. As it dries, the stem becomes rigid and extremely light, and ideal for the arrow shaft. This type of cane, however, is rare in the Caloveborita watershed. Some hunters travel a day or more to areas where it can be found or transplant young plants in their dooryard gardens.

Arrow points consist of thin, flat, diamond-shaped pieces of steel made from old machete blades. They are mounted in a slot cut into the arrow shaft and secured with gummy tree resins and thread. The same resin and thread is used at the other end of the arrow for strength and durability. Side feathers to stabilize the arrow's flight are not used. The length of arrows varies from about 1.25 to 1.75 meters depending on the type of prey it is intended for. The size and shape of arrow points likewise vary according to the target species. The bow is made from strong palm wood, usually *gira* or *jirote*, or sometimes the peach palm. It is carved so that its cross section has a flat diamond shape which is thickest in the middle, tapering to each end where a hole is drilled or a notch carved for the bow string, which is made from **iké** fiber. Bows are typically about 1.5 meters in length.

There are many indications that the use of bows and arrows will not persist for more than a few decades. Already the use of this weapon has become limited, whereas in the past it was very common and even used by Campesino residents of northern Veraguas. When financial resources are available, hunters readily replace this weapon with a rifle. Rifles are preferred for their projectile range and more effective impact. People complain that arrows can only be used at short distances, and that they are easily lost during the hunt, which represents a significant loss of time and effort. Moreover, very few young men make arrows, and they were not used by anyone in the Caloveborita region under the age of 30 during the study period. The use of different hunting technologies is also associated with social status. The use of the bow and arrow is associated with indigenous traditions which are considered by many people – Campesino mostly, but also many Buglé – to be remnants of a way of life that is gradually being replaced by a more "civilized" culture as the region becomes more integrated into national society.

Good hunting dogs are extremely valued by the Buglé. Many people state that without a good dog, hunting is simply not worthwhile. Dogs are, of course, especially valuable at tracking and pursuing terrestrial game and greatly improve hunting success for animals such as pacas, agoutis, peccaries, or deer. Dogs are also brought along to agricultural fields and sometimes flush animals and trap them in a burrow or tree hollow. Hunters go into great detail when discussing the character of hunting dogs, noting whether they are lethargic or motivated, which animals they chase, whether they bark at the right times, of if they attack or not. Especially good dogs may be described in terms of how many peccaries or pacas they caught during their lifetime, which can reach 50 or more. Most dogs, however, are described as lazy and not interested in tracking and chasing game, or that they are disloyal and return home on their own when it rains or they become tired. Most dogs are bought as pups during trips outside of the region, for about $3 to $5. Dogs that have especially good potential, however, may sell for much more.

Slingshots are used by children and adults alike and are the most common hunting weapon used in the Caloveborita region. The main body of this weapon is made from a strong, forked piece of wood about 15 to 20 cm long. Thick, elastic tubing is attached to the body and a small strap or cup made from **iké** fiber or a synthetic fabric is attached to hold the shot. Ammunition consisting of small, rounded stones are easily found on the banks of rivers or in dry side channels. Young boys are the ones who make the most use of slingshots, which allow them to capture an astonishing variety of small birds including orioles, tanagers, manakins, flycatchers, woodpeckers, woodcreepers, trogons, motmots, hummingbirds, and pigeons, as well as basilisk lizards and squirrels. Some girls also use slingshots, but this is less common. Adult men take slingshots along when working in their fields and on hunting trips. Many have excellent aim, and can hit a squirrel or toucan at a distance of 25 meters or more after a few attempts. Sometimes, a slingshot is the only weapon a person has when encountering an animal unexpectedly, and they are occasionally effective in capturing animals as large as an agouti or great currasow.

Many other tools are used to obtain game, although they may not be the primary weapon. These include machetes, axes, stones, and improvised spears.

6.3 Hunting yields

This section presents the type and quantity of game caught by the 59 households that participated in the hunting activity questionnaires administered by local investigators over a period of eight months, from October 1999 to May 2000.[5] The results represent the total game harvest for men, women and children, from the smallest birds to the largest mammals. I compiled the questionnaire data myself after the field research was complete, producing totals according to animal class, hunting strategy, weapon, gender, habitat, and other variables.

2,481 animals were caught by the 59 households that participated in the hunting activity study, with a total yield of 2,580 kg. When extrapolated over the entire year (by multiplying by 1.5), this represents an annual average of 66 kg per household. This average, however, is not applicable to all of the families in the study area, because many households were removed from the hunting study because they are involved in hunting very infrequently.

The total yield recorded includes a great variety of game species, including over 25 mammals, seven reptiles, and over 100 birds (Table 6.1). Nevertheless, just five mammal species account for over half of the total harvest: pacas (325 kg), agoutis (297 kg), armadillos (294 kg), collared peccaries (272 kg), and howler monkeys (190 kg). An additional 21 species each account for over 10 kg of the harvest. Mammals make up 87

Table 6.1. Hunting yields, Caloveborita region, October 1999 to May 2000, 59 households (species with total yields ≥ 2 kg).

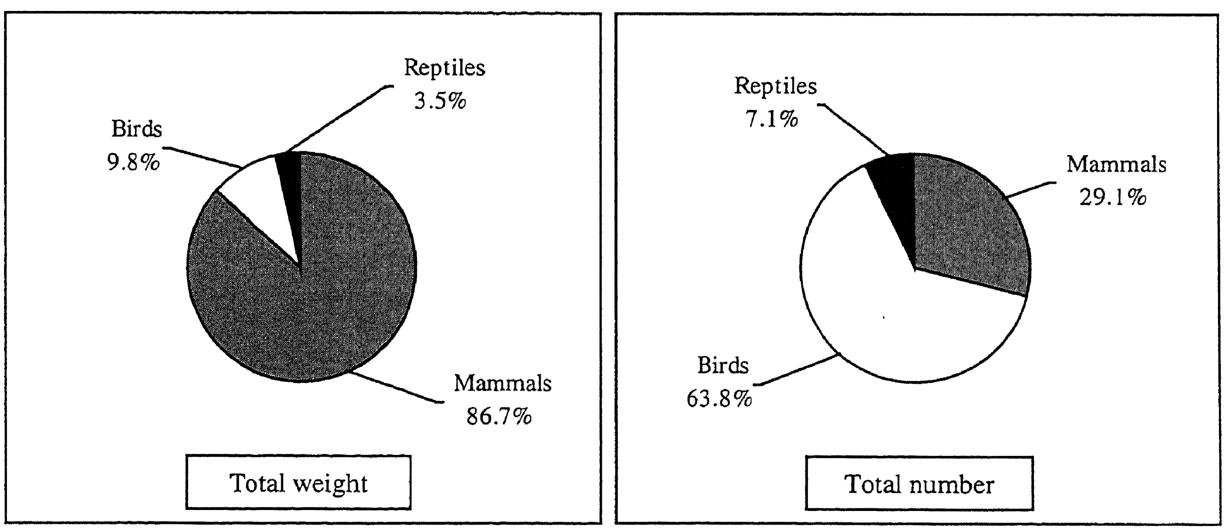
Rank	Scientific name	English name	Total (kg)	Number
1	*Agouti paca*	Paca	325	51
2	*Dasyprocta punctata*	Central American agouti	297	102
3	*Dasypus novemcinctus*	Nine-banded armadillo	294	110
4	*Tayassu tajacu*	Collared peccary	272	18
5	*Alouatta palliata*	Mantled howler monkey	190	33
6	*Tapirus bairdii*	Baird's tapir	150	1
7	*Bradypus variegatus*	Brown-throated three-toed sloth	119	39
8	*Choloepus hoffmanni*	Hoffmann's two-toed sloth	113	17
9	*Mazama americana*	Red brocket deer	104	4
10	*Sciurus granatensis*	Red-tailed squirrel	64	188
11	*Potos flavus*	Kinkajou	61	27
12	*Ateles geoffroyi*	Central American spider monkey	53	7
13	*Crax rubra*	Great curassow	52	14
14	*Rhinoclemys annulata*	Neotropical wood turtle	44	43
15	*Cebus capucinus*	White-faced capuchin monkey	41	14
16	*Puma concolor*	Puma	37	1
17	*Tinamus major*	Great tinamou	32	34
18	*Penelope purpurascens*	Crested guan	28	16
19	*Sylvilagus brasiliensis*	Forest rabbit	26	32
20	*Nasua narica*	White-nosed coati	25	9
21	*Ramphastos swainsonii*	Chestnut-mandibled toucan	24	39
22	*Basiliscus plumifrons*	Green basilisk	22	100
23	*Pteroglossus torquatus*	Collared aracari	18	84
24	*Panthera onca*	Jaguar	17	1
25	*Chelydra serpentina*	Common snapping turtle	15	3
26	*Bassaricyon gabbi*	Olingo	11	5
27	*Procyon lotor*	Northern raccoon	9	1
28	*Columba* spp.	Pigeons (3 species)	9	41
29	Echimyidae	Spiny rats (2 species)	8	19
30	*Iguana iguana*	Green iguana	8	3
31	*Lutra longicaudis*	Neotropical river otter	7	1
32	*Ortalis cinereiceps*	Gray-headed chachalaca	7	17
33	*Ramphastos sulfuratus*	Keel-billed toucan	6	20
34	*Eira barbara*	Tayra	6	2
35	*Trogon spp.*	Trogons (5 species)	5	55
36	*Pionus menstruus*	Blue-headed parrot	5	20
37	*Geotrygon* spp.	Quail-doves (3 species)	4	20
38	*Microsciurus* spp.	Pygmy squirrels (1 or 2 species)	3	37
39	*Baryphthengus martii*	Rufous motmot	3	25
40	*Amazona farinosa*	Mealy amazon	3	6
41	*Odontophorus melanotis*	Black-eared wood-quail	2	8
42	*Chamaepetes unicolor*	Black guan	2	2
43	*Kinosternon leucostomun*	White-lipped mud turtle	2	8
44	*Leptotila* spp.	Doves (2 species)	2	14
45	*Pionopsitta haematotis*	Brown-hooded parrot	2	15
46	*Coendou mexicanus*	Mexican porcupine	2	1
47	*Conepatus semistriatus*	Striped hog-nosed skunk	2	1
48	*Crypturellus soui*	Little tinamou	2	7
Other mammals (1 species)			1	1
Other birds (over 100 species)			43	1,059
Other reptiles (2 species)			1	18
Total			**2,580**	**2,481**

percent of the total harvest, followed by birds, with 10 percent, and reptiles, making up 4 percent (Table 6.2, Figure 6.1). Numerically, birds account for the majority (64 percent) of game animals captured, with over 1,500 individuals.

Table 6.2. Hunting yields by animal class (Caloveborita region, October 1999 to May 2000, 59 households).

	Total yield		Number caught
	(kg)	(%)	
Mammals	2,237	87	722
Birds	252	10	1,584
Reptiles	91	4	175
Total	2,580	100	2,481

Figure 6.1. Proportion of total harvest by animal class (Caloveborita region, October 1999 to May 2000, 59 households).



The most important game bird is the great currasow (52 kg), with an overall rank of 13. The diversity of birds that are hunted by the Buglé and their neighbors – especially by children – is astounding, and all are not listed here. Instead, Table 6.3 lists total harvest by family. Among reptiles, the herbivorous, terrestrial neotropical wood turtle (44 kg) is the most significant, with an overall rank of 14.

Table 6.3. Birds captured by zoological family (Caloveborita region, October 1999 to May 2000, 59 households).

Family	**Total yield (kg)**	**Total number caught**	**Number of species**
Cracidae	88.6	49	4
Ramphastidae	48.4	144	3
Tinamidae	33.6	41	2
Columbidae	14.7	87	10
Psittacidae	10.2	43	4
Picidae	7.5	40	4
Accipitridae and Falconidae	6.2	11	4
Trogonidae	5.2	55	5
Thraupinae	5.1	251	22
Momotidae	4.3	43	2
Formicariidae	3.8	115	8
Phasianidae	2.9	14	2
Ardeidae	2.4	4	3
Pipridae	2.1	145	5
Tyrannidae	2.1	79	8
Cardinalinae	1.8	39	4
Icterinae	1.8	26	3
Strigidae	1.8	6	3
Bucconidae	1.7	41	1
Other families (Alcedinidae, Alcedinidae, Capitonidae, Coerebinae, Cotingidae, Cuculidae, Dendrocolaptidae, Emberizinae, Eurypygidae, Furnariidae, Parulidae, Rallidae, Sylviinae, Trochilidae, Troglodytidae, Turdinae, Vireonidae)	8.1	351	> 35
Total	**252**	**1,584**	**> 125**

Several animals are not hunted because they are not considered edible. Among mammals these include bats and most rodents. Most Buglé consider opossums (and skunks) to be unappetizing, but they are still sometimes eaten. Some people do not eat the meat of large cats, but most do – jaguars are, in fact, a preferred species for many hunters because of their large size. Three mammals are taboo foods: the northern tamandua (*Tamandua mexicana*), the silky anteater (*Cyclopedes didactylus*), and the northern naked-tailed armadillo (*Cabassous centralis*). While the symbolic meaning and significance of these taboos among the Buglé were not ascertained, these three species seem to be avoided because they are associated with malignant spirits. It is believed that when a person encounters one of them, a death or other tragic event will occur to someone in that person's family. Other mammals are not eaten simply because they are very small, or extremely rare. One of the main differences between the Buglé and the Ngöbe with respect to food prohibitions is that the Ngöbe are more adverse to consuming the three-toed sloth.

Among birds, the great majority – even tiny ones – are considered edible. Those that are not eaten are in the main herons and egrets. In contrast, very few of the reptiles present in the area are considered edible. Snakes, frogs, and most small lizards are not eaten. Snakes are killed, however, for fear of poisonous bites, and some have fat tissue that apparently have medicinal value, but their use does not appear to be common.

6.3.1 Hunting yields by strategy

Hunting yields were divided into four categories according to hunting strategy at the time questionnaires were administered. Actively seeking game during hunting trips was the most important strategy, but only accounted for 55 percent of the total harvest (Table 6.4). Awaiting accounted for 13 percent of the total harvest, and the use of traps accounted for 12. The lower figures for these latter two strategies, however, obscure the fact that certain hunters await game or use traps much more frequently than others. One of the more startling results is that a full 20 percent of game is caught opportunistically. By categorizing the game harvest by hunting strategy, these results show that wildlife use among indigenous hunters in the humid neotropics consists of much more than just hunting trips deep into the rain forest.

Table 6.4. Hunting yields by strategy (Caloveborita region, October 1999 to May 2000, 59 households).

	Total yield		Number caught	Strategy							
				Hunting trips		Awaiting		Traps		Opportu-nistic	
	(kg)	(%)		(kg)	(%)	(kg)	(%)	(kg)	(%)	(kg)	(%)
Mammals	2,237	87	722	1,228	55	314	14	293	13	402	18
Birds	252	10	1,584	144	57	18	7	25	10	64	25
Reptiles	91	4	175	46	51	0	0	0	0	44	49
Total	2,580	100	2,481	1,418	55	332	13	318	12	511	20

Not surprisingly, different game species tend to be caught more frequently using different strategies (Table 6.5). For example, monkeys were captured exclusively during hunting trips. The great currasow was caught almost entirely during hunting trips. In the case of the paca, the quantity caught using different strategies is comparatively even. About 44 percent of the yield was caught during hunting trips, 39 percent while awaiting, and another 14 opportunistically. Well over half (60 percent) of the agouti harvest, however, was caught during hunting trips. A similar proportion of armadillos was captured using traps. Several species were captured primarily during opportunistic hunting, including both sloth species, olingos, the neotropical wood turtle, basilisk lizards, the blue-headed and brown-hooded parrots, the rufous motmot, and other bird species.

The principal species caught during hunting trips were the howler monkey (190 kg), the agouti (178 kg), the tapir (150 kg), the collared peccary (140 kg), and the paca (140 kg). The principal species caught while awaiting were the paca (128 kg), the collared peccary (88 kg), the brocket deer (52 kg), and the agouti (22 kg). The most important game species caught in traps were the armadillo (179 kg), the collared peccary (44 kg), and the agouti (34

Table 6.5. Hunting yields of most important game species by strategy (Caloveborita region, October 1999 to May 2000, 59 households).

Scientific name	Common name	Total yield (kg)	Number caught	Strategy			
				Hunting trips (%)	Awai-ting (%)	Traps (%)	Opportu-nistic (%)
Agouti paca	Paca	329	52	44	39	4	14
Dasyprocta punctata	Central American agouti	297	102	60	7	12	21
Dasypus novemcinctus	Nine-banded armadillo	294	109	27	1	61	11
Tayassu tajacu	Collared peccary	272	18	52	32	16	-
Alouatta palliata	Mantled howler monkey	190	33	100	-	-	-
Tapirus bairdii	Baird's tapir	150	1	100	-	-	-
Bradypus variegatus	Three-toed sloth	119	39	33	3	-	64
Choloepus hoffmanni	Two-toed sloth	113	17	28	-	-	72
Mazama americana	Red brocket deer	104	4	50	50	-	-
Sciurus granatensis	Red-tailed squirrel	64	188	51	3	1	46
Potos flavus	Kinkajou	63	27	47	8	-	45
Ateles geoffroyi	Spider monkey	53	7	100	-	-	-
Crax rubra	Great curassow	52	14	88	-	4	8
Rhinoclemys annulata	Neotropical wood turtle	44	43	41	-	-	59
Cebus capucinus	Capuchin monkey	41	14	88	-	-	12
Puma concolor	Puma	37	1	100	-	-	-
Tinamus major	Great tinamou	33	35	44	-	50	6
Penelope purpurascens	Crested guan	28	16	81	-	7	11
Nasua narica	White-nosed coati	25	9	38	31	15	15

kg), and the great tinamou (16 kg). The most important game species caught opportunistically by weight were the two-toed sloth (81 kg), the three-toed sloth (77 kg), the agouti (63 kg), and the paca (45 kg).

6.3.2 Hunting yields using different technologies

There are also distinctions in the type and amount of game captured using different technologies, although at times more than one weapon is used to catch an animal and they are difficult to separate quantitatively. This is especially true for dogs, which are instrumental in tracking and pursuing prey, but which to not constitute the primary weapon used to make the kill. A large number of terrestrial animals (pacas, agoutis, and armadillos) were caught after a dog trapped the animal in its burrow, after which it was dug out or forced out with smoke and then killed with a machete or an improvised spear.

For the purposes of comparison, the use of firearms, the bow and arrow, and slingshots are the most easily distinguished technologies used during hunting trips. Among traps, the rock-fall trap, the snare, and the *trinchera* are the most important. The importance of *olivo* latex as a distinct technology is also presented. In terms of the weight of the harvest using different technologies, the rifle represents the most important weapon (Table 6.6). Together rifles (which account for 38 percent of the total harvest) and shotguns (11 percent) were used to catch almost half of the total harvest. The rock-fall trap is the third most important technology, accounting for eight percent of the total harvest. Numerically, slingshots were used to catch over half (55 percent) of all animals captured, but the average weight of animals caught with a slingshot is only 0.12 kg, compared to higher averages weights using firearms (3.29 kg combined). The average weight of animals caught with the bow and arrow is relatively high (2.27 kg), but this weapon accounts for less than three percent of the total yield. Just over 30 percent of all game was caught using methods that are difficult to distinguish, including dogs, machetes, axes, improvised spears, fire, and one's bare hands.

An understanding of which species are more susceptible to different hunting technologies is essential in order to gauge the impacts of trends that affect the adoption of different weapons, and how conservation management strategies might attempt to reduce hunting pressure on sensitive species by regulating the use of hunting weaponry. For example, one prominent Buglé leader who is concerned about game depletion has proposed that hunting should only be done using "traditional" technologies – in other words, without firearms.

There are significant differences in the type of game caught using different technologies (Table 6.7). This can be explained by several factors, two of which are the ease of capture using different weapons, and the expense of ammunition. For example, primates that are located high in the canopy are difficult to catch using the bow and arrow, and are not

Table 6.6. Hunting yields using different technologies (Caloveborita region, October 1999 to May 2000, 59 households).

	Total yield (kg)	Percent of total	Number of kills	Average weight (kg)
Rifle	982	38.1	343	2.86
Shotgun	275	10.7	39	7.05
Rock-fall trap	216	8.4	80	2.71
Slingshot	159	6.2	1,368	0.12
Bow and arrow	75	2.9	33	2.27
Snare	59	2.3	13	4.52
Trinchera	26	1.0	39	0.66
Olivo sap	6	0.2	189	0.03
Other (machetes, dogs, fire, etc.)	783	30.4	377	2.08
Total	2,580	100	2,481	1.04

susceptible to any of the traps made by the Buglé. Deer are wary and fast, and the only truly effective weapon to catch them (along with hunting dogs) is a rifle. Many small animals are not valuable enough to use ammunition, which is expensive, especially in the case of shotguns. Sloths, when spotted, are most often caught by felling the tree in which they are found with a machete or an axe. As already mentioned, small birds are caught primarily with slingshots. *Olivo* latex is also used almost exclusively to capture small birds. Firearms are used to catch a wide variety of larger birds and mammals, but it is important to note that all of the primates captured during the study period were caught with rifles or shotguns. The high average weight of game animals killed with a shotgun (7.05 kg) attests to the fact that hunters will not use the expensive shells for anything but large game.

Table 6.7. Hunting yield of selected game species using different technologies (Caloveborita region, October 1999 to May 2000, 59 households).

Species	Total yield (kg)	Number caught	Percent of total yield (kg) caught with different technologies					
			Firearms	Bow and arrow	Rock-fall trap	Slingshot	*Trinchera*	Other
Agouti paca	325	51	38	10	4	-	-	48
Dasyprocta punctata	297	102	28	3	8	1	-	59
Dasypus novemcinctus	294	109	-	-	56	-	-	44
Tayassu tajacu	272	18	77	6	-	-	-	16
Alouatta palliata	190	33	100	-	-	-	-	-
Mazama americana	104	4	100	-	-	-	-	-
Sciurus granatensis	64	188	35	4	-	58	-	3
Potos flavus	61	27	82	8	-	-	-	10
Ateles geoffroyi	53	7	100	-	-	-	-	-
Crax rubra	52	14	88	-	-	8	4	-
Cebus capucinus	41	14	100	-	-	-	-	-
Tinamus major	32	34	36	-	-	11	48	5
Penelope purpurascens	28	16	85	-	-	7	7	-
Nasua narica	25	9	54	15	-	-	-	31
Ramphastos swainsonii	24	39	72	-	-	25	-	3
Pteroglossus torquatus	18	84	13	1	-	76	-	9
Echimyidae	8	19	3	28	34	14	6	16
Ortalis cinereiceps	7	17	57	-	-	43	-	-
Trogon spp.	5	55	14	-	-	81	-	5

6.3.3 Hunting yields by gender

Hunting among the Buglé is primarily a male activity. Men caught 94 percent of the total yield recorded during the administration of the hunting activity questionnaires (Table 6.8). However, women do participate, although their participation is distinct. While men obtained virtually all of the game caught during hunting trips, women play a significant role in the use of traps. Women caught 21 percent of the 318 kg of game caught using traps. The use of the *trinchera* by women is especially pronounced – women caught 65 percent of all game caught using this method (although the trap only accounts for about one percent of the total harvest). The *trinchera* accounts for just over one quarter of all game caught by women.

Table 6.8. Hunting yields by gender (Caloveborita region, October 1999 to May 2000, 59 households).

	Total		Traps		*Trinchera*	
	(kg)	%	(kg)	%	(kg)	%
Male	2,436	94	253	79	9	35
Female	143	6	65	21	17	65

6.3.4 Yields of individual hunters, households, and communities

There is great variability in the amount of game captured by different people in the Caloveborita region. As already noted, women are much less involved in hunting than men. Small children and the elderly and infirm likewise contribute very little to the total harvest. Among adult men, there is also considerable variation in the degree of participation in hunting trips according to individual inclinations – some people are more motivated to hunt than other. Some people seem to simply enjoy hunting more than others, but there are a host of reasons that affect levels of participation in this activity. Some individuals are more skilled at detecting and capturing game. The amount of time spent hunting and the quantity of game caught is also affected by how much time a hunter spends working outside of the region, whether or not they have access to a firearm or a good hunting dog, and whether or not they are inclined to make traps. Ethnicity is another important factor: the Buglé are much more active hunters than Campesinos. The majority of households that were eliminated from the hunting activity study (based on limited involvement in hunting) were Campesino households, despite the fact that they are a minority in the study area. Among the Ngöbe men in the study area, most do not hunt very often. This is likely due, in part, to the fact that most Ngöbe families here are recent immigrants to the humid northern slope of western Panama, coming from savanna areas that are largely devoid of game. As such, they do not have a direct heritage of hunting passed down from generation to generation, and are less familiar with the habits of rain forest wildlife species.

Among the 59 households included in the hunting activity study, just 13 hunters were responsible for half of the total harvest. All of these hunters were men, and all but three had access to a firearm (Table 6.9). The most active hunter caught an astounding 11 percent (287 kg) of the total yield. A large number of people, however, were involved in hunting to some degree. A total of 30 hunters caught over 20 kg of game during the eight-month questionnaire period, and an additional 24 people caught at least 10 kg. Figure 6.2 shows the amount of game caught by individual hunters declining from left to right. Two or three hunters were especially active, but after these individuals, there is a much more gradual decline in the amount of game caught.

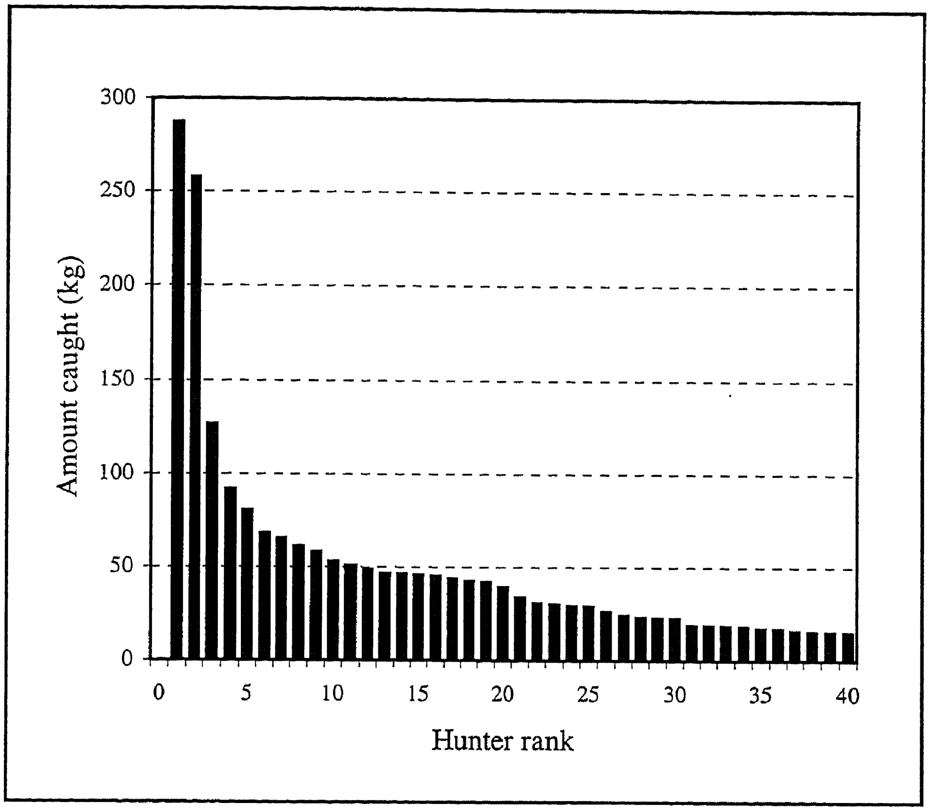
A similar variability in hunting yields is found at the household level (Table 6.10) – the top nine households caught over half of the total harvest. A total of 24 households each caught over 30 kg of game, and an additional 23 households caught at least 10 kg during the study period. It is noteworthy that the household catching the most game (419 kg, 16 percent of the total harvest) is the most remote in the study area, located far upriver along the Río Caloveborita surrounded by extensive rain forest, and includes two of the most active hunters in the region. The number of hunters per household, however, does not always significantly increase the amount of game caught. For example, in one case the

Table 6.9. Total yield and selected characteristics of the 35 most active hunters (Caloveborita region, October 1999 to May 2000).

Hunter Rank	Total harvest (kg)	Community	Gender	Ethnicity[1]	Access to firearm?	Age
1	287	Río Pedregoso	m	B	yes	34
2	257	Río Palmar	m	B	yes	32
3	126	Río Palmar	m	B	yes	24
4	92	Río Pedregoso	m	B	yes	28
5	80	Río Pedregoso	m	B	no	30
6	68	Río Pedregoso	m	B	yes	35
7	65	Río Palmar	m	B	yes	29
8	61	Río Palmar	m	B	yes	38
9	58	Quebrada Larga	m	NB	yes	24
10	53	Quebrada Larga	m	B	no	32
11	51	Quebrada Larga	m	NB	yes	46
12	49	Río Pedregoso	m	B	no	41
13	46	Río Palmar	m	B	yes	28
14	46	Río Pedregoso	m	BC	yes	15
15	46	Río Pedregoso	m	B	yes	24
16	45	Río Pedregoso	m	B	no	25
17	44	Alto Limón	m	B	no	34
18	42	Alto Limón	m	NB	no	35
19	42	Río Pedregoso	m	NBC	yes	51
20	39	Quebrada Larga	m	NB	yes	22
21	34	Río Pedregoso	m	B	no	34
22	31	Quebrada Larga	f	B	no	26
23	30	Alto Limón (visitor)	m	B	yes	35
24	29	Quebrada Larga	m	NB	yes	27
25	29	Río Pedregoso	m	B	yes	14
26	26	Río Palmar	m	B	no	17
27	24	Caloveborita	m	B	no	23
28	23	Río Pedregoso	m	B	no	39
29	23	Caloveborita	m	C	yes	49
30	22	Caloveborita	m	NBC	yes	28
31	19	Río Palmar	m	B	yes	27
32	19	Caloveborita	m	B	no	25
33	19	Río Pedregoso	m	NBC	no	17
34	18	Río Palmar	m	B	no	14
35	17	Alto Limón	m	B	no	44

[1] Ethnicity: B, Buglé; NB, Ngöbe-Buglé; BC, Buglé-Campesino; NBC, Ngöbe-Buglé-Campesino; C, Campesino.

Figure 6.2. Game caught by the 40 most active hunters (Caloveborita region, October 1999 to May 2000).



father of a family told me that he had reduced the amount of time he spent hunting because his eldest son, aged 14 at the time, was starting to go hunting on his own.

The amount of game caught by the different communities of the study area was by no means uniform, despite the fact that they are all found in close proximity and share a similar social and physical environment. The differences in the amount of game caught are undoubtedly related a variety of variables, including proximity to extensive rain forest and ethnic composition.

Average hunting yields were highest for households in Río Palmar and Río Pedregoso (Table 6.11). These two settlements are located very close to extensive rain forest habitat (Figure 3.2), and have a high proportion of Buglé households (Table 3.1). Quebrada Larga, located farther from the forest, has a lower average, but remains above the

Table 6.10. Total hunting yield and selected characteristics of the top 35 households (Caloveborita region, October 1999 to May 2000).

Household rank	Total caught (kg)	Community	Number of active hunters*	Access to a firearm?
1	419	Río Pedregoso	5	yes
2	259	Río Palmar	1	yes
3	134	Río Palmar	1	yes
4	114	Río Pedregoso	2	yes
5	111	Quebrada Larga	2	yes
6	80	Río Pedregoso	1	no
7	75	Alto Limón	2	no
8	72	Río Pedregoso	3	yes
9	72	Río Pedregoso	2	no
10	68	Alto Limón	1	no
11	66	Río Palmar	1	yes
12	64	Quebrada Larga	1	no
13	62	Río Palmar	1	yes
14	61	Río Pedregoso	2	no
15	61	Río Palmar	1	yes
16	58	Quebrada Larga	1	yes
17	58	Río Pedregoso	1	yes
18	49	Río Pedregoso	1	yes
19	49	Alto Limón	1	no
20	41	Quebrada Larga	1	yes
21	36	Caloveborita	1	yes
22	36	Río Pedregoso	1	no
23	32	Río Pedregoso	1	no
24	31	Caloveborita	1	yes
25	29	Quebrada Larga	1	yes
26	27	Río Pedregoso	1	no
27	26	Alto Limón	1	no
28	26	Río Pedregoso	1	no
29	26	Río Palmar	1	no
30	24	Caloveborita	1	no
31	22	Río Palmar	1	no
32	19	Caloveborita	0	no
33	19	Caloveborita	0	no
34	19	Alto Limón	1	no
35	19	Río Palmar	1	yes

* An active hunter is defined here as a person who goes on hunting trips at least a few times per year, or who makes traps at least occasionally, and can be expected to capture at least roughly 15 kg of game annually.

Table 6.11. Total hunting yield and average household yield by community (Caloveborita region, October 1999 to May 2000).

Community	Number of participating households	Total yield (kg)	Number of animals captured	Average yield per household (kg)	Community ethnicity
Río Palmar	9	669	331	74	Buglé
Río Pedregoso	17	1,122	1,132	66	Buglé
Quebrada Larga	6	310	366	52	Ngöbe-Buglé
Alto Limón	8	239	86	30	Ngöbe-Buglé
Caloveborita	15	211	546	14	Buglé-Campesino
Quebrada Larga Arriba and Quebrada Tuza	4	29	20	7	Campesino
Total	59	2,580	2,481	45	

overall average. The average household yield for Alto Limón is significantly lower, despite being relatively close the rain forest. Finally, Caloveborita, the largest village in the middle of the study area with a large Campesino population, and the neighboring settlements of Quebrada Larga Arriba and Quebrada Tuza – the only wholly Campesino settlements – have very low household hunting yield averages. It should be reiterated here that the average household yields solely represent the households that are actively involved in hunting. As discussed earlier, several households were excluded from the study because hunting does not constitute a significant element of their subsistence activities.

6.3.5 Seasonality in hunting yields

Strong seasonal variations in hunting yields have been documented in previous hunting studies (Bergman 1980:135; Grenand 1992:37). One of the main causes of month to month change in the quantity of game caught stems from seasonal rainfall patterns, which lead to flooding during certain periods when game is concentrated in smaller areas, and which at the same time reduces fishing productivity. Variation in hunting over the year is also attributable to the seasonal scheduling of other subsistence activities, in particular agricultural tasks which are also timed in relation to rainfall where a pronounced dry season exists. Understanding the nature and causes of seasonal variation in game extraction is necessary in any attempt to evaluate the impact of hunting on different species, especially those which are more vulnerable during certain periods of the year. In many parts of the world, seasonal bans on wildlife use have been chosen as the most desirable conservation measure. Selecting the boundaries of closed seasons, however, requires not only some knowledge of the ecological characteristics of those species at risk, but also how they relate to seasonal patterns of use by local people.

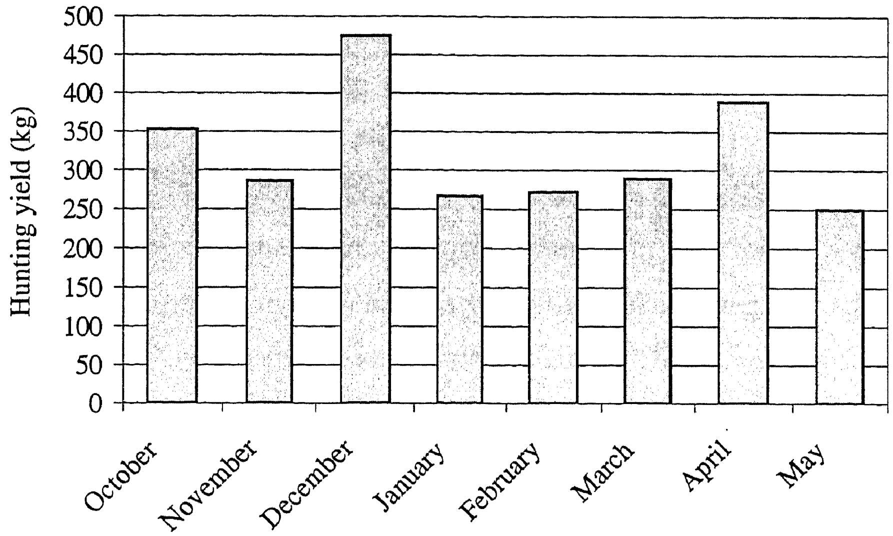
In the Caloveborita region, there are periods of especially high rainfall, and a short dry season usually occurs in March or April, and sometimes in October, as indicated by precipitation data collected in the field and interviews with local residents. Overall, however, a significant, pronounced dry season is lacking – rainfall is abundant in all months, although it is especially abundant from about November to January. As such, the region does not experience pronounced dry periods when fish become concentrated in small pools or isolated in ox-bow lakes or ponds that are separated from the main river channel. If this were the case, hunting efforts might be abandoned for increased opportunities to catch large amounts of fish. Conversely, because the Caloveborita watershed is heavily dissected, with steep slopes and restricted floodplains, large-scale inundations that concentrate game on shrinking land surfaces do not occur. Nevertheless, based on my own observations and informal interviews with numerous hunters, it is clear that precipitation is a deterrent to engaging in hunting trips. Hunters simply do not like to go hunting in the rain. Although rainfall is abundant in every month of the year, in the wettest months, there are fewer days when hunters will plan a hunting trip. Conversely, during months when there are many days without rain, hunters will tend to go on more trips, including extended expeditions.

In the Caloveborita region there is some seasonality in the amount of agricultural work that is done, but without a pronounced dry season, there are no clearly defined periods when most farmers are either heavily occupied or have a lot of free time. The timing of clearing and planting is flexible for many crops, and for some (for example, bananas or dasheen), planting can occur in any month. *Maize chiquito* (as well as rice) has a more defined growing season, but even so, individual farmers clear their fields and broadcast seeds anywhere from about September to December. As such, when considering the entire region as a whole, there are no obvious, strongly pronounced month to month changes in the amount of agricultural work that must be done that would significantly affect hunting yields over the course of the year. Individual farmers, on the other hand, definitely experience periods when they are quite busy and others when they have spare time for hunting trips.

It was expected that the primary factor affecting the seasonality in hunting yields would be the departure of men to work on sugar cane plantations on the drier, Pacific slope of western Panama during the harvest season from late January to early May, which is known as the "*zafra*." For people in the Caloveborita region, the *zafra* is the most important opportunity for earning cash for purchasing manufactured goods such as clothing, tools, and school supplies. Most adult men participate in this work, and it is not uncommon for men to spend a month or more outside of the study area during the sugar cane harvest season.

Detailed hunting activity data were collected for a period of eight months, which gives a good, albeit incomplete picture of the seasonal variation in the amount of game harvested over the year. As can be seen in Figure 6.3, there do not appear to be any significant month to month trends in game yields. The months when more people are away cutting cane are February, March, and April, and these three months do not show a consistently lower game harvest. A significant amount of game was caught in every month, with an average of 322 kg, and the only value outside of the standard deviation (77 kg) is that of December, with a total of 474 kg. It is possible that hunters had more free time during this month, that fishing opportunities were not available, and that rainfall was not a significant deterrent to undertake hunting trips. Nevertheless, on the whole, the data do not support the existence of any significant seasonal pattern. This does not mean, however, that seasonal factors are not important. It is entirely possible that certain factors tend to offset each other. For example, the departure of hunters from the region to work on sugar plantations in February and March may be countered by more frequent hunting by those who remain during these months when the weather tends to be more favorable. If opportunities

Figure 6.3. Seasonality in hunting yields (Caloveborita region, October 1999 to May 2000, 59 households).



to work on the sugar plantations were to end, it is not unlikely that hunting yields for this period would rise dramatically.

6.3.6 Hunting yields in anthropogenic versus natural habitats

A primary hypothesis of my dissertation research was that the type and quantity of game captured by the Buglé in anthropogenic and natural habitats would be significantly different. As discussed in Chapter 2, hunting in gardens and fallows by indigenous peoples in the humid neotropics has been noted by a great number of researchers, although it has received very little systematic study. The ecological dynamics of wildlife populations in areas where shifting cultivation creates a mosaic of habitats ranging from cultivated fields, to secondary forests, to rain forest has likewise received little scientific attention, despite the fact that the use of anthropogenic habitats by wildlife is a critical element in the ability of different species to coexist with indigenous and other rural populations. The frequency with which a species is encountered in anthropogenic versus natural habitats is not only an important indication of the breadth of its foraging strategy, but also an indicator that can be used by conservation biologists to develop better conservation measures. Yet, several important issues remain poorly understood. Which game species are more predisposed to make use of gardens and fallows, and what are the specific conditions that attract them? What is the relative importance of hunting in anthropogenic versus natural habitat? Does the use of resilient "garden game"[6] species reduce hunting pressure on other, more vulnerable species? The first step in answering some of these questions is to review the type and quantity of game caught in these two distinct types of habitat.

Table 6.12 presents the amount of game caught in rain forest versus agricultural areas within the hunting zone used by hunters in the Caloveborita region. Almost half of the total yield (47 percent) was obtained in agricultural areas. This is a significant quantity that clearly indicates that anthropogenic habitats are frequented by a large number of game animals, and that garden hunting is an extremely important component of wildlife use among the Buglé. Of the game caught in agricultural lands, 36 percent was captured in tall fallow, 28 percent in short fallow, 28 percent in active gardens, 3 percent in pasture, and 4 percent in the immediate vicinity of a house.

Table 6.12. Hunting yields by habitat and animal class (Caloveborita region, October 1999 to May 2000, 59 households).

	Total yield (kg)	Habitat			
		Forest		Agricultural lands	
		(kg)	(%)	(kg)	(%)
Mammals	2,237	1,197	53.5	1,040	46.5
Birds	252	145	57.3	108	42.6
Reptiles	91	25	28.0	65	72.0
Total	2,580	1,367	53	1,213	47

The game species that are captured frequently in agricultural areas are distinct from those caught primarily in the rain forest. The 15 most important game species caught in rain forest habitat, by weight, are listed in Table 6.13. The three monkey species found in the

Table 6.13. Most important game species harvested from forest habitat (Caloveborita region, October 1999 to May 2000, 59 households).

Rank	Scientific name	English name	Total caught in forest habitat (kg)	Total caught (kg)	% from forest
1	*Dasyprocta punctata*	Central American agouti	207	297	70
2	*Alouatta palliata*	Mantled howler monkey	190	190	100
3	*Tapirus bairdii*	Baird's tapir	150	150	100
4	*Dasypus novemcinctus*	Nine-banded armadillo	114	294	39
5	*Tayassu tajacu*	Collared peccary	105	272	39
6	*Agouti paca*	Paca	78	325	24
7	*Bradypus variegatus*	Brown-throated three-toed sloth	73	119	61
8	*Choloepus hoffmanni*	Hoffmann's two-toed sloth	68	113	60
9	*Ateles geoffroyi*	Central American spider monkey	53	53	100
10	*Crax rubra*	Great curassow	43	52	84
11	*Potos flavus*	Kinkajou	39	61	63
12	*Cebus capucinus*	White-faced capuchin monkey	36	41	88
13	*Penelope purpurascens*	Crested guan	27	28	96
14	*Tinamus major*	Great tinamou	26	32	82
15	*Mazama americana*	Red brocket deer	26	104	25

region were caught exclusively in the forest while others were caught primarily in the forest, including the agouti, the great currasow, the crested guan, and the great tinamou. Other species on this list were also caught frequently in agricultural areas. Some were even caught more frequently in anthropogenic habitat but are included in the table because of the sheer quantity that were captured and the fact that they are caught in both types of habitat. The collared peccary for example, is the fifth most important species caught in the rain forest (105 kg), although more individuals were caught in agricultural areas.

Table 6.14 shows the 15 most important game species encountered in agricultural areas. The paca, the armadillo, and the collared peccary are the three most important garden game species. The agouti also figures prominently, despite the fact that it is encountered more frequently in the forest.

Again, it should be emphasized that the proportion of a species harvested in different types of habitat does not necessarily indicate that the species is more abundant in either forest or agricultural areas. Hunting yields are certainly affected by game abundance, but are also related to encounter rates – at least for preferred species that will always be sought and pursued when encountered. Encounter rates, in turn are dependent on where hunters spend their time. The Buglé, in the course of a normal week or month, will spend much more time at home and in agricultural areas than in the forest, and as a result, more individuals of certain species will be caught in agricultural areas simply because there are more opportunities for encountering them. Many of the garden game species are, in fact, usually caught opportunistically. For less preferred species, there is in fact a bias that increases their harvest in agricultural areas. Less desirable, small game species are often ignored in the rain forest while on hunting trips. For example, a hunter will not use a rifle to shoot a squirrel or a pigeon while pursuing a tapir, because the report will alarm the preferred prey and cause it to flee.

In addition to animal population densities, the amount of time people spend in agricultural areas, and game preferences, there are other factors that affect the relative number of individuals caught in agricultural zones. These include the type of crops and age of fallows, the spatial distribution of anthropogenic habitats and their proximity to mature

Table 6.14. Most important game species harvested from agricultural lands (Caloveborita region, October 1999 to May 2000, 59 households).

Rank	Scientific name	English name	Total from agricultural lands (kg)	Total caught (kg)	% from agricultural lands
1	*Agouti paca*	Paca	247	325	76
2	*Dasypus novemcinctus*	Nine-banded armadillo	180	294	61
3	*Tayassu tajacu*	Collared peccary	166	272	61
4	*Dasyprocta punctata*	Central American agouti	90	297	30
5	*Mazama americana*	Red brocket deer	78	104	75
6	*Bradypus variegatus*	Brown-throated three-toed sloth	47	119	39
7	*Sciurus granatensis*	Red-tailed squirrel	45	64	71
8	*Choloepus hoffmanni*	Hoffmann's two-toed sloth	45	113	40
9	*Puma concolor*	Puma	37	37	100
10	*Sylvilagus brasiliensis*	Forest rabbit	26	26	98
11	*Potos flavus*	Kinkajou	22	61	37
12	*Rhinoclemys annulata*	Neotropical wood turtle	21	44	47
13	*Basiliscus plumifrons*	Green basilisk	20	22	90
14	*Nasua narica*	White-nosed coati	14	25	54
15	*Pteroglossus torquatus*	Collared aracari	12	18	69

forest, and the technologies employed. Rock-fall traps and awaiting make especially significant contributions to the game harvest from agricultural areas. The relative number of individuals caught in anthropogenic and rain forest habitat still provide a good indication ofwhich species forage in anthropogenic habitat, and clearly show the contribution of these two distinct zones as sources of game. Moreover, this type of information provides guidance for developing effective wildlife management strategies. Conservationists must take into account that indigenous peoples will probably reject initiatives that include the protection of animals that may be relatively abundant in their homelands and that, at the same time, are responsible for significant crop losses.

A more indicative picture of the gradient from a "garden game" to a "deep forest game" species is shown by the proportions caught in anthropogenic versus natural habitat (Table 6.15). Based on the relative amounts encountered in anthropogenic versus natural habitats, I have tentatively grouped the most important game species into three categories: garden game, intermediate species, and deep forest game. The categorization is based on a conservative threshold. Species whose total harvest was greater or equal to 25 percent in either forest or agricultural areas were classified accordingly – all others were considered intermediate. The classifications should be considered tentative, but the results provide clear evidence that there are important differences in the type of game caught in anthropogenic versus natural habitat, which may also be found in other parts of the humid neotropics.

The species that can most clearly be categorized as a "garden game" species is the forest rabbit, with 98 percent of the catch encountered in agricultural areas (mostly in pastures). Following this are the green basilisk, which is encountered along streams; the paca which is a significant crop pest and a preferred species caught frequently while awaiting; the brocket deer which eats the leaves of yuca plants; and the red-tailed squirrel which is often spotted in trees along walking trails. The six "deep forest game" species are the three monkey species, and the crested guan, the great currasow, and the great tinamou.

Table 6.15. Garden game and deep forest game (Caloveborita region, October 1999 to May 2000, 59 households).

Classification	Scientific name	English name	Total yield (kg)	Total from agricultural areas (kg)	Number caught	% from agricultural lands
Garden game	*Sylvilagus brasiliensis*	Forest rabbit	26	26	32	98
	Columba spp.	Pigeons	9	8	41	93
	Basiliscus plumifrons	Green basilisk	22	20	100	90
	Ortalis cinereiceps	Gray-headed chachalaca	7	6	17	86
	Echimyidae	Spiny rats	8	7	19	84
	Agouti paca	Paca	325	247	51	76
Intermediate	*Sciurus granatensis*	Red-tailed squirrel	64	45	188	71
	Pteroglossus torquatus	Collared aracari	18	12	84	69
	Bassaricyon gabbi	Olingo	11	7	5	63
	Tayassu tajacu	Collared peccary	272	166	18	61
	Dasypus novemcinctus	Nine-banded armadillo	294	180	110	61
	Nasua narica	White-nosed coati	25	14	9	54
	Rhinoclemys annulata	Neotropical wood turtle	44	21	43	47
	Ramphastos swainsonii	Chestnut-mandibled toucan	24	11	39	45
	Choloepus hoffmanni	Hoffmann's two-toed sloth	113	45	17	40
	Bradypus variegatus	Brown-throated three-toed sloth	119	47	39	39
	Potos flavus	Kinkajou	61	22	27	37
	Dasyprocta punctata	Central American agouti	297	90	102	30
Deep forest game	*Tinamus major*	Great tinamou	32	6	34	18
	Crax rubra	Great curassow	52	8	14	16
	Cebus capucinus	White-faced capuchin monkey	41	5	14	12
	Penelope purpurascens	Crested guan	28	1	16	4
	Alouatta palliata	Mantled howler monkey	190	0	33	0
	Ateles geoffroyi	Central American spider monkey	53	0	7	0

* Species with less than five individuals captured were not classified.

[1] This description focuses on the Buglé although the study area also contains Ngöbe and Campesino families, primarily because the Buglé are the predominant indigenous culture in the region, and because hunting is a much less common activity among Campesinos (and to some degree this is true of the Ngöbe as well). The hunting strategies and techniques of these two other groups, however, are similar.

[2] No hunting trips to pursue white-lipped peccaries occurred during the study period, but several that had taken place in previous years were recounted to me.

[3] In local Spanish, this hunting strategy is known as "*aguetar*" which appears to derive from the English verb "to await."

[4] Hunters say that the paca in particular, which is one of the most coveted game species and caught frequently using this method, does not arrive in the early evening, but later on into the night, because it is a species that becomes very wary in areas where it is hunted.

[5] Questionnaire data from the last few days of September 1999 and the first few days of June 2000 were omitted to retain a discrete, rounded eight-month total.

[6] I use the term "garden game" for convenience, but includes game that is caught frequently in both active gardens and fallow fields.

7. The Spatial Dynamics of Hunting in Relation to Human Settlement and Habitat

7.1 Why document the spatial patterns of game extraction?

The spatial patterns of subsistence hunting hold revealing clues about the relationship between indigenous people and wildlife. At the most basic level, it is useful to know exactly what lands are used by hunters. This tells us something about how far are hunters willing to travel to find game, or alternatively, how far they need to travel to obtain sufficient quantities of game. By documenting the limits of indigenous hunting zones we can also discover the size of areas that are free from the impacts of hunting. These unhunted zones are likely important sources of animals for repopulating hunting grounds in many parts of the humid neotropics. However, while straightforward in theory, mapping lands used by hunters accurately can require considerable effort. Hunting areas are irregularly shaped, and can not be easily estimated with precision without documenting where people go and where animals are caught.

Beyond a simple delineation of hunting zones, knowledge of where animals are captured within these areas should indicate, to some degree, the ability of different game species to coexist with people. I argue that species that are caught close to human settlement are more resilient to hunting pressure, while those species that are caught almost exclusively on the peripheries of indigenous hunting grounds provide evidence of game depletion. Yet, aside from anecdotal information, there are precious few studies upon which to evaluate this hypothesis. I have seen only one map that shows point locations of game kill sites (Tobias 2000:15) – big game caught by Algonkin hunters in Quebec – and to my knowledge there are no examples from a neotropical setting.

This chapter begins with a description of the spatial patterns of settlement and land cover, followed by a discussion of the hunting zone and the relative importance of anthropogenic and natural habitats within the hunting zone as distinct sources of game. The results of the participatory mapping of game kill sites is also presented, along with an analysis of hunting yields as a function of distance from human settlement.

7.2 *Spatial patterns of settlement and land cover*

The settlement pattern in the Río Caloveborita region consists of a few village areas as well as dispersed hamlets and individual houses. The largest concentration of people occurs around the school in Caloveborita, followed by some nucleation in Alto Limón, Río Pedregoso, Quebrada Larga, and Río Palmar (Figure 3.2). There are also a few separate clusters of related households that have recognized names, but which are associated with one of the larger villages and are not considered to be separate communities by local people. Quebrada Larga Arriba (a few kilometers upstream from the larger community, Quebrada Larga), with about 30 residents who are associated with Caloveborita is the largest of these, and Quebrada Tuza is another. In addition, many families live in relatively isolated locations as far as one kilometer or more from their closest neighbor. One of the main reasons for this is the desire to live closer to gardens that are far from villages. Farmland near village centers is scarce, and families that arrived to the region after earlier arrivals were forced to farm more distant areas near the edges of the forest. The location of these households near the outer peripheries of agricultural areas means that many hunters live within easy reach of the forest and tend to be more inclined to engage in hunting trips. Moreover, they are more likely to encounter game animals that leave the forest to forage in adjacent agricultural areas. Thus, from a geographic and ecological point of view, settlement patterns, the distribution of anthropogenic and forest habitat, and hunting activity are inextricably linked.

The dispersed nature of Buglé settlement (and close proximity between people and the rain forest) is even more pronounced when considering the use of secondary house sites. Entire families with a principal residence in village centers move to other residences closer to active gardens periodically, usually when more labor is required for agricultural tasks or during vacations when children do not have to walk to school. Over one third of the households that participated in the hunting activity study have secondary residences within 500 meters of the rain forest (Figure 3.2). While these sites may only be used for a few weeks at a time, these periodic stays undoubtedly have impacts on wildlife. Some hunters look forward to these stays as good opportunities to catch game. In fact, occasionally the primary impetus to move to a secondary house site is to inspect fields for evidence of crop predation by animals, and to capture them if possible.

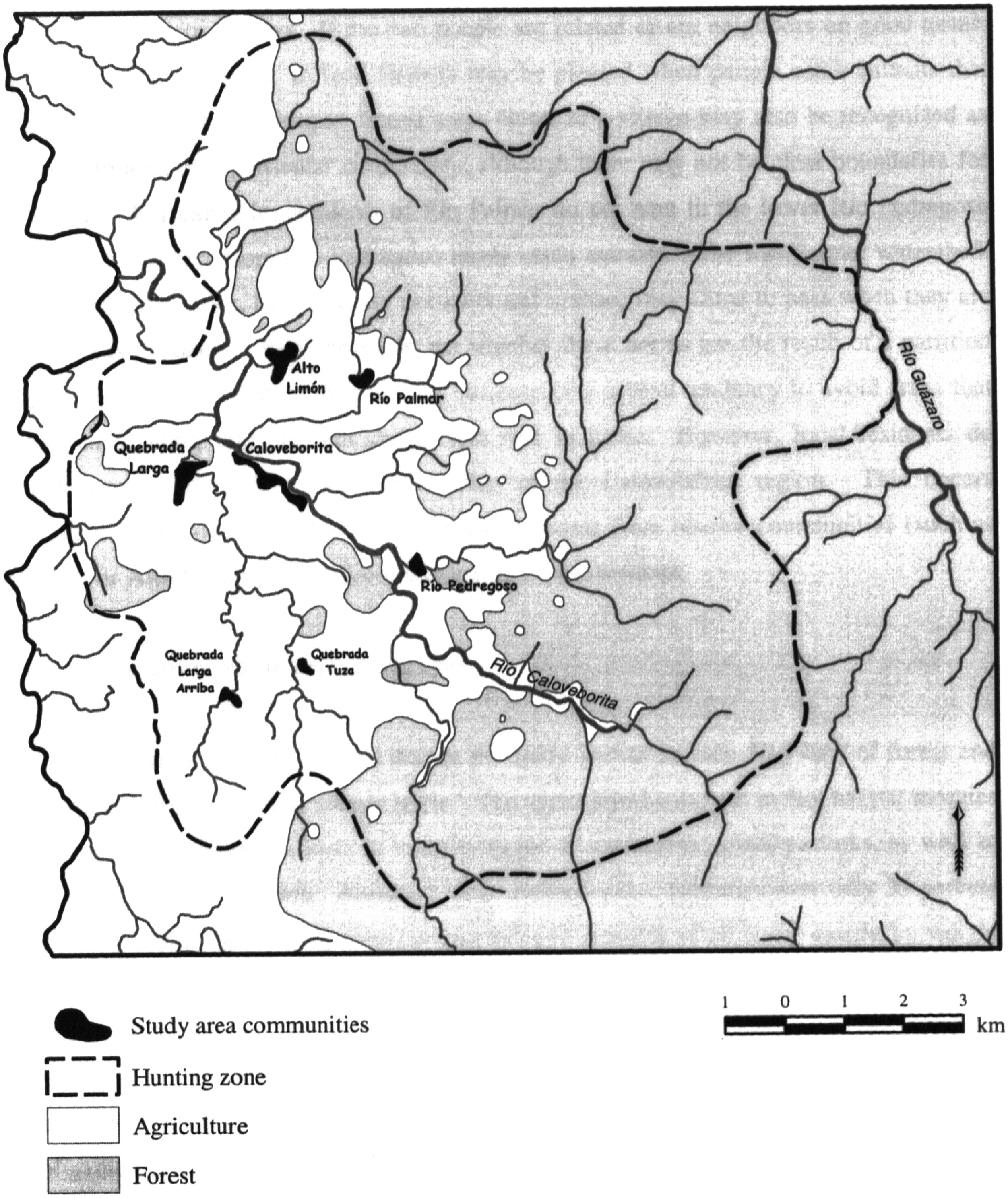
7.3 The hunting zone used by the residents of the Caloveborita region

The lands used for hunting by the Buglé and other hunters living in the Caloveborita watershed have a total area of approximately 131 km^2. The most distant areas used by hunters are about 8 kilometers from village centers (Figure 7.1). This hunting zone, anchored on village lands and extending into vast areas of rain forest to the northeast, east, and southeast, was delimited based on the distribution of 1,278 game kill sites documented through participatory mapping, along with my own observations while accompanying hunters over a period of about one year. Village lands were included in the total hunting area because many species are caught in the village, and even in dooryard gardens. Within this hunting zone, 2,580 kg of game were caught during the study period, resulting in an average harvest of 19.9 kg per km^2 over eight months.

The limits of Buglé hunting activity are diffuse and dynamic, and the delimitation presented here is merely an estimation of all areas used by hunters at the time of this study.[1] Hunters would likely travel beyond these limits to pursue preferred prey such as a tapir or a herd of white-lipped peccaries if fresh tracks were discovered. There are no fixed boundaries that define hunting territories[2] that belong to one group of people or another. Hunters frequent different areas depending on their assessment of the changing abundance of different species and the amount of free time they have. Residents of Río Palmar, for example, used to hunt in the lower Río Guázaro valley, but abandoned these areas after the arrival of Ngöbe settlers at the site of Alto Marañon located about eight kilometers from the coast. These Ngöbe families arrived from the province of Bocas del Toro in the mid-1980s and are apparently responsible for a reduction in preferred game species in the forest surrounding their settlement. This shift in hunting activity, however, appears to be the result of perceptions of decreased game abundance rather than a partition of hunting lands.

Nevertheless, among the Buglé there is some recognition of a certain degree of exclusive hunting rights to particular areas under certain conditions. First of all, there is an

Figure 7.1. Lands used for hunting by residents of the Caloveborita region, 1999 - 2000.



expectation that a hunter should have permission to set traps or seek game in another person's gardens or fallows. If the two people are related or are neighbors on good terms, this is a matter of course. In fact, farmers may be pleased when people catch animals that might otherwise eat their crops. Forest areas closer to a village may also be recognized as the hunting area of a particular community, although there may not be clear boundaries for such areas. For example, residents of Río Palmar do not hunt in the lower Río Pedregoso valley, and villagers from Río Pedregoso rarely catch animals in the Río Palmar watershed. These customary rules, however, are not strict and nothing may come to pass when they are occasionally "broken." It is unclear to me whether these norms are the result of a partition of hunting areas, or whether they are the outcome of a natural tendency to avoid areas that other people hunt, that are presumably less rich in game. However, local residents do complain when hunters arrive from outside of the Caloveborita region. This occurs infrequently, and outsiders that do arrive tend to come from nearby communities (such as Río Luís or Alto Ortega), often accompanied by a local resident.

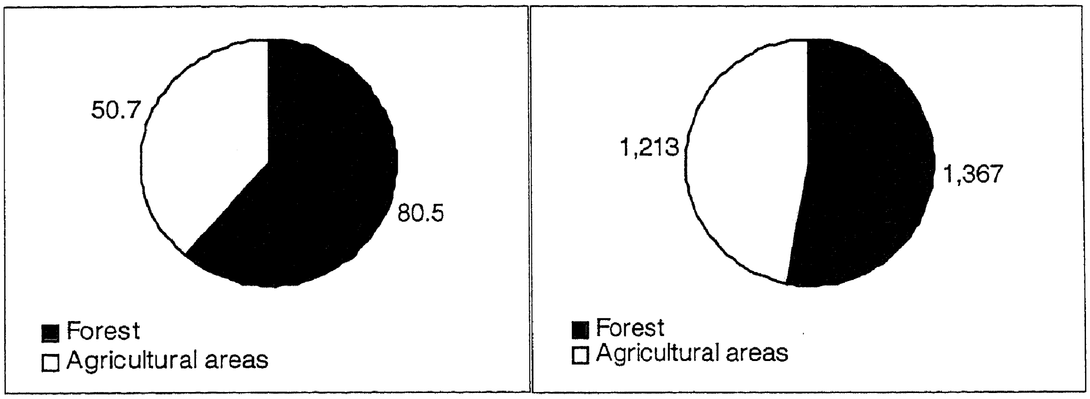
7.3.1 Land cover within the hunting zone

The lands used by hunters during the study period include 80.5 km^2 of forest and 50.7 km^2 of agricultural and village lands.[3] The agricultural areas are in fact habitat mosaics containing active fields, fallows in various stages of succession, small pastures, as well as some small forest fragments. Although these anthropogenic habitats cover only 39 percent of the area within the hunting zone, almost half (47 percent) of all game caught by weight was obtained from agricultural areas (Figure 7.2). Thus, agricultural areas provided slightly more game per unit area than mature forest, which is in keeping with other studies that have documented the relative contribution of anthropogenic versus natural habitat to the total hunting yield (Baleé 1985:495-499; Grenand 1992:37-38). Agricultural areas provided 24 kg of game per km^2, while the forested areas provided an average of 17 kg per km^2 over the eight-month data collection period. It is important to reiterate here though, that this does not necessary mean that agricultural areas are more productive. Moreover, game caught opportunistically is more frequent in agricultural areas simply because people spend more time in these areas. Awaiting game is done almost exclusively in agricultural areas.

Figure 7.2. (a) The relative proportion of the hunted area and (b) the relative contribution to the total game harvest of agricultural and forest areas (Caloveborita region, October 1999 to May 2000, 59 households).

(a) Land cover within the hunting zone (km^2)

(b) Quantity of game caught within the hunting zone (kg)



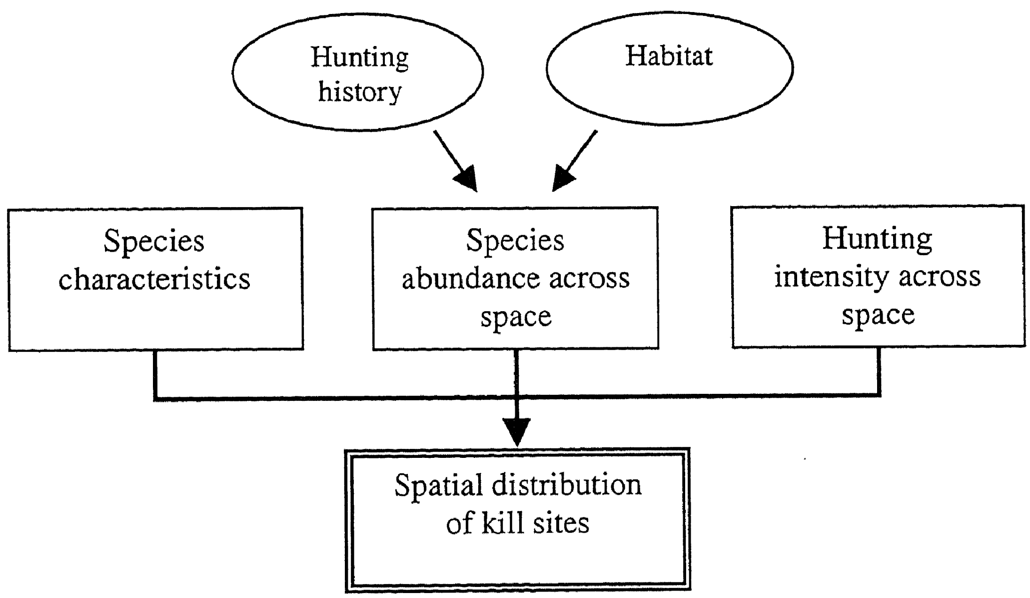
Moreover, the proximity of forest likely contributes to higher game availability in neighboring agricultural areas, just as unhunted forest lands are likely a source of some of the game that is caught in forest habitat closer to Buglé settlement. Higher yields from agricultural areas, then, do not necessarily indicate that game abundance is higher here.

7.4 Variables that condition the spatial distribution of game kill sites

The intensity of wildlife use within the hunting zone, and the type and quantity of game caught, are of course variable across space. There are many direct and indirect factors that condition where individuals of a particular species are caught that must be kept in mind when evaluating the distribution of game kill sites of different taxa. There are, however, three primary "variables" that explain most of the variation in the spatial distribution of hunting yields: species abundance, species characteristics, and hunting intensity across space (Figure 7.3).

Species abundance, or population density, affects the spatial distribution of hunting yields simply because the more abundant a species is in a certain area, the more likely individuals will be encountered by hunters who go there. Population density, of course, varies across space, conditioned in large measure by variations in habitat quality. Notwithstanding microenvironmental conditions and varying degrees of human modification that lead to habitat heterogeneity, two broad categories of habitat are easily identified: agricultural lands and broadleaf, evergreen forest. While some species are fairly tolerant of the conversion of forest to agricultural fields and fallows and make use of them, others have specific requirements. Species population density is also affected by past hunting activity which can reduce the population density of a species well below carrying capacity, especially in the case of preferred game species with lower reproductive rates.[4]

Figure 7.3. Factors influencing the spatial distribution of game kill sites.



Another important variable to consider when interpreting the spatial distribution of kill sites is the variability in the intensity of hunting pressure within the hunting zone. The intensity of hunting pressure – which may be thought of as the amount of human "traffic" across space – affects encounter rates, and in turn, the frequency of kills from place to place. Given that the Buglé are opportunistic hunters, and that many species will be pursued whenever they are encountered, the intensity of hunting pressure is greatest where people spend most of their time. Because people spend most of their time away from home working in agricultural fields, there is greater hunting intensity in anthropogenic habitats closer to the village, rather than in forest areas. Thus, even if a species were more abundant in mature forest, more individuals might still be captured in agricultural areas closer to human settlement simply because of higher encounter rates associated with greater hunting intensity.

In addition to variations resulting from differences in game species abundance and levels of hunting intensity across space, there are also certain species characteristics that condition where different species are captured. Each game animal has a unique combination of traits that will affect the spatial distribution of kill sites. One of the most important characteristics is its value to hunters, ranging from a less desirable species that may be frequently ignored when encountered, to the most preferred species that are highly valued and will almost always be pursued. Additional species characteristics that condition kill site patterns are wariness, activity patterns (whether it is diurnal, nocturnal, or crepuscular), and detectability, which is influenced by coloration and size, calling behavior, and whether or not it is terrestrial or arboreal.

The spatial distribution of kill sites for different species was documented and evaluated to assess which game species are able to persist in the vicinity of indigenous hunters, and which are being hunted at unsustainable rates. One of the research hypotheses was that species that are tolerant of habitat modification and that have higher reproductive rates (allowing for rapid recovery of the population in response to declines caused by hunting) would be caught more frequently closer to where hunters live. The corollary of this hypothesis is that game species that are dependent on rain forest habitat and that have lower reproductive rates would tend to be caught farther from human settlement through the process of game depletion.

7.5 The geography of Buglé hunting yields

The 1,278 game kill sites that were documented through the participatory mapping process were entered into a Geographic Information System (GIS) for analysis. Each kill site point in the spatial database was linked to attribute information such as the species name, the hunter who caught the animal, the weapon used, and so on. These kill sites represent the spatial distribution of hunting yields for a period of 33 weeks, from October 16, 1999 to June 3, 2000, including all mammals that were captured, four reptile species (those with a body mass greater than 100 grams), and the large and medium sized, common game birds. The kill sites of small birds such as tanagers, orioles, hummingbirds and the like were not recorded, and neither were those of larger birds that are rarely captured (e.g., herons, owls, falcons).[5]

The most striking pattern that emerges is that kill sites are concentrated around settlements, gradually dispersing into the large expanse of unsettled rain forest to the northeast, east, and southeast of the study communities (Figure 7.4). This pattern reflects the fact that a large proportion (20 percent) of the harvest by weight consisted of game caught opportunistically during various daily activities, mainly near the home. Many of these are small animals (such as basilisk lizards, squirrels, and pigeons) that were included in the map, although individually they make very small contributions to the total harvest. Another 13 percent of all game was harvested while awaiting, which takes place almost exclusively in agricultural areas close to the home. Traps likewise tend to be placed near the home. Nevertheless, if we focus only on those kill sites for animals caught during hunting trips, a pattern of concentration around human settlement continues to be evident, albeit less pronounced (Figure 7.5).

An exception to the general pattern is apparent around the hamlets of Quebrada Tuza and Quebrada Larga Arriba. Unlike all other settlements, there is a conspicuous absence of kill sites around these two places. While it is true that only a few families from these two hamlets participated in the study, the primary reason that there are so few kill sites around them is that these households simply do not have active hunters. All are Campesino, and rarely go hunting. These people do not carry hunting weapons with them during their daily activities, and are less inclined to pursue small game when encountered.

Linear patterns along forest trails are also apparent. The most obvious is a series of kill sites along a trail that is used by hunters from Río Palmar that crosses over to the Río Guázaro watershed. Other examples along trails used for shorter hunting trips become

Figure 7.4. Location of all game kill sites, Caloveborita region, October 1999 to June 2000 (59 households).

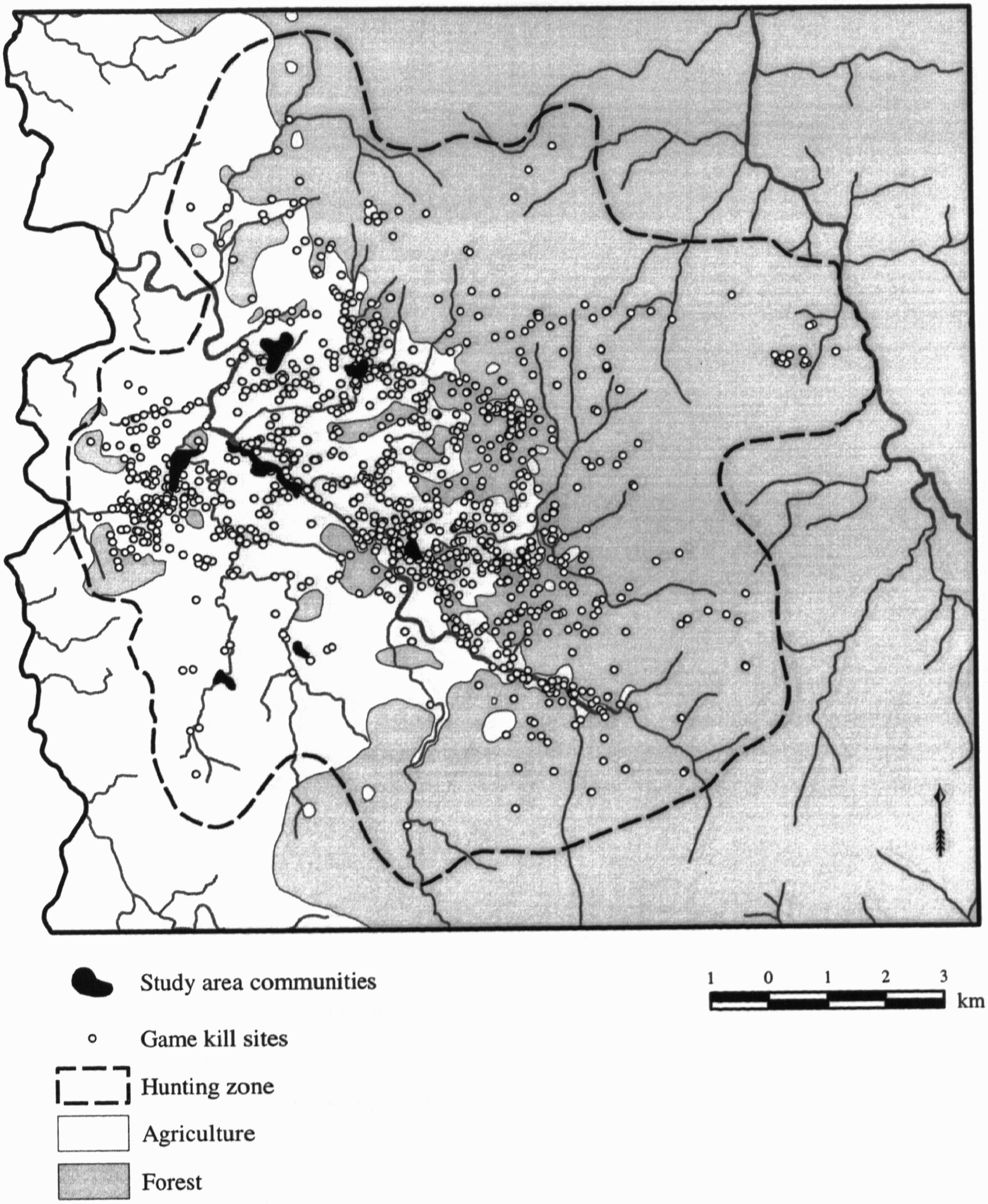
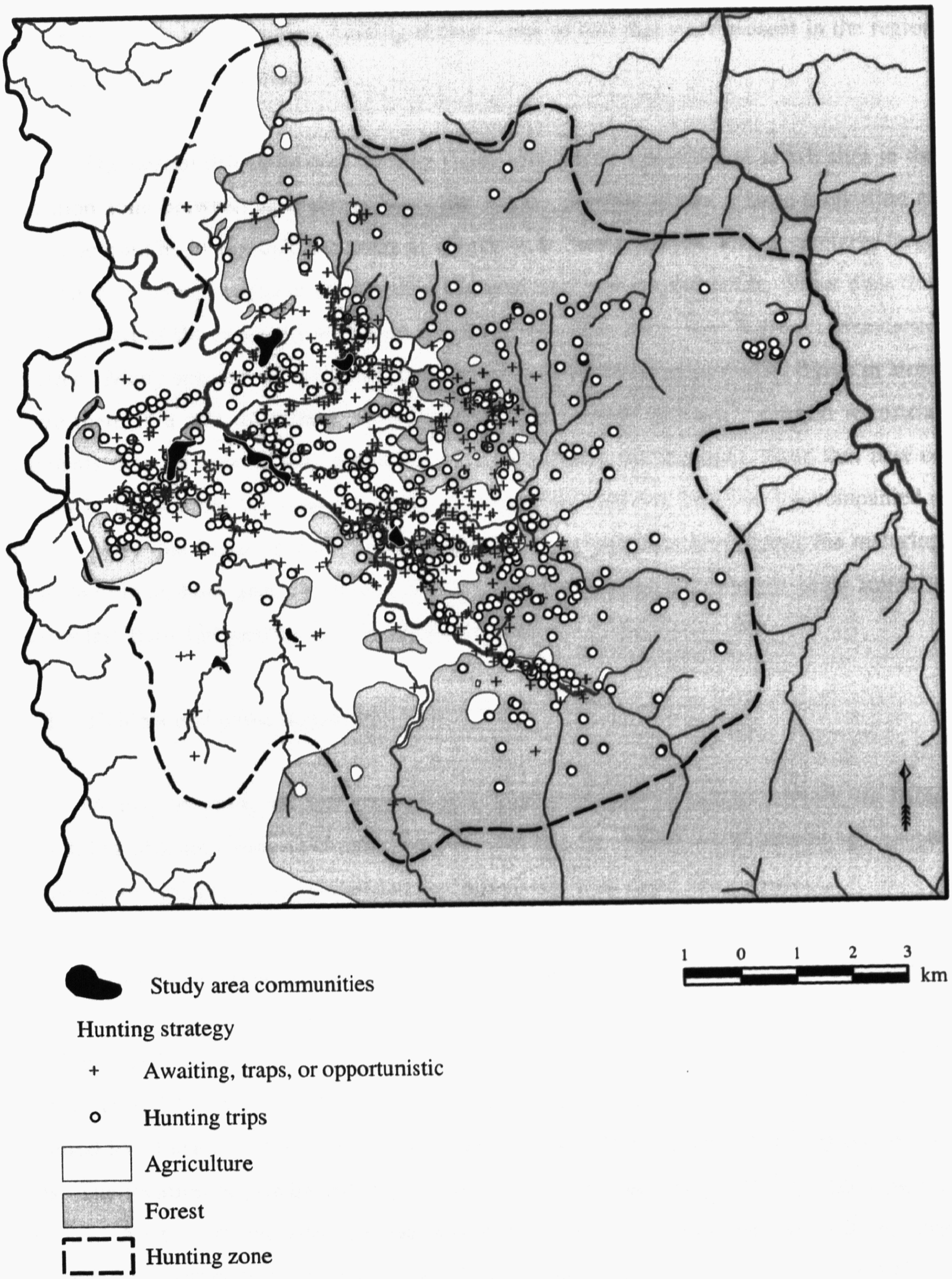


Figure 7.5. Location of kill sites by hunting strategy, Caloveborita region, October 1999 to June 2000 (59 households).



apparent at larger map scales. An isolated cluster of kill sites can also be seen in the easternmost part of the hunting zone, close to the main channel of the Río Guázaro. This cluster of sites is located near a hunting shelter – one of two that were present in the region at the time of the investigation.

The spatial distribution of hunting yields also shows a prevalence of kill sites in the transition zone between agricultural lands and forest. In other words, a large proportion of the game caught in agricultural areas is caught near forest habitat, and a similarly large proportion of game caught in the forest is captured near agricultural lands. What does this signify? Part of the explanation may be that these transition zones have a greater abundance of game. Many species, such as deer, certain rodents, and collared peccaries, thrive in areas where there is a mix of natural, anthropogenic, and ecotone habitats.[6] Certain terrestrial mammals may be able to take advantage of both habitats, for example, those that nest or burrow in forest areas but forage in indigenous gardens. On one occasion I accompanied a hunting party that began in a maize field where a young paca had been eating the maturing crop. Within an hour after we arrived, a dog found what presumably was the same animal's burrow less than 150 meters away in adjacent forest.

7.5.1 Evidence of game depletion

A map showing all kill sites gives a good indication of where animals are being caught, but obscures important variations between species. While some animals are caught frequently in agricultural areas surrounding indigenous settlement, others are not.

Primates are typically more vulnerable to hunting pressure and are among the first species to be depleted in areas where they are hunted (Bodmer, Eisenberg, and Redford 1997:462, 465; Hill et al. 1997:1349-1350; Orejuela 1992:73-74; Stearman 1995:215; Vickers 1991:77). If this is the case in the Caloveborita region as well, where hunting has occurred for at least 50 years, primate depletion should be reflected in the distribution of kill sites. The location of primate kill sites (Figure 7.6) gives some indication that this is indeed the case. All but one primate was captured in rain forest, and most were encountered near the outer peripheries of the hunting zone. If we compare these distributions to the kill site

Figure 7.6. Location of primate kill sites, Caloveborita region, October 1999 to June 2000 (59 households).

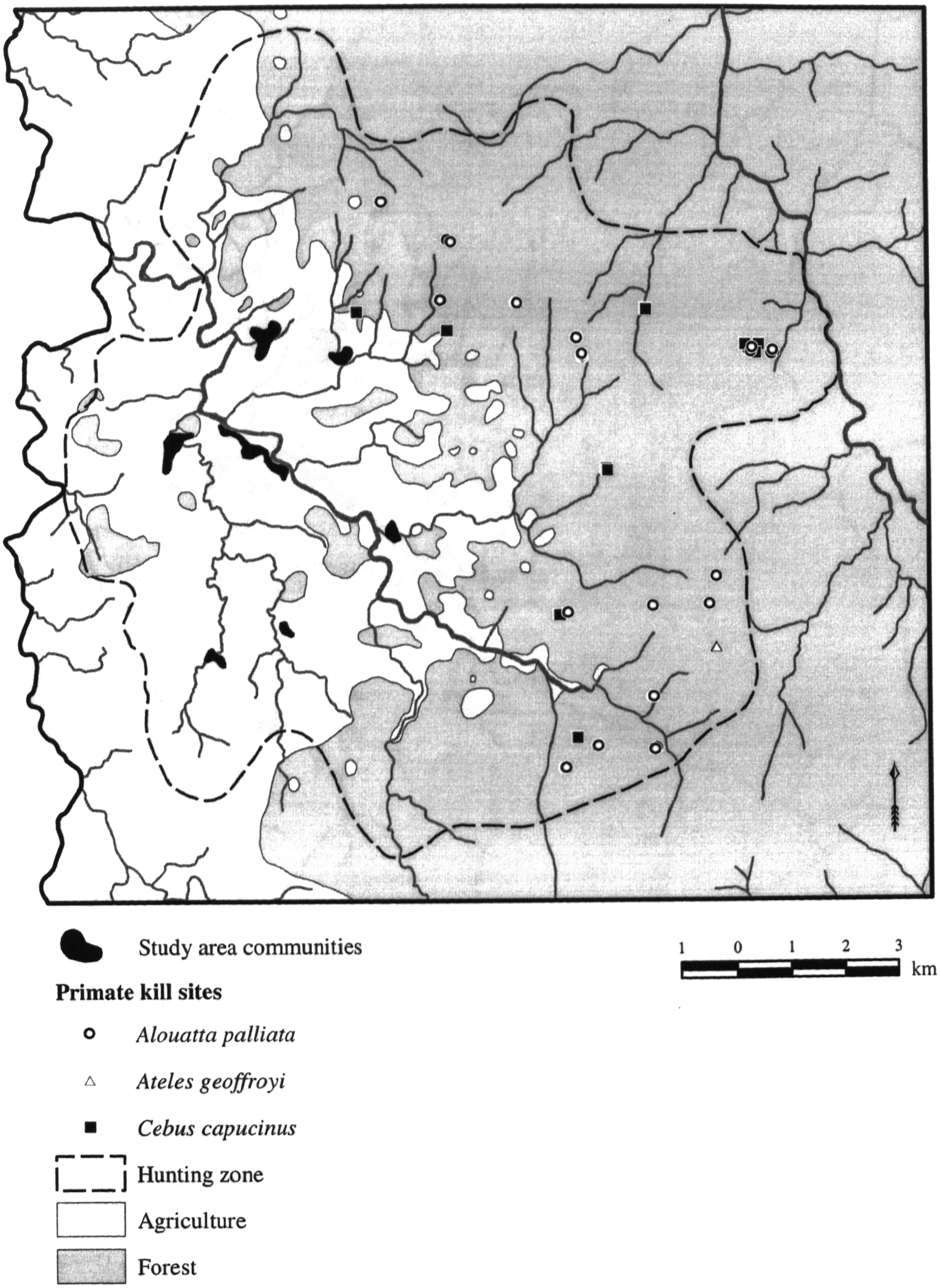
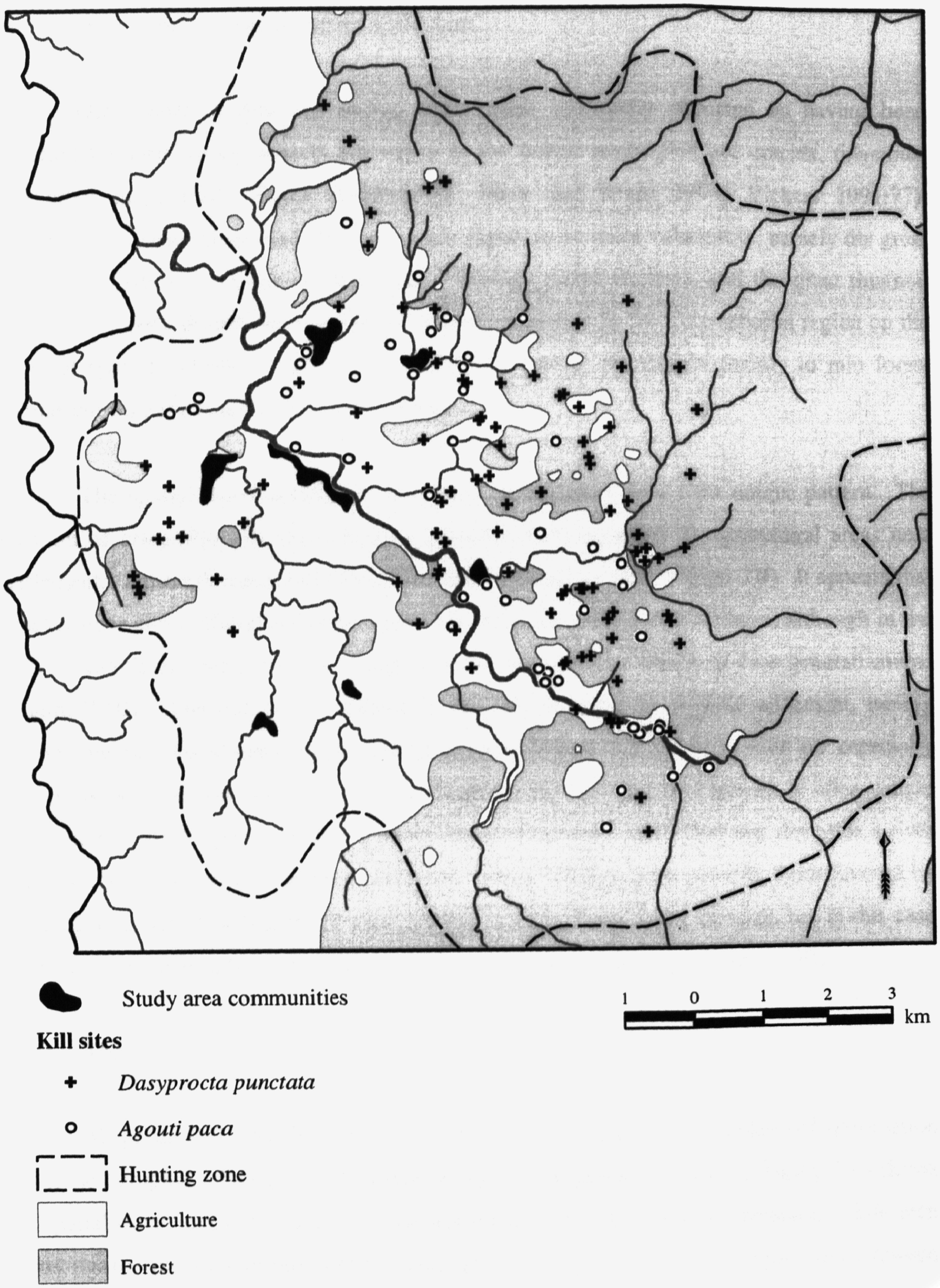


Figure 7.7. Location of large rodent kill sites, Caloveborita region, October 1999 to June 2000 (59 households).



distribution of the paca, and to a lesser extent that of the agouti (Figure 7.7), the divergent pattern becomes clearer. Most agouti and paca kill sites are found in agricultural areas or nearby forest habitat close to human settlement.

Other species that are among those most commonly reported as having been depleted by subsistence hunters elsewhere in the humid neotropics are cracids, tinamous, and other large birds (Peres 2000b:40-41; Silva and Strahl 1991; Vickers 1991:77). However, the large game birds that we might expect to be most vulnerable, namely the great currasow (*Crax rubra*), the crested guan (*Penelope purpurascens*), and the great tinamou (*Tinamus major*), do not show evidence of game depletion in the Caloveborita region on the basis of spatial patterns (Figure 7.8). All three species are caught mainly in rain forest habitat within easy reach of the study villages.

The spatial distributions for other taxa each display their own unique pattern. The location of armadillo kill sites shows a prevalence of locations in agricultural areas near settlements, although many were caught in nearby forest as well (Figure 7.9). It appears that brocket deer and collared peccaries also tend to be caught close to villages, although in the case of ungulates, there are not enough kill site points upon which to base generalizations (Figure 7.10). The red tailed squirrel is also caught close to human settlement, mainly within one or two kilometers of village centers (Figure 7.11). Kill sites are especially numerous near certain streams – this is related to the fact that this species is often caught opportunistically by people walking along some of the main trails that run alongside a river where large forest trees have been protected. Many of these trees provide foods favored by the squirrels. Basilisk lizard kill sites are found exclusively along streams, but in this case the pattern is attributable to the fact that this species is semi-aquatic (Figure 7.12).

7.5.2 The distribution of kill sites in relation to other variables

Mapping kill sites in relation to other variables can reveal additional information about the complex relationships between indigenous people and wildlife. Figure 7.13 shows the spatial distribution of hunting yields according to gender. Not surprizingly, while men capture game throughout the hunting zone, all of the game caught by women was captured

Figure 7.8. Location of selected large bird kill sites, Caloveborita region, October 1999 to June 2000 (59 households).

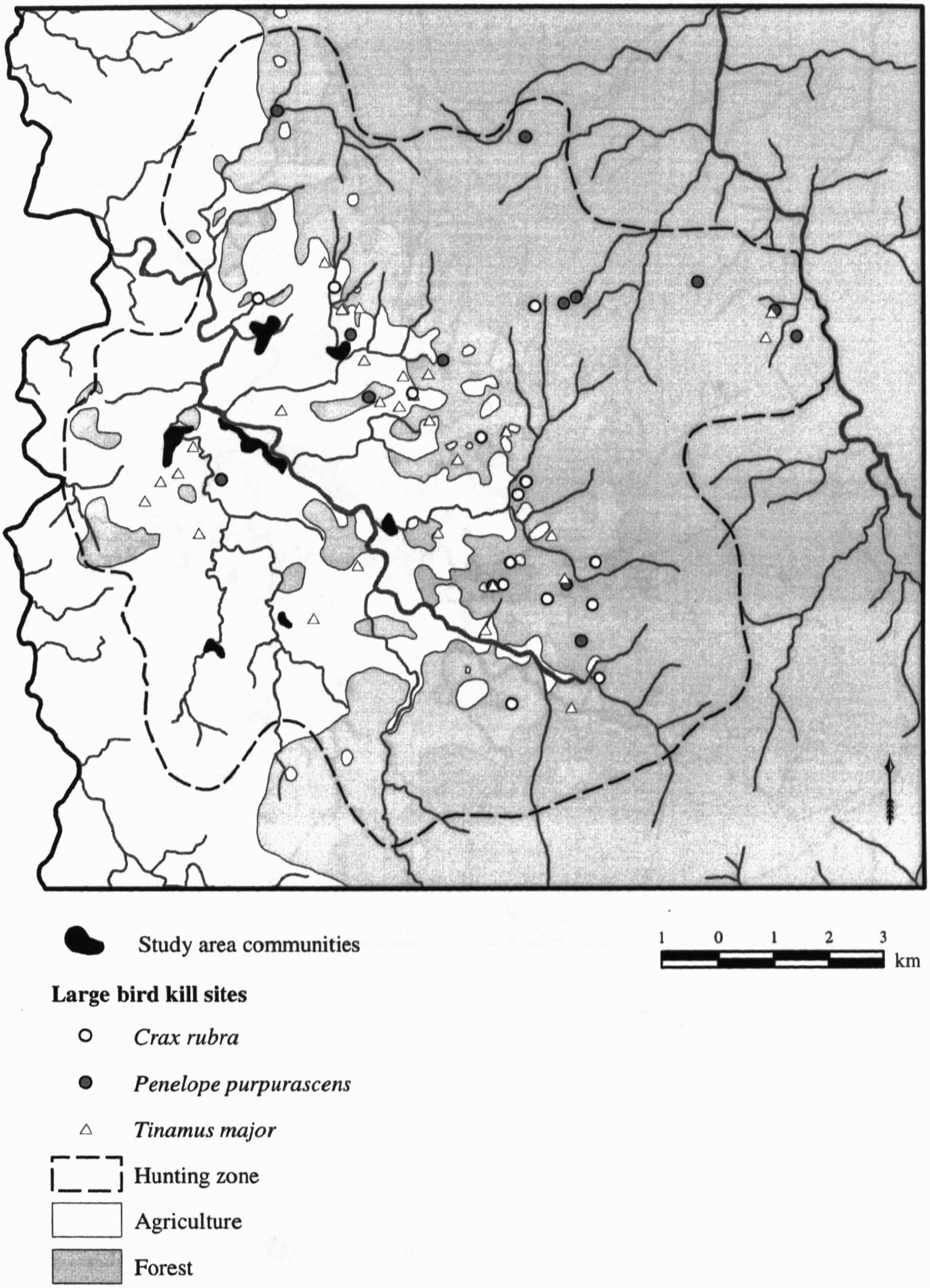


Figure 7.9. Location of sloth and armadillo kill sites, Caloveborita region, October 1999 to June 2000 (59 households).

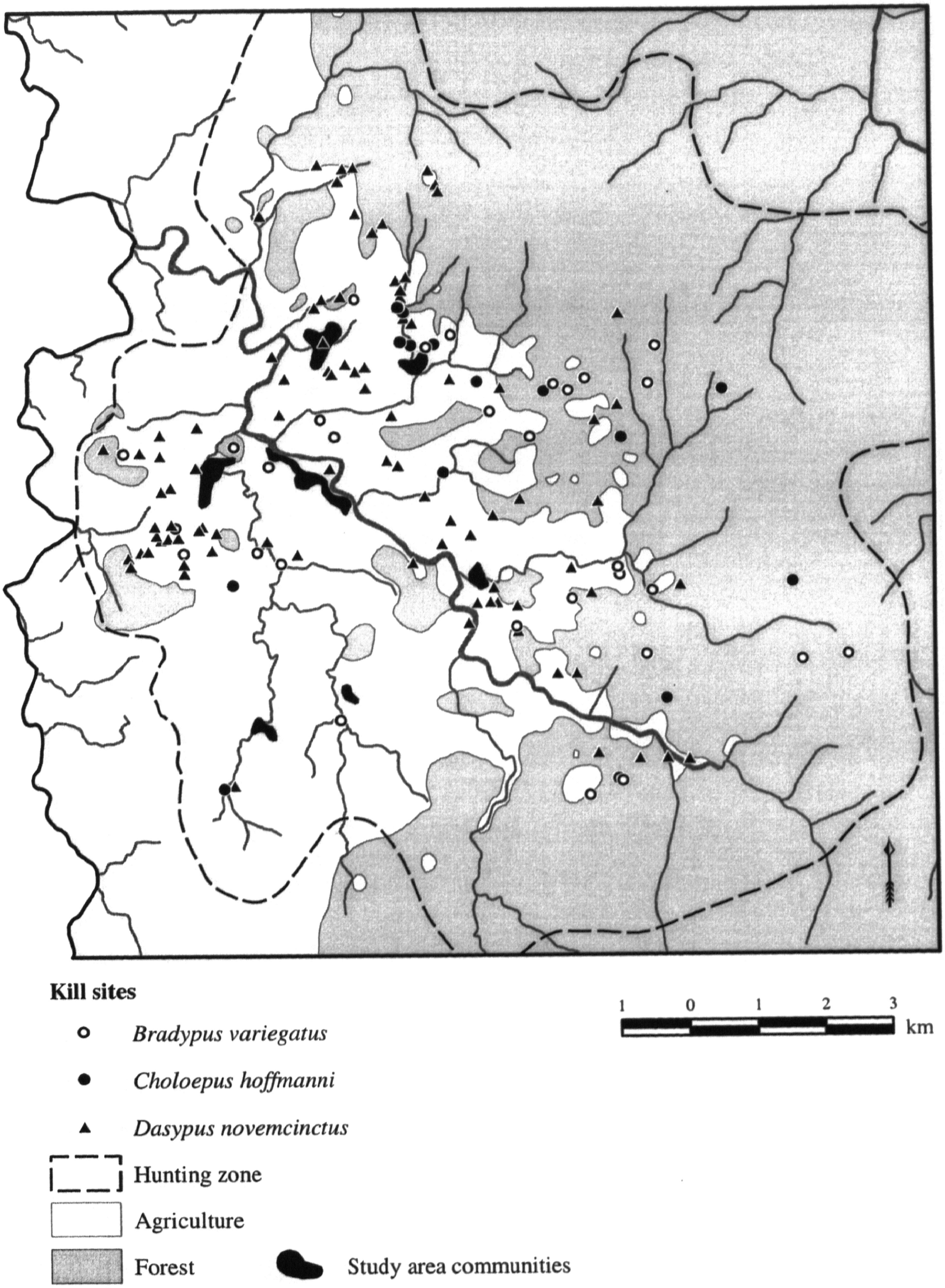


Figure 7.10. Location of ungulate kill sites, Caloveborita region, October 1999 to June 2000 (59 households).

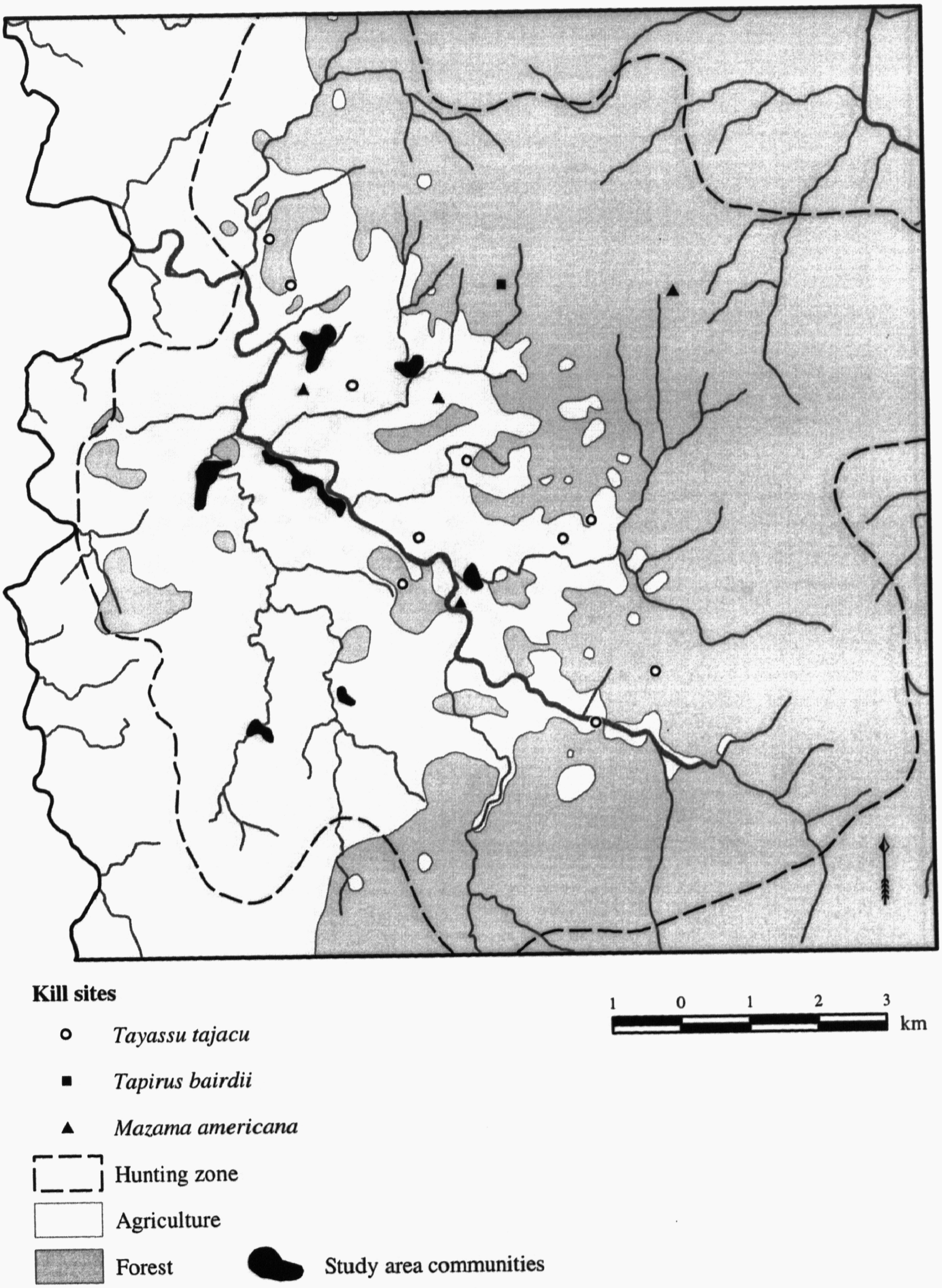


Figure 7.11. Location of squirrel and spiny rat kill sites, Caloveborita region, October 1999 to June 2000 (59 households).

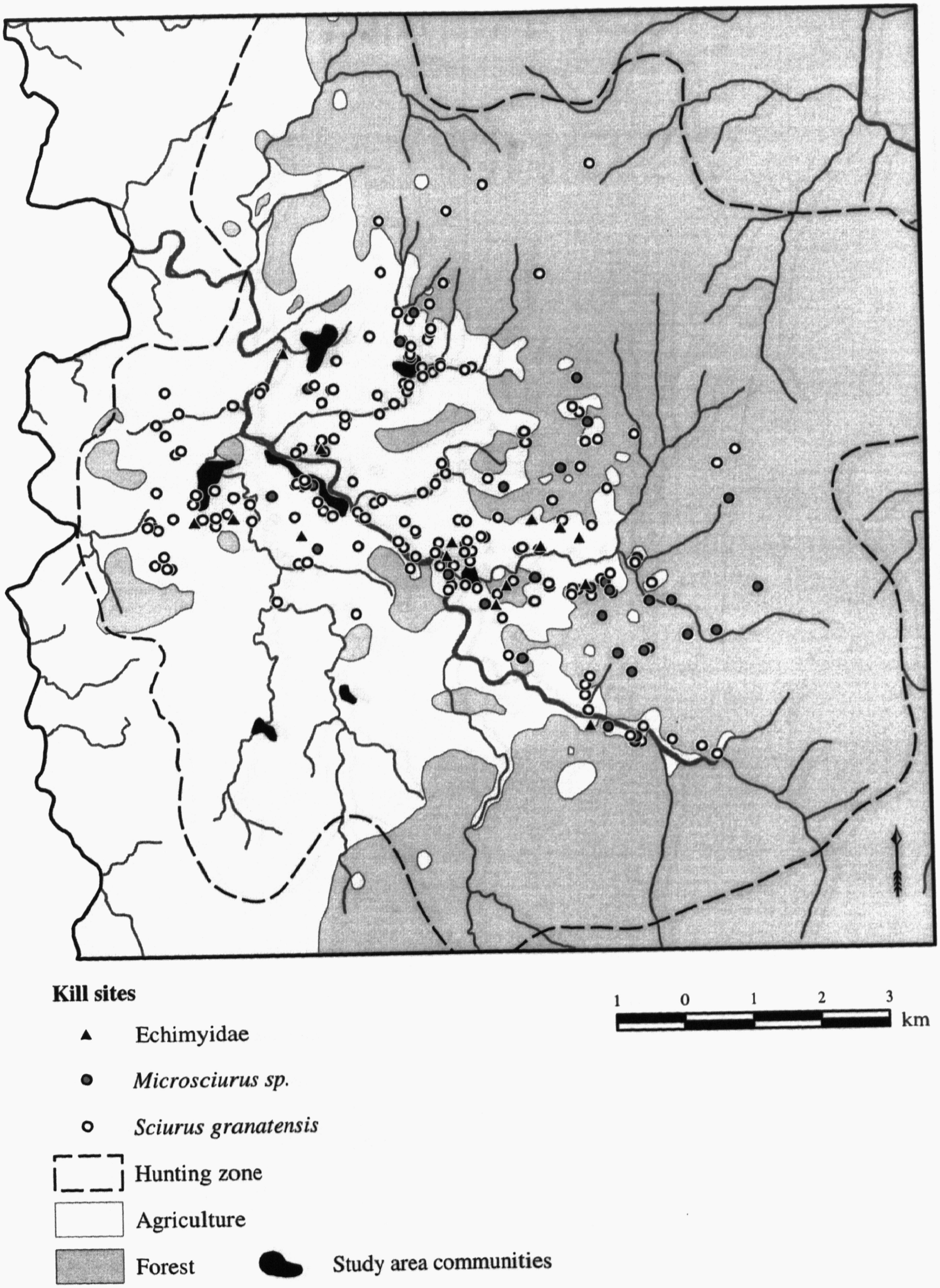


Figure 7.12. Location of reptile kill sites, Caloveborita region, October 1999 to June 2000 (59 households).

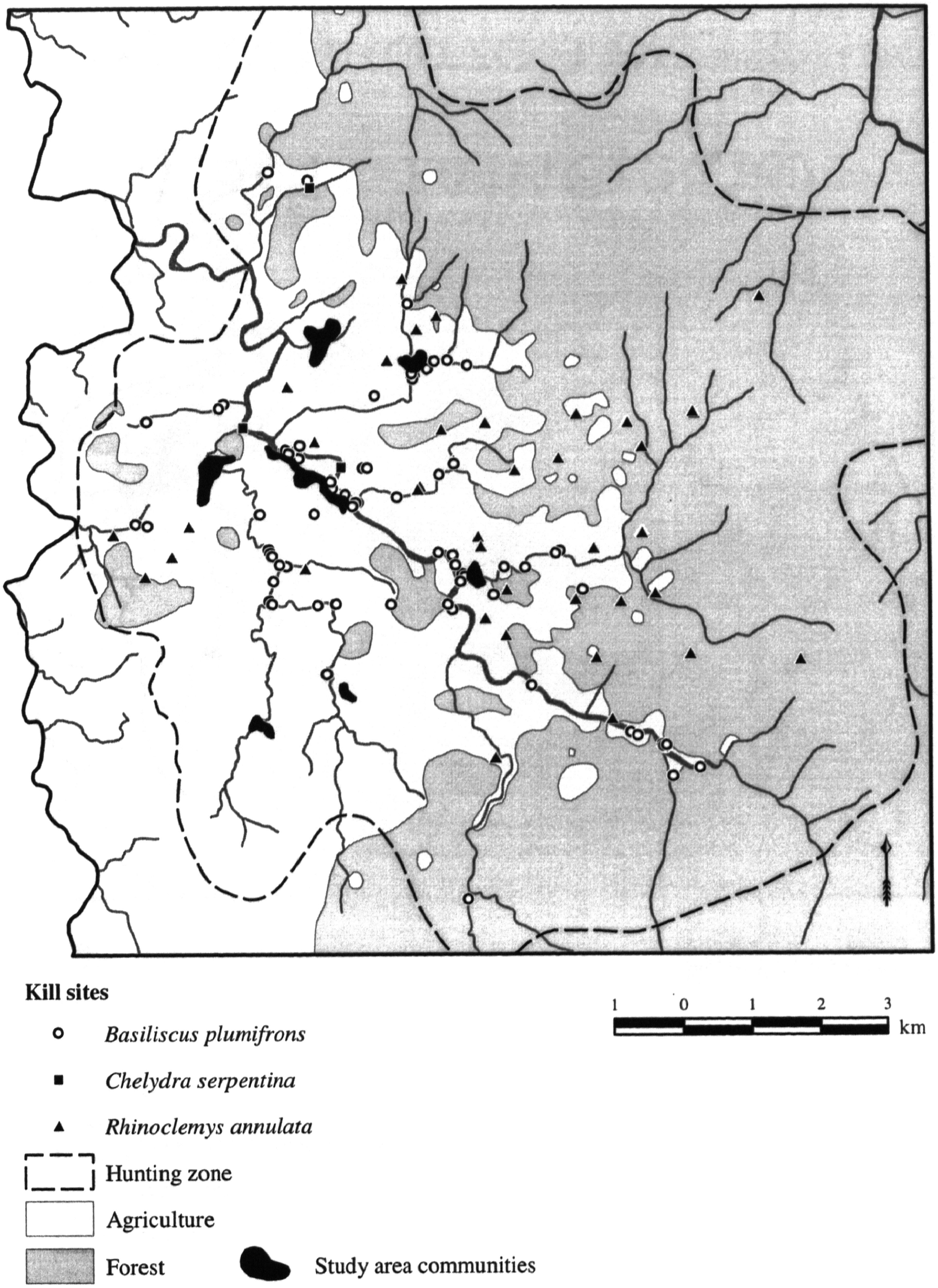
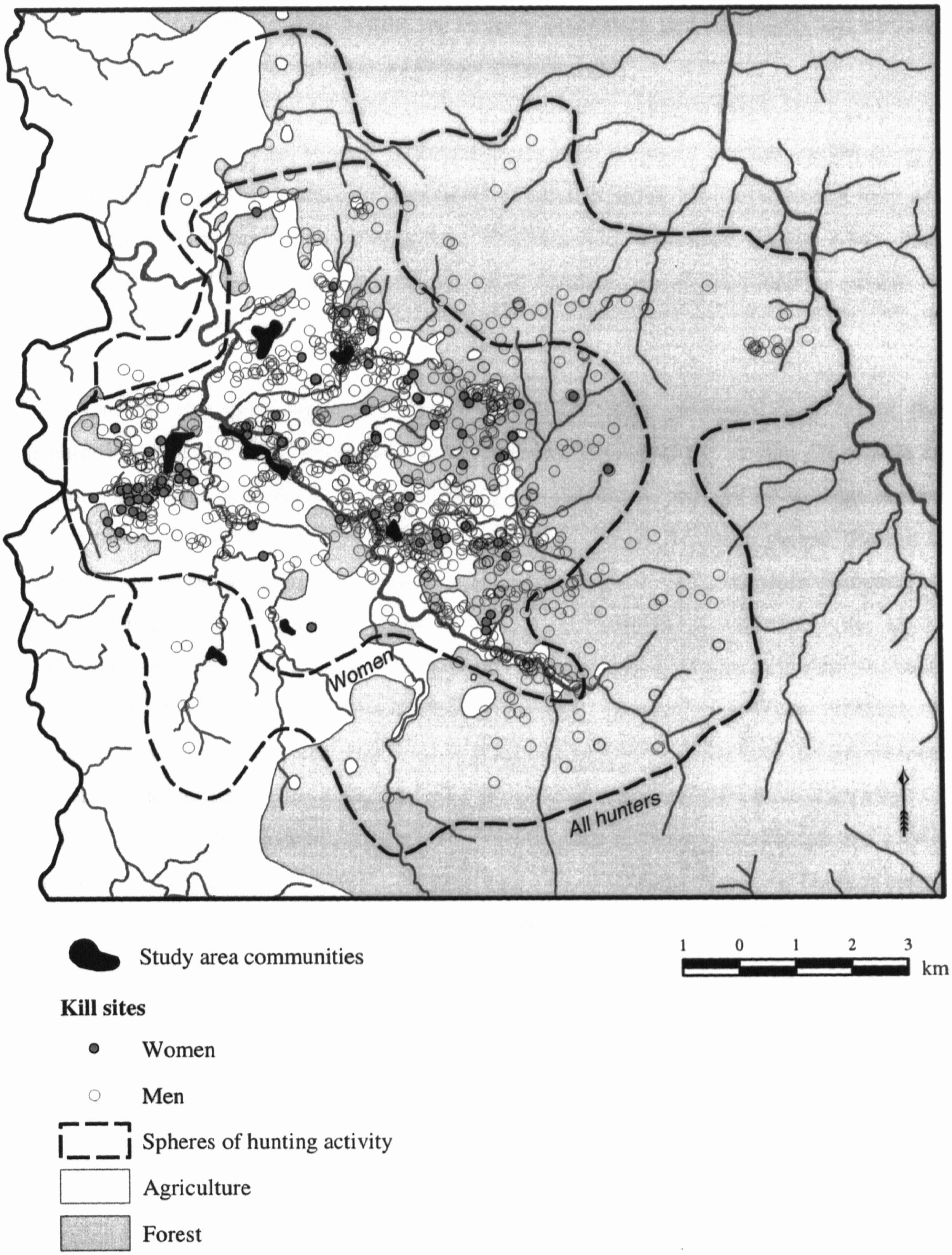


Figure 7.13. Location of kill sites according to gender, Caloveborita region, October 1999 to June 2000 (59 households).



close to the home. This is an accurate reflection of the fact that most hunting expeditions into the forest are done exclusively by men, and when women accompany their spouses on long trips, their primary responsibilities are to carry equipment and provisions and to cook meals. Women rarely travel into distant forests without men.

Most of the kill sites located in distant forest areas represent animals caught using a firearm, which is congruent with the statements of local residents who explain that they are much less inclined to undertake hunting trips without a rifle or shotgun (Figure 7.14). Not having access to a firearm, in fact, was the most common reason provided by people to explain why they do not hunt.

One of the most significant findings that has been presented thus far is the concentration of game kills around human settlement. This tendency is also observable at the community and household levels. Although a significant amount of overlap occurs between the zones where each community caught game during the study period, there is a strong concentration of kill sites around each settlement (Figure 7.15). A minor exception to this pattern is a separate cluster of game caught by Quebrada Larga residents in the upper Río Palmar watershed. These sites, however, are located near a secondary house site used periodically by two families that live in Quebrada Larga. The pronounced concentration of kill sites around each settlement within the shared hunting zone reflects both the importance of opportunistic hunting, awaiting game in nearby garden areas, and the use of traps close to the home, as well as the tendency to frequent hunting zones in the forests adjacent one's own community. Even within a single community there is a some partitioning of hunting areas, due to the dispersed nature of settlement and a tendency for different families to use certain nearby areas more frequently. This is especially evident in Río Pedregoso where families are located far from each other, and where large areas of rain forest are close at hand (Figure 7.16). However, there is much greater overlap between the kill site distributions of individual households than the kill site distributions of different communities.

Figure 7.14. Location of kill sites according to hunting weapon, Caloveborita region, October 1999 to June 2000 (59 households).

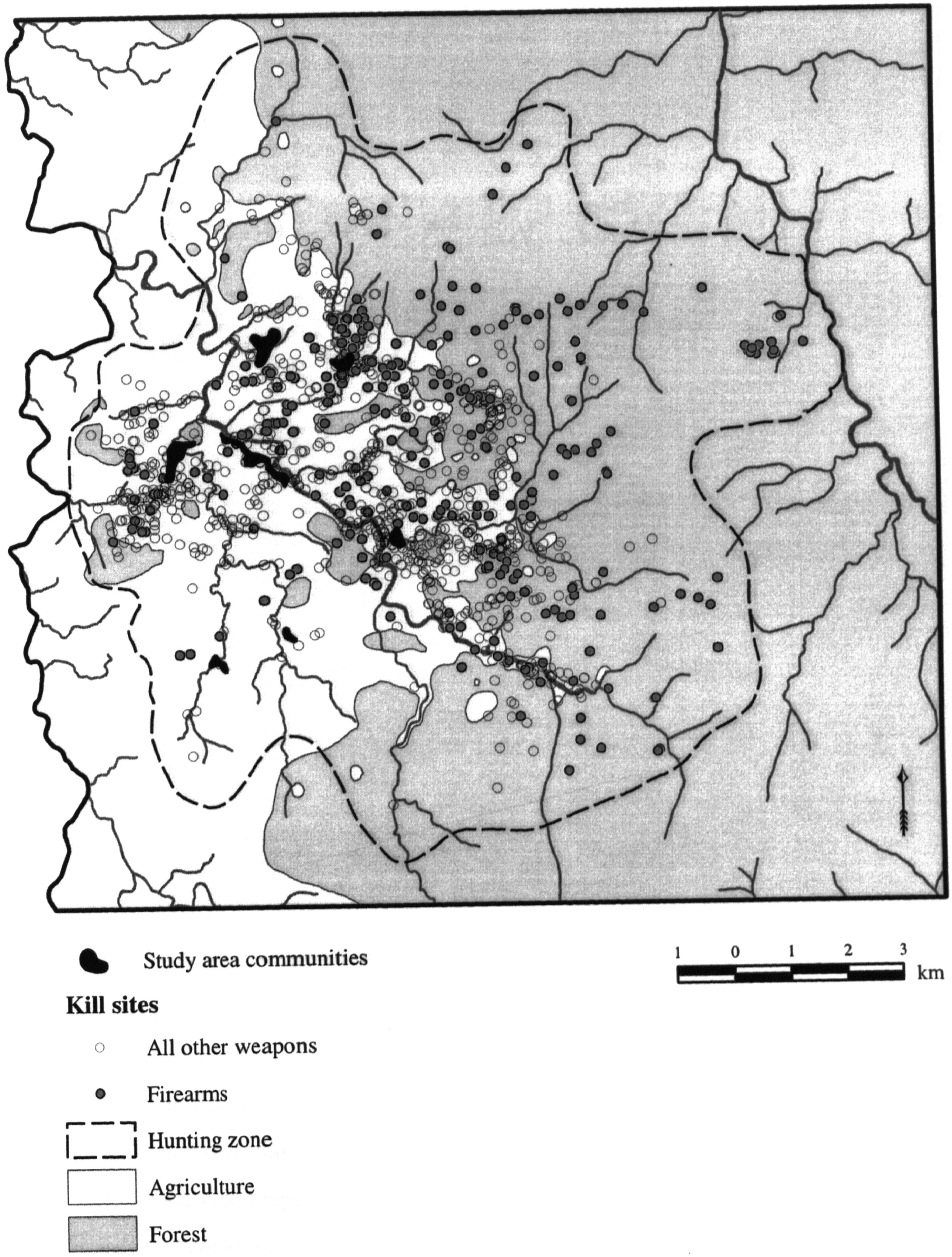


Figure 7.15. Location of game captured by each community in the Caloveborita region, October 1999 to June 2000 (59 households).

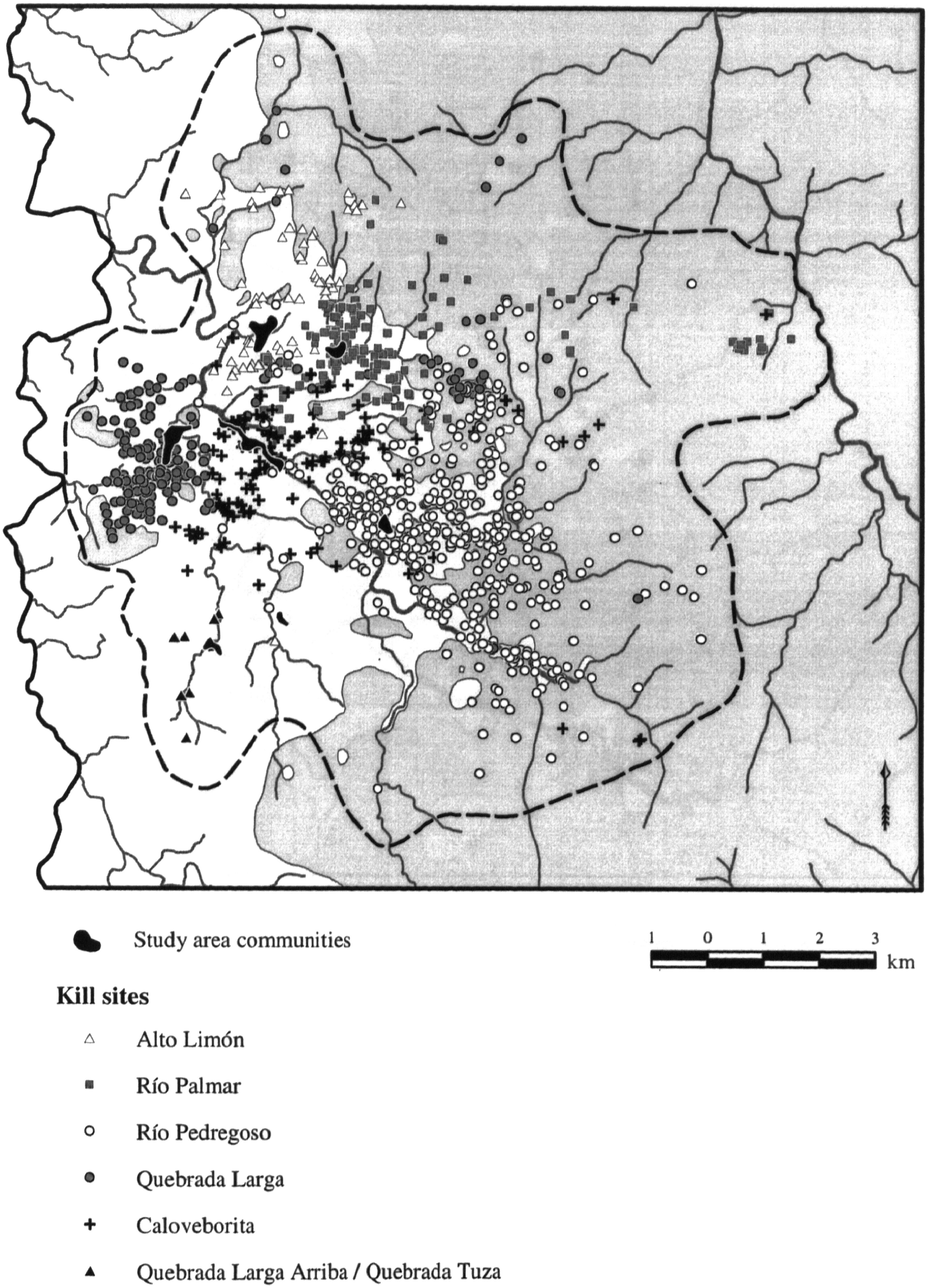
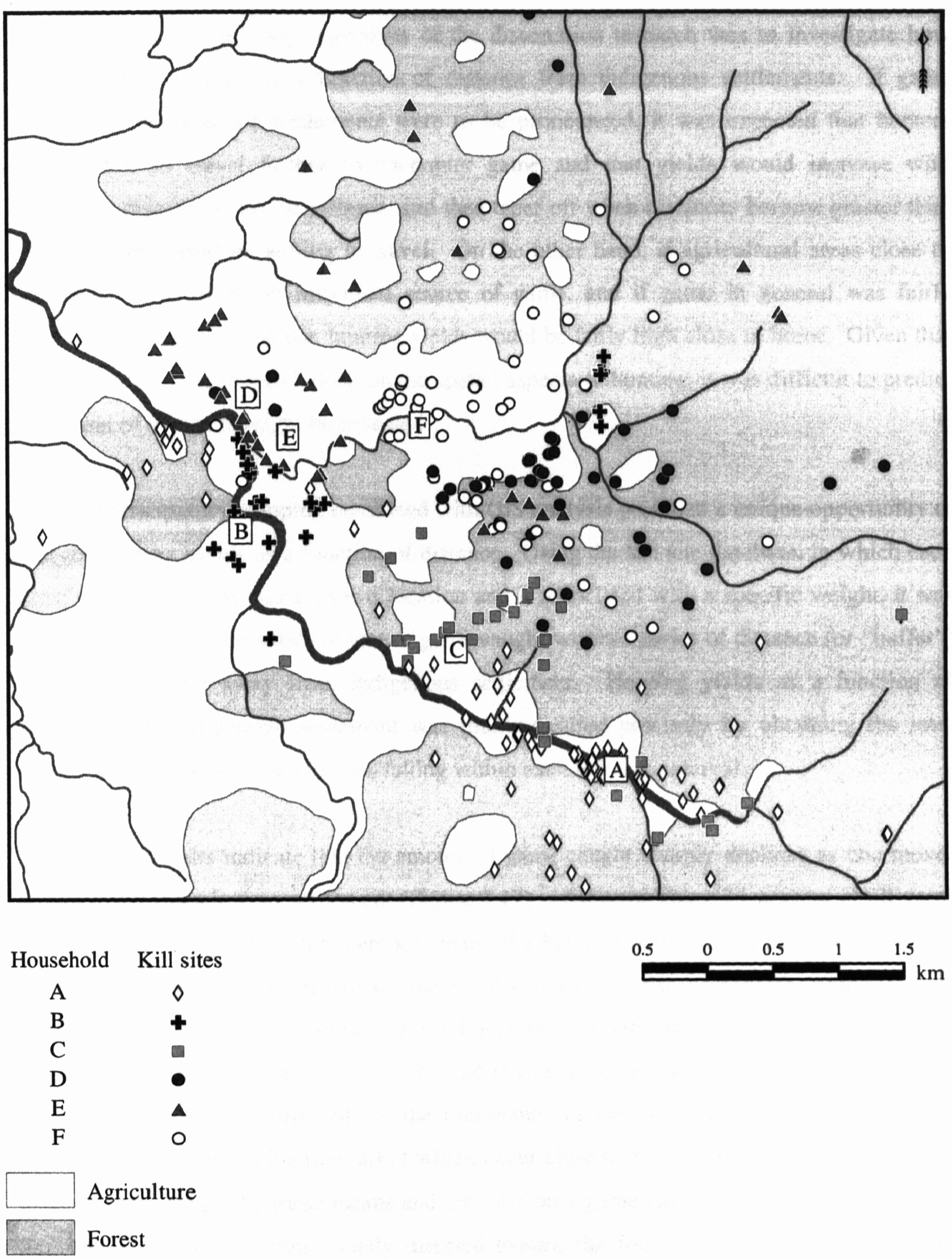


Figure 7.16. Game kill sites of selected households, Río Pedregoso, October 1999 to June 2000.



7.5.3 Hunting yields as a function of distance

One of the primary objectives of the dissertation research was to investigate how hunting yields change as a function of distance from indigenous settlements. If game depletion around Buglé settlements were to be pronounced, it was expected that hunters would have to travel farther to encounter game and that yields would increase with increasing distance from the villages, and then taper off when distances became greater than what hunters would be willing to travel. On the other hand, if agricultural areas close to settlement were to be an important source of game, and if game in general was fairly abundant, it was expected that hunting yields would be fairly high close to home. Given that there has been little research done on the spatial aspects of hunting, it was difficult to predict what kind of a pattern might be revealed.

Participatory mapping combined with GIS analysis provided a unique opportunity to analyze hunting yields as a function of distance. Using the kill site database, in which each game animal captured has a known location and is associated with a specific weight, it was possible to tabulate the total amount of game caught within a series of distance (or "buffer") intervals radiating away from indigenous settlement. Hunting yields as a function of distance from indigenous settlement was thus measured precisely by obtaining the total weight associated with the kill sites falling within each distance interval.

The results indicate that the amount of game caught sharply declines as one moves farther away from human settlement (Figure 7.17).[7] An astonishing 71 percent of all game by weight was caught within a mere kilometer of a hunter's house, and almost 90 percent of all game captured within just two kilometers of a hunter's house. Although game is caught in more distant areas, up to about seven kilometers from settlements, the total amounts are not very significant in comparison with what is caught in nearby areas. One might expect that this pattern is due primarily to the importance of awaiting game in gardens, making traps, and opportunistic hunting, all of which occur close to home. However, even when we remove game caught by these means and consider only game caught during hunting trips, in other words on expeditions usually directed toward the forest dedicated to tracking and pursuing game, the trend remains the same, albeit less dramatic. More than half of all game captured during hunting trips was caught within just one kilometer of a hunter's house, and 80 percent was caught within two kilometers (Figure 7.18). These results demonstrate that Buglé hunters do not need to travel far to find game, and that their impact on game species in distant forest areas is only slight, even though their total hunting zone is fairly large. This supports the notion that when a significant amount of game can be harvested from agricultural and transition areas, much less hunting pressure is placed on species in the forest. The findings also indicate that the geographic parameters of game extraction must be taken into account to get a true assessment of the impact of indigenous hunting on wildlife species.

In the Caloveborita region, hunting pressure, whether it be through hunting trips, using traps, awaiting, or the opportunistic capture of game, is concentrated around human settlement. This is due in large part to the fact that opportunistic hunting close to the home occurs on a daily basis. Awaiting also typically takes place in active gardens within one or two kilometers of a person's house. On average, men only go hunting in the deep forest a few times per month, as opposed to agricultural work which takes place almost every day. Moreover, while hunting trips farther from home fall within the male domain, opportunistic hunting and the use of traps is done by both men and women, further focusing hunting effort in nearby areas. In addition, while most hunting trips are directed towards forest areas, hunters pass through agricultural lands every time they embark on an expedition, and much of the game caught during these trips occurs in anthropogenic habitats on the way to more distant areas. As such, in general, hunting pressure declines steadily with distance, which is reflected in the spatial distribution of kill sites.

To summarize, Buglé hunters in the Caloveborita region do not need to travel great distances to procure adequate quantities of game. Even the most active hunters travel to distant forest areas only occasionally, and obtain most of their wild meat close to home during short hunting trips, using traps, or while awaiting game. So, although the total area used by indigenous hunters is large, much of it is used only lightly. As a result game kill sites are concentrated around where people live, and the amount of game caught by weight sharply declines with increases in distance from human settlement.

Figure 7.17. Hunting yields as a function of distance from primary settlement, all hunting strategies (hunting trips, awaiting, traps, opportunistic; Caloveborita region, October 1999 to June 2000, 59 households).

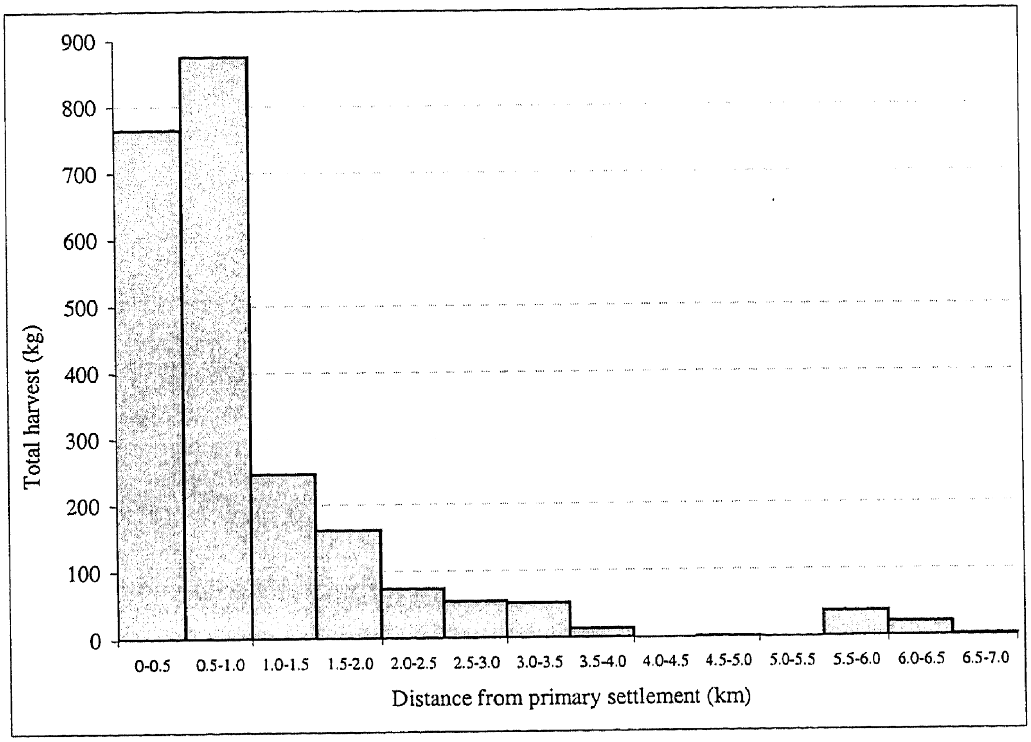
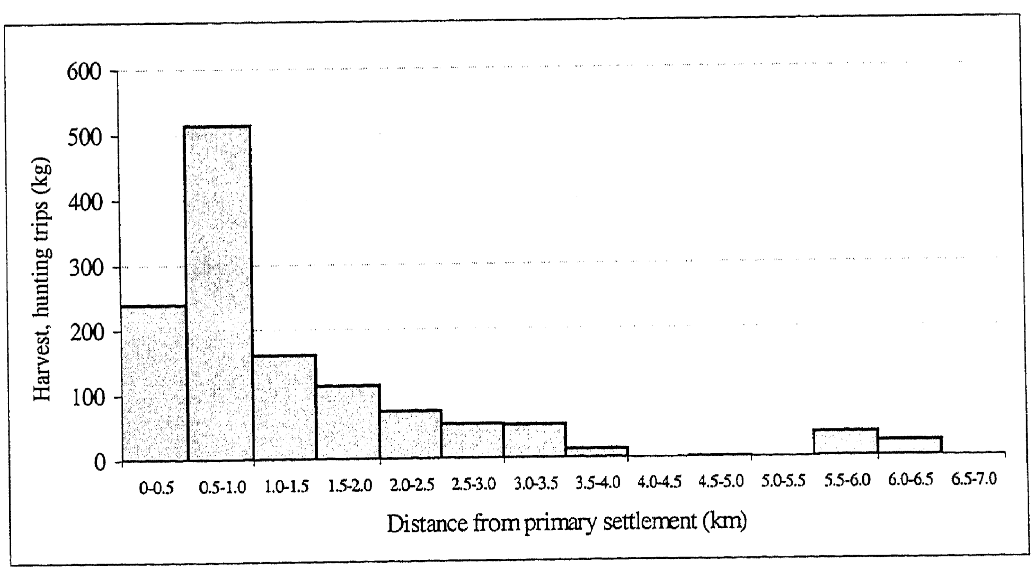


Figure 7.18. Hunting yields as a function of distance from primary settlement, hunting trips only (Caloveborita region, October 1999 to June 2000, 59 households).



[1] An effort was made not to imply too much precision in the limits of the hunting zone, by both generalizing the line (even when more precise limits were known) and using a dashed, rather than a solid line. Delimiting precise limits can be problematic in that distant forest areas are used less frequently. Some subjectivity is involved in excluding areas that may be used, but only very occasionally, for example, less than once per year.

[2] There is a tendency in common parlance to use the term "territory" inappropriately when referring to community hunting grounds. A territory by definition is either a defined area that comes under the jurisdiction of a recognized authority (such as a state), or an area that an animal or group of people will defend against intruders.

[3] The total forested area calculated includes a few islands of mature forest, but all are less than 1 km^2. Numerous small forest fragments within agricultural landscapes, most of them only a few hectares in size, were not mapped and are thus subsumed in the total area of agricultural lands.

[4] The impacts of hunting on one species, of course, can have repercussions on the abundance of others through changes in levels of competition, predation, and food availability, but for the moment, the purpose of the model presented here is to provide a simple overview of the primary, direct factors affecting the spatial distribution of game kill sites.

[5] While roughly half of all prey items were not mapped, these game animals accounted for less than one percent of the total harvest by weight.

[6] Jaguar (*Panthera onca*) tracks appear frequently in these transition zones, which may be related to high prey availability.

[7] Hunting yields as a function of distance can also be measured on a unit area basis (kg/km^2) for each distance interval within the total hunting zone. The yield per square kilometer for areas within 500 meters of hunters' houses is highest, at just over 40 kg / km^2.

8. Indigenous Subsistence and Wildlife Ecology in Western Panama

8.1 General characteristics of Buglé wildlife use

The research results presented here demonstrate that hunting among the Buglé is an occasional activity that is practiced primarily by men to acquire meat for family consumption. The most important game animals by weight are medium and large sized mammals, in particular pacas (*Agouti paca*), agoutis (*Dasyprocta punctata*), armadillos (*Daypus novemcinctus*), collared peccaries (*Tayassu tajacu*), and howler monkeys (*Alouatta palliata*). The tapir (*Tapirus bairdii*) may also be one of the most important game species harvested by weight in other years, but only one was caught during the period of this study. These and closely related species (i.e., in the same genera) are among the most important game animals captured by indigenous hunters throughout the humid neotropics (Beckerman 1980:94; Chicchón 1995:233; Descola 1994:246; Hill and Padwe 2000:95; Townsend 2000:272-274; Vickers 1991:60-61). The paca, representing 13 percent of the total Buglé game harvest, appears to be an especially productive species. It is found among the top five prey items in several other neotropical settings (Berlin and Berlin 1983:307-308; Dufour 1981:167; Hames 1979:238; Hill et al. 1997:1341; Jorgenson 2000:255; Mena et al. 2000:65; Ulloa, Rubio, and Campos 1996:122-123). Other animals, such as brocket deer (*Mazama americana*) spider and capuchin monkeys (*Ateles geoffroyi*, *Cebus capucinus*), coatis (*Nasua narica*), great curassows (*Crax rubra*), great tinamous (*Tinamus major*), and crested guans (*Penelope purpurascens*) are also important game species throughout much of the humid neotropics. One of the remarkable aspects of the composition of the harvest, however, is the sheer number of species that are captured, which includes very small items such as squirrels, spiny rats, basilisk lizards, small turtles, and a tremendous variety of small birds. In total, well over 150 species are captured by Buglé hunters. While the reasons why so many small prey species are hunted are uncertain, one contributing factor may be that many of the families who have arrived to the Caloveborita region come from areas of greater population density and pronounced game depletion where a shift in hunting focus toward small items may have begun a long time ago, and continues in a new setting. Another explanation may be that by collecting hunting activity data at the household level, small animals caught mostly by children were consistently included whereas in other studies they were not.

The total game harvest for the 59 households in the Caloveborita region over a period of eight months is 2,580 kg which, when extrapolated over the year, represents an annual average of 66 kg per household for those families who participated in the study. This is a small amount of food by weight relative to the consumption of agricultural produce, but still represents an important contribution to the local diet. While the yields of all subsistence activities were not measured in this study, Descola (1994:321) found that while Achuar hunting made up only 20 percent of all calories consumed, it accounted for over 55 percent of all protein in their diet. However, it should be kept in mind that the distribution of the game harvest between households was far from even. First of all, the average does not include the 40 households in the study are that rarely participate in hunting (and were consequently excluded from the administration of hunting activity questionnaires). And among the hunting households, the top 10 households can be expected to catch a much higher average of well over 100 kg every year, while one third of the households can be expected to catch less than 25 kg per year.

One of the more salient aspects of Buglé wildlife use is their reliance on several distinct types of hunting. The most important strategy consisted of hunting trips – expeditions dedicated specifically to tracking, pursuing, and capturing game. This is what commonly comes to mind when thinking about indigenous wildlife use in the humid neotropics, and is the focus of most anthropological research. Hunting trips, however, only account for 55 percent of the Buglé game harvest. Awaiting game, mainly in gardens at night, is another strategy used by the Buglé, representing 13 percent of the total yield. This type of hunting may be common elsewhere in the humid neotropics, given that it has been described among the Kuna and Achuar, and has received passing mention by other field researchers (Descola 1994:216; Herlihy 1986a:227; Ventocilla 1992:104-108). However, there is little quantitative information on the relative importance of this strategy or which species are caught using this method. In the Caloveborita region, awaiting is particularly effective in catching pacas, collared peccaries, and brocket deer. The use of a variety of traps in the Caloveborita region is also noteworthy, accounting for 12 percent of the total yield. Although the use of traps by indigenous peoples in the humid neotropics has received attention elsewhere (Gordon 1982:115; Rydén 1950), it does not appear to be a prominent activity today, and to my knowledge, the importance of traps has not been measured quantitatively in similar environments. One of the most interesting things about the use of traps is that they are employed by many Buglé women as a productive means of acquiring game that does not require traveling very far from home. Overall, traps were especially effective in capturing armadillos and tinamous. Opportunistic hunting is also very significant, representing about one fifth of the total harvest. While this "strategy" is frequently mentioned in the literature, there are few if any other quantitative measures of the role of opportunistic hunting for the purposes of comparison. It is not unlikely, however, that opportunistic hunting makes similar contributions among other indigenous groups where agricultural practices, levels of hunting pressure, and species assemblages are similar.

8.2 Agricultural lands as a source of game

Numerous studies of indigenous wildlife use mention the fact that hunters encounter game in agricultural areas as well as in rain forest, or that certain species cause significant crop losses when they raid gardens. Moreover, ethnographic research demonstrates that indigenous people apply their ecological folk knowledge to deliberately manage fallow regrowth to attract game through such practices as transplanting or protecting seedlings and selective weeding (Balée and Gély 1989:134-137; Nations and Nigh 1980:15; Posey 1984:117). Three previous studies provide quantitative measures of the contribution of garden and fallow areas to overall hunting yields (Table 8.1). The study among the Ka'apor found that deer (*Mazama* spp.), collared peccaries, pacas, and armadillos were the most important garden game species. This corresponds very closely with the character of Buglé yields from anthropogenic habitat. The paca was classified as "garden game" species in this study, and over 60 percent of collared peccaries and armadillos were also caught in agricultural lands in the Caloveborita region. Three quarters of the harvest of brocket deer was captured in anthropogenic habitat, but there were not enough kills upon which to base

Table 8.1. Proportion of game caught by indigenous hunters in anthropogenic habitats.

Hunters	% of total	Source of game	Reference
Ka'apor of Maranhão, Brazil	27	Gardens and garden-forest ecotones	Balée 1985
Wayapi of French Guiana and Brazil	28	Secondary forest	Grenand 1992
Chimane of Bolivia (Chaco Brazil)	25	Fallows	Chicchón 1995
Chimane of Bolivia (Puerto Méndez)	40	Gardens and fallows	Chicchón 1995
Buglé of Panama	47	Gardens, fallows, pasture	This study

any generalizations. Several of the species caught in large quantities in anthropogenic habitat by Buglé hunters are the same animals captured in garden areas by colonist and *ribereño* hunters in the Tambopata region of the Peruvian Amazon, except that here tapirs made up about half of the yield over a five month study period (Naughton-Treves 2002:498). In this study, only about half of the people interviewed hunt in gardens, and the relative proportion of animals caught in agricultural areas here appears to be much lower than in the Caloveborita region (Naughton-Treves 2002:498). However, this may result in part from the fact that the study focused on individuals rather than households (thereby potentially missing game captured opportunistically by less active hunters), and included many specialized hunters who appear to focus on larger, more "prestigious" species for local markets.

The figures indicate that the Buglé may catch more game from anthropogenic habitats than most other indigenous groups living in rain forest regions. While the Buglé occasionally spare fruit trees that attract game in new clearings, and some overplanting does occur to compensate from crop losses from animal pests, the high proportion of game caught in gardens and fallows is not the result of widespread, intensive wildlife management. Why then, do the Buglé obtain so much game from gardens and fallows? Part of the answer may be found in their predilection for awaiting game and the use of traps in agricultural areas, and relatively infrequent outings to pursue game in distant forest areas. This, however, still does not account for the sheer number of animals encountered in anthropogenic habitat – wildlife ecology must also be considered. The following section elaborates on the influence of indigenous land use on game distribution and abundance.

8.3 Shifting cultivation and wildlife ecology

It is increasingly recognized that shifting cultivation and deliberate forest management in the humid neotropics have influenced the structure, floristic composition, and ecological dynamics of rain forests surrounding past and present indigenous settlements (Alcorn 1981:413; Denevan 1992; Eduards 1986; Gomez-Pompa, Flores, and Sosa 1987; Gomez-Pompa and Kaus 1992; Gordon 1982; Medellín-Morales 1990:21; Posey 1985:141; Smole 1989:126-127). The scale of human influence is significant: Balée (1989:14-15) estimates that 12 per cent of the terra firme of the Brazilian Amazon, long thought to be one of the largest pristine environments in the world, is covered by different types of human-modified vegetation. Yet, a sharp dichotomy separating people from nature persists as the dominant scientific paradigm. This is partly the result of the reluctance of many ecologists to conduct research where humans "interfere" with "natural" processes, as well as an under-appreciation of the history of anthropogenic disturbance at many study sites (Hamburg and Sanford 1986; Hoopes 1996:3).

While many studies have highlighted how indigenous shifting cultivators have affected the flora surrounding their communities, less attention has been given to the possibility that they have directly influenced wildlife ecology, although some researchers have gone as far as to suggest that indigenous subsistence activities may have played a role in the evolution of some species (Gordon 1982:96; Smole 1989:126). An obvious example of how species adjust to human activity is the shift that some species – coatis, tapirs, and probably others – make from diurnal toward nocturnal activity patterns where hunting occurs (Kaufmann 1983:479). Others quickly become more wary where hunting is introduced (Ridgely and Gwynne 1989:115). The conversion of mature forest to fields and fallows, however, has likely had a much greater impact. While many species are obviously harmed by the loss of mature forest habitat, positive effects may accrue when shifting cultivators living at relatively low population densities create cultural landscapes that include a mix of natural and anthropogenic habitats. What follows is an argument that this is indeed the case.

The geographic distribution and abundance of animal species is tied the irregular distribution of available resources across space (Eisenberg and Thorington 1973:152; Foster 1980:83; Peres 1994:104-108; van Shaik et al. 1993:367). Distributions also vary over the year due to seasonal variation in leaf growth, fruiting, and flowering in response to biotic and abiotic factors (Foster 1982; Leigh and Windsor 1982; van Shaik et al. 1993:367). Primary consumers respond to fluctuations in food availability in a variety of ways, including dietary switching, seasonal breeding, and migration (Peres 1994:104-108; van Shaik et al. 1993:353). Shifting cultivation increases habitat heterogeneity through the creation of cultural landscapes containing mosaics of undisturbed ecosystems, fallows in various stages of succession, cultivated fields, and a diversity of ecotones. The results of shifting agriculture are in many ways similar to those associated with tree-fall gaps. They both begin with a disturbance that opens the canopy and facilitates the colonization of fast-growing plant species that invade the site from the surrounding forest, followed by successional regrowth. As with tree-fall gaps, young fallows are invaded by insects and herbaceous, heliophytic plants, many of which are attractive food sources for various vertebrates. Active gardens are likely even more attractive foraging areas for certain forest animals due to the presence of abundant, highly nutritious cultivated crops. This may be especially true for terrestrial animals that rely on limited forest floor foods.

The ecological importance of early successional stages is manifest in the fact that certain rodent species were not able to persist on Barro Colorado Island, Panama as secondary forests matured (Glanz 1982:464). Leopold (1959) stresses the fact that tolerance of secondary growth has been an essential survival tool for many game species in Mexico. Ojasti (1991:251) likewise states that capybara (*Hydrochaeris hydrochaeris*) populations in South America have not decreased to the same degree as other species of similar size in part because they easily adapt to open habitat and are less sensitive to deforestation. Subsistence farming based on shifting cultivation surrounded by forests is associated with increases in the diversity and abundance of certain marsupials, bats, and small to medium sized rodents in part due to the presence of crops and an increase in edge effects and ecotone habitat (Timm 1994:234). Where secondary growth is abundant due to human disturbance, riparian birds are especially common, and certain woodpeckers, tanagers, orioles, pigeons and other birds are seen much more often in anthropogenic habitats than in mature forest (Gordon 1982:103-107; Terborgh 1975:370). One of the most well respected pioneers of neotropical ornithology, in fact, suggested over a half century ago that birds that nest in secondary growth in neotropical forest areas may have adjusted their breeding season to the clearing and burning cycles of shifting cultivators (Skutch 1950:215). Indigenous horticulturists, by providing additional cultivated food sources and increasing the diversity and patchiness of habitats, may also provide resources that buffer times of seasonal scarcity. A study in Costa Rica indicates that many bird species adapted to tall forest habitat forage in secondary growth during periods when food sources in the forest are scarce (Loiselle and Blake 1992), suggesting that anthropogenic habitat can serve as a "keystone" resource in certain contexts.

One of the reasons why indigenous farmers seem to coexist well with a diversity of wildlife may be because they rely on an extensive system involving the rotation of fallows and interplanting to improve yields rather than intensive cultivation using agrochemical inputs, which is a favored strategy among other groups who have more economic resources or who are more integrated in market economies. This was found to be the case in one study that included neighboring indigenous Maya and mestizo villages. Game was more abundant around the Maya village, despite the fact that hunting pressure there was more intense, something that was attributed to a lesser degree of habitat conversion and disturbance at this site (Escamilla et al. 2000:1598).

Thus, there are some strong indications that in some cases, mature rain forests do not support as many mammal and bird species as cultural landscapes that contain gardens, fallows, and mature forests, and that the activities of indigenous shifting cultivation can enhance biodiversity at a regional scale, at least where human population densities are relatively low. However, it should be kept in mind that biodiversity as measured by the total number of species does not take into account the importance of rare or endemic species that may have a higher priority from a conservation perspective. For example, a comparison of bird diversity in mature forest and abandoned cacao plantations in the Talamancan region of Costa Rica indicates that overall, fewer species are found in forest habitat. However, four times as many forest specialists were found in natural habitat, while many of the additional species found in anthropogenic habitats are common agricultural and woodland generalists with large ranges (Reitsma, Parrish, and McLarney 2001:189).

Although it is clear that shifting cultivation has significant effects on wildlife, there are few studies that systematically compare the abundance of different rain forest animals in undisturbed versus secondary forest. An exception comes from the Ituri Forest in Central Africa, where researchers compared the relative abundance of game species in secondary growth and mature forests used by Efe hunters (Wilkie and Finn 1990). Four mammal species were significantly more abundant in regrowth areas, despite the fact that these zones experience more intensive hunting pressure, strongly suggesting that their productivity is greater in secondary forest (Wilkie and Finn 1990:94-97). It has been suggested that anthropogenic habitats may be more productive sources of game than natural habitat in the neotropics as well, but this hypothesis has apparently not yet been the subject of systematic investigation (Hames 1980:52).

In the case of the Caloveborita region, conditions are ideal for the coexistence of people and wildlife. Farmland is relatively abundant and small agricultural plots are widely dispersed and left fallow for up to 15 years or more, leading to a mix of gardens and secondary growth of varying ages. Landscape heterogeneity is further enhanced by the presence of small forest reserves in agricultural zones that are protected for their valuable plant products. This transitional mosaic between forest and village lands, then, is one that provides attractive foraging opportunities for a number of wildlife species found in the nearby forest, which is reflected in high harvest rates of certain game species from agricultural areas. Maize and root crops are especially attractive to several terrestrial mammals, and peach palm fruits are eaten by many additional species. Moreover, in northern Veraguas there is no true dry season, and unlike most shifting cultivators, the Buglé do not burn the majority of their fields. As a consequence, crops in different stages of growth are present at all times of the year, so that in theory at least, anthropogenic habitats can serve as important foraging areas for forest species during periods of dietary stress, regardless of when they may occur. An absence of burning may also have important consequences for the availability of insects, seeds, and other items eaten by game species.

Although there remains much to learn about the foraging dynamics of game species in different environments, at least one study clearly demonstrates that both agoutis and pacas suffer seasonal food shortages during periods of reduced fruit fall. Despite a shift to less optimal food items and the use of stored fat reserves, both species suffer stressful conditions and juveniles are more likely to perish during these lean times (Smythe, Glanz, and Leigh 1982). Similar patterns were found in an investigation of the feeding habits and reproductive activity of the red tailed squirrel, *Sciurus granatensis* (Glanz et al. 1982). The availability of forest fruit also varies across space, which may cause localized shortages affecting small species with limited home ranges, such as spiny rats (Adler 1998). Thus, foraging opportunities in agricultural areas may be critical for animals in nearby forests during periodic food shortages in different places and at different times, or during infrequent but potentially devastating stochastic events (tropical storms, severe temperatures, disease outbreaks, etcetera) that affect food availability. In the Caloveborita region, game animals can easily move back and forth between mature forest and agricultural areas as needed. Adult paca home ranges, for example, are fairly small (on the order of about 1.5 to 3.5 hectares), but can rapidly shift location in response to changes in fruit production (Beck-King and von Helversen 1999:678, 681). Even if food scarcity does not pose a serious threat to a species, seasonal variation in food availability can have a significant impact on population density by affecting the timing of reproduction and the age at first reproduction (Russell 1982).

The six "garden game" taxa that are caught especially frequently in anthropogenic habitat (see Table 6.15) have been described by zoologists as either opportunistic foragers, tolerant habitat disturbance, or as species that are commonly found in secondary forest (with the exception of the green basilisk which is a semi-aquatic species that is found along stream margins) (Chapman and Ceballos 1990:100; Delacour and Amadon 1973:96; Reid 1997; Ridgely and Gwynne 1989; Seamon and Alder 1999:900; Timm et al. 1989:108). This suggests that they are either predisposed to these types of anthropogenic habitats created by indigenous shifting cultivators or because of behavioral adaptations that enhance survival and reproductive success. The forest rabbit (*Sylvilagus brasiliensis*), for example, is "fairly common and widely distributed in edges bordering evergreen forest, such as tree-fall gaps, roadsides, pastures, clearings, and brushy second growth" (Reid 1997:250) and "more common in the successional plots and in clearings... than in primary forest" (Timm et al. 1989:108). The spiny rat, *Proechimys semispinosus*, is a frugivorous habitat generalist that is common and often abundant in both evergreen forest and second growth (Reid 1997:246-247; Seamon and Alder 1999:900). The gray-headed chachalaca (*Ortalis cinereiceps*) "inhabits humid regions, but... shuns forest, preferring tangles of vines and brush" (Delacour and Amadon 1973:96). The three *Columba* pigeon species hunted in the Caloveborita region are all common near forest edges (Ridgely and Gwynne 1989:163-164). The red brocket deer (*Mazama americana*) forages on the leaves of many plants as well as fungi, flowers, and fruit and although it may be more common in mature forest, it often forages in small clearings (Eisenberg 1989:325; Reid 1997:285). The paca, the most important game species in the Caloveborita region, is found in evergreen, deciduous, and secondary forest, often close to streams or swamps, and can be "surprisingly common in small strips of riparian forest in agricultural zones" (Reid 1997:245). The paca may also be more resilient in agricultural areas where it is hunted due to effective escape behavior which includes jumping into streams and remaining submerged for long periods of time, a trait for which it is famous in the Caloveborita region (Smythe 1983:463).

Aside from the species classified as garden game, many others are frequently encountered in agricultural areas. For example, 60 percent of armadillos (*Dasypus novemcinctus*) were captured in gardens and fallows, and almost all of the remainder were caught in forest within 200 to 300 meters of agricultural areas (Figure 7.9). Part of the reason for this is that they are very susceptible to the rock fall trap which is used more frequently in agricultural areas. Another part of the explanation is that it is a less preferred game animal, with an average ranking of about 17 among 30 species. A hunter in search of preferred species on an expedition in the forest will not pursue an armadillo when the possibility of catching a more preferred item exists. Nevertheless, the sheer quantity of armadillos encountered in agricultural areas is doubtless related to the fact that it is a wide-ranging species that occurs in many different habitats and eats a wide variety of foods, including insects, larvae, fruit, fungi, snails, slugs, earthworms, millipedes, centipedes, and small vertebrates (Kalmbach 1943:23-54; Wetzel 1983:466). These are all the types of food that can be found in old fields and fallows, as well as in mature forest. The coati (*Nasua narica*) has a similarly wide diet breadth and is also found in a variety of habitats (Kaufmann 1983:479-480). During the study period, five out of nine coatis were caught in farmland. Among the Buglé, they are known to be particularly fond of maize, and farmers often await them in maturing fields. The collared peccary (*Tayassu tajacu*) is another adaptable species that is tolerant of a wide variety of habitats, from tropical forest to scrub and even desert environments (Sowls 1983:497-498). Wild tubers and rhizomes represent one of the most important sources of food for peccary herds, so it is no surprise that they are a common pest in areas where manioc, yams, and dasheen are grown. Over 60 percent of the collared peccary harvest documented in this study was encountered in gardens and fallows, and it was the third most important species captured in agricultural areas by weight.

Other species that are caught frequently in village and agricultural areas are those that make use of large trees or patches of forest spared by farmers. The red-tailed squirrel (*Sciurus granatensis*) is one of these. These squirrels rely heavily on hard-shelled palm seeds, *almendro* (*Dipteryx panamensis*) seeds, and the large fruits of *membrillo* (*Gustavia superba*) and other trees (Glanz et al. 1982:241; Heaney 1983:489). These are all among the plants that are spared by the Buglé in clearings, along trails, and in small forest reserves near their homes. The squirrel also commonly eats peach palm fruit that is abundant in certain months of the year, and as a result, it appears to be quite abundant in then Caloveborita region near human settlement. An average of about 25 individuals were caught every month by the 59 households during the study period, and over 85 percent of these were encountered within one kilometer of someone's house.

"Deep forest" game species on the other hand, are more discerning in their choice of foraging areas and what they eat. Howler monkeys, for example, only eat the young leaves of certain forest trees, and avoid foliage with low amounts of protein or high concentrations of tannins and other secondary compounds (Glander 1983: 448). The spider monkey (*Ateles geoffroyi*) exhibits "an extreme specialization for an arboreal way of life… [and] feeds with great selectivity at moderate to extreme heights in mature forests" (Eisenberg 1983:451). Not surprisingly, neither of these species were caught by the Buglé in anthropogenic habitat. The white-faced capuchin (*Cebus capucinus*) is more tolerant of human disturbance and will forage in secondary forest and has a fairly "eclectic" diet that includes the fruits of 100 or more plant species, leaves, flowers, and insects, and has also been known to raid agricultural fields (Baldwin and Baldwin 1976:24; Freese 1983:458-459; Hernández-Camacho and Cooper 1976:57). The only primates captured in anthropogenic habitat in the Caloveborita region during the study period were in fact two capuchins that were discovered unexpectedly one late afternoon at the edge of a garden.

The three other species classified as deep forest game in this study are three large birds, all of which are sensitive to the conversion of mature forest: the great tinamou, the great curassow, and the crested guan. The great tinamou is a wary terrestrial bird that is found almost exclusively in either humid or deciduous forest habitat (Ridgely and Gwynne 1989:51). The great curassow, another esteemed game bird, feeds on fallen fruit, seeds, and large insects, primarily in rain forest habitat; it is threatened throughout much of its range by a deadly combination of a slow reproductive rate, hunting, and deforestation (Delacour and Amadon 1973:212; Amadon 1983). The crested guan is an arboreal frugivore found primarily in rain forest habitat (Delacour and Amadon 1973:136-139).

8.4 *Spatial patterns and the sustainability of indigenous hunting*

Are wildlife harvest rates in the Caloveborita region sustainable? This question is not an easy one to answer, and there are several different approaches that could be used in an attempt to answer it. One way of measuring the sustainability of hunting is to look at the harvest rates over time. In a way, this is the measure that the Buglé use themselves. Many older hunters lament game depletion by stating how people used to capture many more tapirs, monkeys, or white-lipped peccaries, but that now these animals are scarce as a result of overhunting and yields are much lower than in the past. Studies in various settings have reported declining yields over time, which could indicate unsustainable hunting rates (Baksh 1995:192; Good 1995:114-115; Mittermeier 1991:105; Orejuela 1992:73-74; Stearman 1995:215). The best quantitative study of harvest rates over time, however, shows that the harvest rates of most species were stable over a 10 year period (Vickers 1991). Using harvest rates over time, however, is an imperfect measure of whether or not hunting levels are sustainable or not. The introduction of hunters to a region may result in high harvest rates until an initial abundance of game is reduced (or appears to be less abundant because certain species become more wary), after which time lower, stable rates may prevail indefinitely, at least in theory. As long as the total population remains above a certain critical threshold – the minimum viable population size – the species will likely persist. Population ecology models based on the concept of carrying capacity, or "the maximum population that can exist in equilibrium with average conditions of resource availability," suggest that game species may in fact be more productive when their populations are somewhat reduced due to decreases in intraspecific competition for food and shelter (Cox 1993:246). Declining yields over time can indicate game depletion, but they are not a conclusive measure. They could in fact be the result of a deliberate choice not to hunt species that local people recognize as in need of protection. Studies that neglect the fact that hunters are not merely optimal foragers, but rather intelligent human beings with the capability of making decisions about how to manage vulnerable resources will likely overlook the effect of grassroots conservation measures on game yields. It should also be reiterated that game depletion is not the same thing as unsustainable hunting. Even a reduced game population can be hunted sustainably as long as harvest rates do not exceed what the species can withstand over time. A better evaluation of the sustainability of hunting, then, may require a different approach.

As discussed in more detail in the previous chapter, the spatial patterns of game extraction hold revealing clues about the relationship between indigenous people and wildlife. They also represent an important variable in the sustainability of hunting activity. First of all, evaluating whether or not a particular game species is being overexploited can benefit from documenting harvest rates in relation to the total size of the area used by hunters. This is done by comparing the number of individuals that are killed with estimated rates of production within the hunting zone. Production rates are calculated by applying the reproductive rate of the species in question to the total population within the hunting zone, which is estimated in turn using an estimate of the species' population density. Higher population densities would result in higher rates of production. Maximum sustainable harvest rates have been calculated for several common neotropical game species, using a model based on this approach (Robinson and Redford 1991), and have become one of the main tools used to evaluate the sustainability of hunting in the neotropics (Alvard et al. 1997; Mena et al. 2000).

The lands used for hunting by the Buglé and other hunters living in the Caloveborita watershed have a total area of about 131 km^2, which include roughly 80.5 km^2 of forest and 50.5 km^2 of agricultural and village lands. With an accurate knowledge of the size of this hunting zone, we can calculate the harvest rates of each species per km^2 for either the total hunting area or just the forested area, and compare these to published estimates of maximum sustainable yields (Table 8.2).

Keeping in mind that maximum sustainable yields are subject to a large degree of potential error (see below), the results of this study suggest that pacas (*Agouti paca*), agoutis (*Dasyprocta punctata*), armadillos (*Dasypus novemcinctus*), collared peccaries (*Tayassu tajacu*), brocket deer (*Mazama americana*), and red-tailed squirrels (*Sciurus granatensis*) are all harvested at rates below the maximum sustainable yield, even if we take into consideration other factors such as a modest incidence of mortally wounded animals that

Table 8.2. Annual harvest rates compared to estimated maximum sustainable yields for the primary game species caught in the Caloveborita region, 1999-2000.

Species Rank	Scientific name	Total harvest (kg)	Estimated annual harvest (kg/km^2)	Annual harvest (kg/km^2), forest only	Maximum annual sustainable yield (kg/km^2)[1]
1	*Agouti paca*	325	3.75	6.09	10.78
2	*Dasyprocta punctata*	297	3.43	5.57	25.54*
3	*Dasypus novemcinctus*	294	3.39	5.52	18.4
4	*Tayassu tajacu*	272	3.14	5.10	42.22
5	*Alouatta palliata*	190	2.19	3.56	2.52*
6	*Tapirus bairdii*	150	1.73	2.81	4.47*
7	*Bradypus variegatus*	119	1.37	2.23	?
8	*Choloepus hoffmanni*	113	1.30	2.12	?
9	*Mazama americana*	104	1.20	1.95	17.49
10	*Sciurus granatensis*	64	0.74	1.20	15.52*
11	*Potos flavus*	61	0.70	1.14	?
12	*Ateles geoffroyi*	53	0.61	0.99	1.22*
13	*Crax rubra*	52	0.60	0.98	?
14	*Rhinoclemys annulata*	44	0.51	0.83	?
15	*Cebus capucinus*	41	0.47	0.77	0.62*

[1] From Robinson and Redford, 1991.
* Estimate of a close relative in same genus, or an average of multiple species of the genus.

escape capture, animals captured by members of "non-hunting" households that were not incorporated into the study, and questionnaire error. Spider monkeys (*Ateles geoffroyi*) appear to be harvested at sustainable rates even when only considering the forested portion of the hunting zone, but at a level that is closer to the maximum sustainable yield. However, for some primates the number of orphaned infants and animals that are fatally wounded but not brought home may be very high (Peres 1991:91). If this were the case in the Caloveborita region, this would likely contribute to a steady decline in the howler monkey population. Tapirs (*Tapirus bairdii*) would seem to be harvested at a sustainable rate, but in this case the annual harvest is based on the capture of just one individual during the study period, and in other years more could be caught, which would make the harvest unsustainable based on this type of assessment. Of greater concern is the harvest of howler monkeys (*Alouatta palliata*) and capuchin monkeys (*Cebus capucinus*). After subtracting the agricultural areas that they do not inhabit, the harvest rates for these species are 3.56 and 0.77 kg per km^2 respectively, significantly above the maximum sustainable yield estimates of 2.52 and 0.62 kg per km^2 (for closely related species in the same genus, the only estimates available). This is certainly a cause for alarm, but there are other factors that must be considered before making the conclusion that these species are being overhunted.

Although the maximum sustainable harvest model is useful, there are many problems associated with it. Firstly, there is a tremendous potential for error in the maximum sustainable yield estimates calculated by Robinson and Redford (1991). The calculations are based on intrinsic rates of reproductive growth under optimal conditions for game populations that are assumed to be at 60 percent of carrying capacity. Clearly, optimal conditions are not always present, and populations are not always at 60 percent of carrying capacity. Carrying capacity is in fact a theoretical limit that is very difficult if not impossible to measure precisely. In this case, carrying capacity was calculated based primarily on an average of observed population densities at different sites which are assumed to be representative of populations at carrying capacity (Robinson and Redford 1986, 1991:417-419)[1]. Depending on the nature of a particular environment, the actual carrying capacity then, could be significantly higher or lower.

Further potential error in the maximum sustainable yield is introduced through the uncertainties involved in estimating population densities, which are notoriously difficult to measure accurately. The main method that is used is strip censusing which is sensitive to species size and coloration, observer skill, whether the species is diurnal or nocturnal, the condition of leaf litter, wind conditions, and whether indirect or direct sightings are used (Cant 1977:689-690; Glanz 1982:446-447; Hill et al. 1997:1343-1344, 1347-1348). Underestimations occur because some species are simply difficult to detect. The three-toed sloth (*Bradypus variegatus*) provides a good example of effective camouflage – they can be virtually invisible even when their precise location has been determined using radio collars (Montgomery, Cochran, and Sunquist 1973). Population density estimates also vary tremendously from place to place (Robinson and Redford 1986:676-678). Strip censusing estimates for pacas at 10 different sites, for example, range from 3.5 to 93 individuals per km^2 and a new method based on counting burrows suggests that strip censusing underestimates paca densities by about one third (Beck-King and von Helversen 1999:679). Species abundance varies dramatically for many other species as well, in relation to soil fertility, forest structure, interspecific competition, and other factors (Emmons 1984). Population density is a primary variable in calculating the maximum sustainable yield of a species, and accuracy is of critical importance – an error in this estimate can lead to very different conclusions about whether or not indigenous communities are hunting at sustainable rates.

When comparing harvest rates with maximum sustainable yields a bias toward results that indicate overhunting is also introduced. This is because if a species is especially abundant in a particular region, encounter rates will tend to be higher, and hunters will be more likely to capture more individuals of the species. However, the maximum sustainable yield estimate remains tied to an average population density at a number of sites. If a game population in an area is large, one would expect higher harvest rates – rates that might be over the estimated sustainable yield precisely because the population is thriving. The opposite problem is true as well. If a game species is less abundant in a particular region due to some environmental condition, a large, unsustainable proportion of the population could be harvested by hunters at a level well below the estimated maximum sustainable yield.

Clearly, while sound in theory, there is a considerable amount of error involved in using population density estimates derived from several sites to argue that indigenous peoples at a completely different site are overhunting. In addition, coming to the conclusion that low harvest rates indicate sustainable hunting will be false if low yields are rather the result of game depletion that has already occurred. The tenuous degree of certainty is exacerbated in cases where the accuracy of hunting zone area estimates is also suspect. In virtually all of the cases where this method has been used, hunting zones were not mapped and area estimates were obtained indirectly, for example, by using the average maximum distance that hunters travel from their village, which may in turn be calculated using an estimate of how fast they walk through the forest (Alvard et al. 1997:978-979)[2].

A complementary method to evaluate the impact of hunting on wildlife populations is to compare the abundance of game species at hunted and unhunted sites in similar, nearby environments. Peres (1990, 2000a, 2000b) has done this by comparing the population density of game species at over twenty sites in the Brazilian Amazon that have experienced varying degrees of hunting pressure. He found that total biomass was almost two thirds lower at heavily hunted sites compared to unhunted sites, due to the reduced number of large game species (Peres 2000a:246, 248). Other studies have also shown that certain game species favored by hunters are less abundant where hunting pressure is higher, especially those species with lower intrinsic rates of reproduction (Bodmer, Eisenberg, and Redford 1997; Carrillo, Wong, and Cuarón 2000; Hill et al. 1997; Mena et al. 2000:67-69). However, it should be reiterated here that a lower population density does not necessarily indicate that a species is being driven to extinction. Populations below carrying capacity actually tend to have a greater potential for reproductive growth due to reduced intraspecific competition for food and shelter. Lower population densities, then, can lead to higher game productivity. As long as a minimum viable population is maintained, the species can persist even if it is less abundant than in unhunted areas.

A close examination of the spatial parameters of game extraction is a promising means of overcoming the limitations of the various methods that have been used to date in an attempt to measure the impacts of indigenous hunters on neotropical wildlife. Mapping the distribution of kill sites can provide a direct indication of whether or not a game species has suffered a population decline, or whether it has been able to persist in the vicinity of indigenous communities with active hunters. If a highly prized game species is almost never captured within a hunting zone where it can otherwise be expected to be found and captured with existing technologies, there is good reason to conclude that it has been overhunted. Similarly, if a particular species is captured only on the peripheries of the hunting zone, there is reason to believe that it is has been depleted at a local scale, and is only present in the most remote forest areas that are used less frequently by hunters.

Conversely, species that are caught close to villages in significant numbers would seem to be more resilient, possibly because they have higher reproductive rates, smaller area requirements, or more flexible diets that include a variety of food items found in both in natural and anthropogenic habitats. The distribution of kill sites, however, is conditioned not only by species abundance and the level of hunting intensity across space, but also by unique species characteristics. The kill site pattern for each species will reflect a unique combination of several factors and requires careful interpretation.

In this study, the spatial distribution of game extraction sites reveals a somewhat surprising concentration of kill sites immediately surrounding Buglé communities, with a gradual dispersion of sites into the rain forest mainly to the east. The Buglé are not unique in the fact that they catch most of their game nearby. For example, Ka'apor hunters (in at least one village) obtain most of their game from within 5 km of their home (Balée 1985:492). However, what is striking about the Buglé case is that so much game is caught within a much smaller distance from settlement. Almost 90 percent of game was caught within a mere 2 kilometers of a hunter's house. This clearly indicates that wildlife in more distant forest areas are subject to much lower harvest rates. However, the patterns are not the same for all species. The absence of primate kill sites in forest areas near human settlement does seem to indicate that they have suffered localized depletion and are now only encountered only near the outer peripheries of the hunting zone. Other species however, even highly preferred species such as the paca, collared peccary, and curassow have kill site distributions showing that they continue to be caught close to home and may be fairly abundant in the vicinity of human settlement. The concentration of kill sites in the transitional mosaic of habitats between villages and the forest lends credence to the notion that species like deer, certain rodents, collared peccaries, and others seem to thrive in areas where shifting cultivation produces heterogeneous cultural landscapes composed of both a mix anthropogenic and forest habitats.

Another important dimension of the spatial patterns of indigenous wildlife use is the presence of forest areas outside of hunting lands. These unhunted zones, where game species are likely to be more abundant, can serve as a source of replenishment through the migration of excess individuals into the hunting zone. While the extent of unhunted rain forest areas in northern Veraguas has not been documented, it remains clear that there are large areas adjacent to the hunting grounds used by the Buglé in the Caloveborita region that are presently free of human impacts. This can be ascertained from census maps compiled in the late 1990s that show the locations of all settlements. While the size of other communities' hunting zones are unknown, if we assume that hunters are not traveling more than 10 to 15 kilometers from their homes in search of prey, there are hundreds of square kilometers of forest adjacent to the Caloveborita hunting zone where wildlife is completely free of human predation. Even if the extraction of certain species within the hunting zone occurs at rates above natural rates of increase, these populations might be replenished through immigration from adjacent unhunted forest areas through source-sink dynamics, especially if species in the remote forest are near carrying capacity. This has been postulated as the reason why tapirs have been able to persist in areas where they appear to be overhunted on the basis of harvest rates (Novaro, Redford, and Bodmer 2000:715). There are also indications that white-lipped peccaries can be caught in much larger numbers from hunting grounds that are adjacent to large protected areas (Escamilla et al. 2000:1598). On the other hand, in forest fragments without source areas that contribute to recruitment in hunting zones, hunting exacerbates the effects of fragmentation and is the most important threat to the survival of remaining small, isolated populations of large species (Cullen, Bodmer, and Valladares Pádua 2000).

The role of unhunted source areas as de facto game preserves that help repopulate hunting grounds is by no means a new idea. Several anthropologists have discussed the functional value of such areas over the last few decades. As indicated earlier, Harris (1979:91) and Ross (1978:7) suggested that warfare between Amazonian tribes had adaptive value through the maintenance of unpopulated zones of game reproduction that are necessary in protein-limited environments. Another researcher describes how Tukanoan people avoid certain areas within their subsistence lands for spiritual reasons, but suggests that the underlying purpose of these taboo areas is the maintenance of game populations (Reichell-Dolmatoff 1996:82-86). As indicated earlier, it does not appear that there are areas that Buglé hunters in the Caloveborita region avoid due to cultural prohibitions.

Nevertheless, there are large areas adjacent to the subsistence zone used by residents of the Caloveborita region that are free from the impacts of hunting.

Source-sink dynamics, however, are far from simple and research on how neotropical animals disperse is limited. The movement of animals from areas of higher to lower population density is affected by several factors, including distance, terrain, and the composition, distribution, and connectivity of habitats. Nevertheless, the preliminary model of source-sink dynamics indicates that strict protection of forest areas that are roughly 50 to 100 per cent the size of adjacent hunting zones can prevent population declines in most species (Novaro, Redford, and Bodmer 2000:718-719). The authors applied their model to game species in an area of Peru, finding that 10 of 16 game species reviewed were not prone to extinction, assuming no barriers to dispersal from unhunted areas (Novaro, Redford, and Bodmer 2000:178-719). Unused, pristine forest areas that contribute to the repopulation of game in adjacent hunting zones may currently serve as the foundation of sustainable hunting in many parts of the neotropics. As indigenous communities grow, it will be increasingly important to identify and manage these core areas to ensure that vulnerable wildlife populations will be protected over the long term.

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[1] The maximum sustainable harvest rate, in turn, is calculated by approximating the proportion of animals that would die of natural mortality if hunting were absent, which depends on the lifespan of the species – the model is based the assumption that the potential harvest is 60 percent of the maximum production for very short-lived species, 40 percent for short-lived species, and 20 percent for long lived species (Robinson and Redford 1991:421).

[2] Even if accurate area values are obtained, however, using total area of hunting territory may fail to incorporate the variability in habitat that is important in reproductive rates, in particular the availability of food and shelter, which leads to difference in the abundance of game across space. The degree of overlapping between the hunting zones of different communities is another issue that must be addressed.

9. Hunting, Habitat, and Human Settlement in the Caloveborita Region

9.1 Indigenous peoples and wildlife use in the neotropics

The impact of indigenous peoples on biological diversity is a controversial issue (Alcorn 1993; Alvard et al. 1997; Johnson 1989; Redford and Stearman 1993). While it is commonly accepted that native peoples practice more sustainable forms of land use than other groups, a naive view of indigenous resource use as inherently benign is losing appeal for many reasons. One of the main arguments against the romantic notion that there is an innate harmony between indigenous communities and their natural surroundings is evidence of game depletion. The intensity of the dialogue reflects the fact that such a large share of the world's biodiversity is found in shrinking rain forest regions that are home to growing indigenous populations. However, the primary threat to the untold number of plant and animal species found in neotropical rain forests is not the activities of resident peoples who in most cases have lived in these regions for centuries, but rather deforestation associated with large scale ranching, logging, and commercial plantations, as well as agricultural colonization by poor, non-native farmers. However, it is not only certain plant and animal species that are endangered. Indigenous cultures are also at risk of disappearing if measures are not put into place to help protect their homelands and a way of life and world view that is intimately connected with the forest.

Since the early 1980s, certain large protected areas have been established in Central America to address concerns about the destruction of rain forest while taking into consideration the indigenous communities who have been using these areas for food, medicine, building materials and other products for generations. Notable among these are the United Nations sponsored biosphere reserves that explicitly recognize the rights of resident populations to use resources within the reserve. These include the Río Plátano Biosphere Reserve in Honduras, La Amistad Biosphere Reserve shared by Costa Rica and Panama, and the Darién Biosphere Reserve in Panama. However, balancing the use and conservation of forest flora and fauna in these and other areas remains a complex and difficult task. Aside from the scientific challenges of measuring and evaluating the impacts human activities on plant and animal species, there are also political struggles between different stakeholders with competing interests and divergent views on how protected areas should be used and managed. The use of wildlife is a critical issue because many of the game species favored by hunters are especially vulnerable to extinction, especially those with low reproductive rates and large area requirements that make them more sensitive to habitat loss and fragmentation. Thus, the status of wildlife is arguably a key indicator of the success of conservation programs in the neotropics. The intellectual dialogue surrounding these issues is of critical importance not only from a theoretical point of view, but also because scientific research plays a significant role in shaping the policies of non-government organizations, governments, and international funding agencies that are having a steadily increasing impact on resource use in these heretofore isolated areas.

The interactions between people and wildlife in rain forest regions through both habitat modification and hunting are numerous, dynamic, and complex. Each species is unique in its behavior and requirements, and harvest rates are conditioned by a suite of cultural, economic, and ecological variables. There is considerable variation in hunting patterns for different indigenous groups in different environments, let alone differences between neighboring communities or between individuals within a single village. As such, sound management of faunal resources requires case by case assessments – species that are thriving in one locale may be at risk elsewhere, and vice versa. Conservationists must take into account that local people will likely reject conservation strategies that include the protection of animals that are relatively abundant in their locales and that, at the same time, may be responsible for significant crop losses. Unfortunately, the current knowledge base upon which to build sound conservation strategies remains incomplete at best in most parts of the neotropics. Even reliable basic information about species distributions and diet is in some cases lacking. Understanding the diversity of indigenous cultures and resource use strategies is also a formidable challenge in light of the fact that belief systems, economic orientations, and the political organization of indigenous peoples are changing rapidly in response to greater interactions with other groups at regional, national, and international levels. Yet, despite the variation and complexities involved, case studies of interactions between indigenous peoples and wildlife can still provide important general lessons, especially in those fronts that have received little study.

Much of the debate surrounding the relationship between rain forest peoples and the conservation of neotropical wildlife has an implicit assumption that indigenous hunters are passive foragers independent of their cultural background, when in fact they are knowledgeable folk ecologists. Most of the conservation work that has been implemented to date has sought to protect natural areas by limiting their use of their lands, with the ostensible purpose of ensuring the "rational" use of natural resources, with little or no consultation with the affected resident communities and a complete disregard for their historical rights to manage their lands themselves. Moreover, while much of the research providing evidence of overhunting offers valuable information, conclusions are often drawn with scant attention to the broader political and socioeconomic context of wildlife use. This is a major shortcoming given that we can not fully understand hunting patterns without some knowledge of the realities faced by indigenous groups today. Indigenous peoples have been marginalized within their countries through an onslaught of war, slavery, forced resettlement, and interminable loss of their lands to outsiders over the last five centuries, and external pressures continue to have an impact on their land use practices. To focus solely on hunters without an understanding of the broader social, political, and economic context that influence their behavior is to miss a large part of the story. At the same time, the basic human rights of indigenous peoples, which continue to be neglected in Latin America and elsewhere (Miller 1993; Price Cohen 1998), must remain a priority and should not be overlooked by conservationists or government officials responsible for natural resource management.

The ability of indigenous peoples to recognize and address problems of overhunting and to develop new strategies that combine traditional and scientific approaches to manage wildlife sustainably has been largely ignored. Indigenous people are among the most concerned about the sustainable use of natural resources and have the skills and knowledge to develop effective wildlife conservation measures. Their understanding of the interactions between soil conditions, plant phenologies, reproductive dynamics, predator-prey relationships, and many other processes is derived from frequent use of the forest. Their knowledge of forest dynamics may be quite distinct from that of university-trained scientists in that it is based in large part on personal experience and knowledge that is passed on from generation to generation as opposed to systematic, objective inquiry. Nevertheless, this knowledge is real, and a valuable resource for conservation management at the local level. Grassroots forest or wildlife conservation activities led by indigenous organizations should be supported through partnerships to implement local initiatives, as well as projects that promote sustainable use of existing farmland. Participatory methodologies that directly involve local people in the research process offer a promising avenue for simultaneously improving our knowledge of interactions between indigenous peoples and wildlife and promoting the essential role of local people in wildlife management, and make them equal partners in the design of conservation initiatives from the onset.

9.2 Principle findings of the research

The primary goal of this dissertation was to investigate indigenous hunting from a geographic point of view to improve our understanding of the complex relationships between indigenous subsistence and neotropical wildlife. The study relied on both qualitative and quantitative approaches, and centered on the participatory research whereby I trained local investigators to facilitate community mapping, conduct a census, and administer weekly household questionnaires. The local investigators and myself, working together, transferred game kill site locations from their sketch maps onto topographic sheets. In so doing, we documented the spatial aspects of hunting, one of the most important parameters needed to evaluate the sustainability of indigenous wildlife use.

This ethnogeographic and quantitative study case study focused on two key aspects of indigenous hunting that have as yet received little attention: (1) the differences between mature forest and agricultural areas as sources of game, and (2) the spatial patterns of wildlife use in relation to human settlement patterns. These two aims were in turn tied to two primary hypotheses. The first hypothesis was that the agricultural landscapes created through shifting cultivation affect wildlife foraging patterns, and in turn, where different game species are captured by hunters. Depending on diet preferences, reproductive rates, and other characteristics, I predicted that certain game species would be caught more frequently in anthropogenic habitat, while others would be captured primarily or exclusively in mature forest. A second related hypothesis held that certain game species would be more vulnerable to hunting pressure than others, which would be reflected in the distribution of game kill sites. I expected that while some game species would tend to be caught close to indigenous villages, other species would be more susceptible to localized depletion, which would be evident in an absence of kill sites near human settlement.

I focused on three interrelated objectives to fulfill the broad aims of the research and to test the hypotheses above. The first objective was to document the ethnography of Buglé hunting techniques and strategies. This was done through participant observation and interviews, and complemented by questionnaire data. The findings show that among the Buglé, hunting is an occasional activity practiced exclusively for subsistence. Game is captured primarily by men (about 95 percent by weight), but a few women make significant contributions, especially through the use of traps. Among the different strategies employed, the most important consists of hunting trips, usually directed toward the forests surrounding Buglé villages. These expeditions most frequently take a day or less, but sometimes – especially when weather is fair and people have more free time – groups go to more distant sites for two or more days to hunt where certain preferred species are more abundant. Night hunting with flashlights also occurs close to home. However, hunting trips account for only 55 percent of the total game harvest. Awaiting game in gardens, usually at night, is another common hunting strategy, accounting for about 13 percent of the total harvest, and the use of traps is also an important method of capturing game, representing about 12 percent. Surprisingly, opportunistic hunting makes up about one fifth of the game harvest, showing that certain types of wildlife are fairly abundant in the vicinity of villages and farmland where people spend most of their time, and that animals are encountered frequently during daily activities. The primary technologies used by hunters are rifles, shotguns, traps (mainly rock-fall traps and the *trinchera*), the bow and arrow, hunting dogs, slingshots, and machetes, and the type of game captured varies depending on what is used.

The second objective of the research was to document the type and quantity of game caught in both mature forest and agricultural areas through weekly household questionnaires administered by trained local investigators, complemented by direct observation of hunting activity by myself. The results demonstrate that numerous game species found in the Caloveborita region forage in landscapes modified by shifting cultivation. The heterogeneous mosaic of farms, fallows, and forest that surrounds indigenous villages appears to be a productive environment for a several species, helping them to persist in the vicinity of human settlement over long periods of time, despite the fact that they are captured regularly by hunters. The "garden game" species caught primarily in anthropogenic habitat include the forest rabbit, certain pigeons, the gray-headed chachalaca, spiny rats, and most importantly perhaps, the paca. These species seem to be innately predisposed to make use of habitats modified by humans, and this tendency may even be due in part to evolutionary adaptations resulting from the presence of shifting cultivators on the Central American isthmus for many centuries. On the other hand, several "deep forest game" species are caught primarily or exclusively in undisturbed rain forest habitat. These are the great tinamou, the great currasow, the crested guan, and the three primate species found in the Caloveborita region. Several other species are caught in both anthropogenic and mature forest habitat in significant quantities.

The sheer quantity of game caught in agricultural areas is also of note. Buglé hunters make good use of garden areas, capturing almost half of all game from anthropogenic habitat. The lands used by Buglé and other hunters living in the five study communities have a total area of about 131 km^2, resulting in an average game harvest of about 20 kg per km^2 over a period of eight months. Roughly 80.5 km^2 of these areas are agricultural and village lands providing a harvest of roughly 24 kg of game per km^2, while the forested areas provided an average of 17 kg per km^2.

Thus, there are significant differences in the type of game caught in anthropogenic versus natural habitat, as hypothesized. The results suggest that conditions are ideal for the coexistence of people and wildlife in the Caloveborita region due to the presence of a transitional mosaic of gardens, fallows, and forest. Maize and root crops are especially attractive for some opportunistic foragers. In times of food scarcity in the forest, indigenous gardens and fallows may in fact provide critical foraging opportunities that prevent or alleviate population declines.

The third objective of the research was to map the distribution of game kill sites through participatory research to evaluate the spatial relationships between hunting, habitat, and human settlement. One aspect of this was to map the distribution of game kill sites as a way of determining if certain species were being depleted around indigenous villages. The overall pattern of kill sites shows a heavy concentration around the study area villages, reflecting in part the importance of awaiting, the use of traps, and opportunistic hunting which tend to occur near the home. When considering the spatial distribution of kill sites for individual species, it appears that most species are caught close to indigenous settlement, indicating that they are able to coexist in proximity with hunters over long periods of time. Even large game birds that we might expect to be most vulnerable, (*Crax rubra*, *Penelope purpurascens*, *Tinamus major*), do not show evidence of game depletion in the Caloveborita region on the basis of spatial patterns. All three species are caught frequently in rain forest habitat within easy reach of the study villages. The primate kill sites, however, indicate a different situation. All three primate species were captured closer to the outer peripheries of the hunting zone, indicating that they have been depleted around human settlement. Comparison of harvest rates with estimates of the maximum sustainable yield also suggest that two of the primates (*Alouatta palliata* and *Cebus capucinus*) are being hunted at unsustainable rates, at least within the hunting zone. Nevertheless, the distribution of kill sites of most species, along with the harvest rates per unit area relative to estimates of the maximum sustainable yield, provide convincing evidence that they are being hunted sustainably. Moreover, even current harvest rates of primate species in the Caloveborita region may be maintained over the long term as long as there are no barriers to recruitment from adjacent unhunted areas. Overall, the concentration of kill sites around indigenous villages in the transitional mosaic of gardens, fallows, and forest lends credence to the notion that many game species thrive in areas where shifting cultivation produces heterogeneous cultural landscapes composed of both a mix anthropogenic and natural habitat.

The distribution of kill sites according to other variables revealed additional information about the relationships between people and wildlife in the Caloveborita region. A map of kill sites according to gender confirmed that while men capture game throughout the hunting zone, all of the game caught by women is captured close to the home. With respect to the hunting technologies used, most of the animals caught in distant forest areas were killed using firearms. This is consistent with what local people often told me – that they are much less inclined to undertake hunting trips in distant forest areas without a rifle or shotgun.

Another aspect of the research on the spatial patterns of wildlife use was to measure hunting yields as a function of distance. The buffer analysis measuring hunting yields at increasing distance intervals around hunters' residences clearly demonstrates that while the hunting zone of the study communities is fairly large, the game harvest of all but a few species is concentrated within a very short distance of the study villages. The amount of game caught sharply declines as one moves farther away from human settlement. Over 90 percent of all game caught during the study period was within a mere two kilometers of hunters' residences, showing that the impact of Buglé hunters on wildlife in more distant forest lands is relatively slight. Of course, certain species, in particular the three primates found in the region, were only caught in the outer reaches of the hunting zone. It appears then, that Buglé hunters in the Caloveborita region do not need to travel great distances to procure adequate quantities of game and while the total area used by indigenous hunters is large, much of it is used only lightly.

In summary, this research shows that Buglé hunters obtain large quantities of game from anthropogenic habitats and that most of the harvest is caught within a very short distance of their villages. The results of this study, however, may not be typical of other regions of the humid neotropics where indigenous hunting takes place. Important variables that affect hunting patterns, such as game species abundance, food taboos, the terrain, or the types of crops planted, vary from place to place. Nevertheless, the findings show that in some contexts, anthropogenic habitats play a pivotal role in the relationship between people and wildlife. Moreover, the research demonstrates that documenting the spatial patterns of hunting provides revealing information about the impact of indigenous hunting on game species.

9.3 Advantages and limitations of the participatory research approach

Another broad goal of this study was to demonstrate that indigenous hunters are knowledgeable resource managers with the skills to participate in geographic research with practical conservation applications. Their knowledge and abilities were clearly evident in the field throughout the participatory research component of this investigation. The local investigators were important, active participants in the research, and the skills they brought to the project were extremely valuable. This is especially true of their contributions in documenting the spatial patterns of wildlife use. The local investigators, because of their familiarity with the geography of community lands, were able to visualize exactly where game animals were captured as described to them by their fellow villagers. The cognitive locations were then represented on sketch maps that showed a clear understanding of spatial relationships. Together we transferred these locations to topographic sheets with great precision, with the help of reference features such as house sites, trails, and a dense network of named streams, as well as my own growing familiarity with the region. Notwithstanding the impressive skills of the local investigators, the fact that we were able to plot kill sites with such accuracy meant that the maps of hunting yields were relatively free of bias. They would have looked virtually identical to those that would have been produced if different people had been chosen to participate in the data collection. In addition to the quality of the spatial data, the sheer amount of information on hunting activity collected in an eight month period – including over 1,250 kill sites – would not have been possible without the incorporation of local investigators. They were able to visit many more households on a weekly basis than a single researcher. With their help, I was able to document the type, quantity, and location of game captured by among five neighboring communities with overlapping hunting zones, represented by the 59 households dispersed over the study area.

Thus, the participatory research process used in this study clearly demonstrates the ability of local people to have direct involvement in the production of scientific knowledge with practical applications. Moreover, it shows that this can be done on a limited research budget (in this case, roughly $12,000), and facilitated by a single outside investigator. That is not to say, however, that the participatory research approach was free from difficulties. As the supervisor of the research, much of my time in the field was diverted to administrative responsibilities. Providing training, ensuring that all of the households were being visited every week, and reviewing completed questionnaires were time consuming activities. The reliability of the written information collected by people with little formal education and no prior research experience was also a concern. It was very important to meet with the local investigators frequently throughout the entire study period to ensure the completeness and accuracy of their work. This frequently involved seeking out local investigators in their homes after they had been unable to attend a scheduled meeting.

Another concern about the implementation of the participatory research component was that all of the local investigators were men, thereby limiting the full participation of the community in the research. However, the questionnaire results confirm that women are not very active hunters compared to men, although there are exceptions. Women caught only about five percent of all game caught by weight during the eight months when questionnaires were administered. For research on other subjects, however, it would be essential to make a greater effort to include women as local investigators to achieve representative community participation and reliable results.

No quantitative study is free of error and this one is no exception. Even though respondents were visited every week to minimize chances that information would be forgotten by the time the questionnaire was administered, some of the animals that were captured may not have been recorded during the interviews. This is an inevitable problem associated with questionnaires (as opposed to direct observation), as people pay less attention to small game, especially the birds and other small animals caught by children. However, I cross-checked that the important game animals were being recorded through periodic cross-checking with my own observations taken during trips with hunters and from notes taken during interviews with villagers about their hunting activities.

Part of my confidence in the quality of the questionnaire data comes from my conviction that the local investigators were genuinely concerned that the research was done well. The research was strongly supported by the indigenous federation, and the local investigators understood the practical benefits of documenting hunting as a tool to help ensure continued access to their subsistence lands. Most local investigators were avid hunters themselves, and seemed to be quite interested in the research. Their enthusiasm was also instrumental in the early phases of the research. They acted as strong advocates of the study in their respective communities, explaining the research in their own words and securing widespread cooperation.

Unfortunately, there remains great inertia against using participatory approaches as a new way of producing knowledge, despite the fact that the idea of doing participatory research has been adopted by a great number of individuals and institutions (P. Robinson 1998:7-8). However, as more studies demonstrate the value of incorporating local people as active participants in research and as indigenous peoples continue to assert their rights to have a voice in what happens in their communities, it seems likely that participatory research will continue to gain ground in the social sciences. Geographers, anthropologists, and others have repeatedly highlighted local people's extensive knowledge of natural environments, and interest in ethnoscience (and subfields such as traditional ecological knowledge or ethnozoology) is evident in a voluminous literature. The use and management of natural environments by indigenous and other cultural groups, then, is likely one of the areas where participatory research can offer some of its greatest rewards. Cultural ecologists, who have a longstanding interest in human-environment interactions, are poised to become leaders in further developing the participatory research approach.

9.4 Prospects for sustainable wildlife use among the Buglé

The results of this study provide evidence that the Buglé and other residents of the Caloveborita region are presently hunting at rates that can be maintained indefinitely without exterminating any of the important game species at a local scale, with the possible exception of the three primate species found in the region. Wildlife is protected in large part by low population densities, limited use of firearms, and the fact that game is used exclusively for subsistence and not for commercial purposes. All of these variables may change over time, however, and the establishment of a sound wildlife conservation plan that will be effective over the long term is highly recommended. For example, firearms are the most effective hunting weapon used in the Caloveborita region, accounting for almost 50 percent of the total harvest. Hunting dogs used in tandem with firearms and other technologies also greatly increase hunting success. It has already been shown that the adoption of firearms places more pressure on certain species than traditional technologies, especially many that are particularly sensitive to overhunting (Hames 1979:233, 247; Vickers 1991:67). The three primates hunted by the Buglé, which appear to be the most vulnerable game species in the region, were captured exclusively using firearms. The replacement of bows and arrows with modern hunting technologies almost certainly represents a continuing long term trend associated with increased participation in wage labor by men living in the Caloveborita watershed. If this trend continues and more villagers acquire rifles, this would almost certainly increase hunting pressure on primate species to the point where some type of regulation might be required to prevent their extermination. One conservation management option for this scenario would be to restrict the use of firearms for hunting these more vulnerable species.

The primary threat to vulnerable or endangered wildlife species over the long term, however, is probably not hunting, but deforestation. Northern Veraguas is a region that is being actively colonized, primarily by Ngöbe families from other parts of western Panama. This, combined with internal population growth, will likely lead to the conversion of large areas of rain forest upon which most wildlife species ultimately depend. In the Caloveborita region, many new farms are cleared from the forest every year, as newcomers arrive and young men without inherited lands establish their own gardens. While deforestation rates remain moderate, over several decades a great deal of natural habitat may be lost due to both immigration and internal population growth.

Thus, while current harvest rates appear to be sustainable on the whole, indigenous hunting will likely have an increasing impact on wildlife populations in the Caloveborita region. Deforestation, the proliferation of firearms, the possible future commercialization of wild game, and population growth remain serious threats to many game species over the long term. While the situation is not urgent, it is necessary to develop wildlife management strategies for the Caloveborita region to prepare for the challenges that lie on the horizon. One promising option would be to develop a zoning system that delimits areas where wildlife is strictly protected – areas that lie beyond current hunting zones. Doing this now while there remain large areas that are relatively free from human impacts would be much easier to do before further encroachment occurs. Many other options are also possible. Whatever the case, local people must be involved in the process.

The implementation of grassroots conservation measures, however, is not always a straightforward task. This is especially true outside of the Ngöbe-Buglé Comarca, where the indigenous leadership does not have the legal authority to consult its constituents and enforce land use regulations that have wide support. Lands in northern Veraguas remain available for private sale, and the forests do not have recognized owners or guardians apart from the state. Nevertheless, indigenous peoples now have many allies in their struggle to assert their rights and protect their forests. The Buglé and other indigenous peoples living in rain forest regions have clearly demonstrated that they have the necessary skills to manage their resources in a sustainable manner. Together with outside individuals, organizations, and institutions who are willing to place conservation in the hands of local people, and provide assistance to achieve common conservation goals, there is still time to implement conservation strategies so that these resources will be available for many, many generations to come.

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