SUSTAINABLE FOREST MANAGEMENT IN RURAL NICARAGUA: SELF-REPORTED HOUSEHOLD BEHAVIOR AND STATED MANAGEMENT PREFERENCES IN SANTO TOMÁS, CHONTALES

By

JENSEN REITZ MONTAMBAULT

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This thesis is dedicated to my husband, my parents and my stepparents who have provided unconditional love, patience and support on my journey through life and my academic career.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Abstract of Thesis Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Master of Science

SUSTAINABLE FOREST MANAGEMENT IN RURAL NICARAGUA:
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By

Jensen Reitz Montambault

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Chair: Janaki R.R. Alavalapati
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The increasing human population exacerbates pressure on limited natural resources worldwide. Rapid conversion of tropical forests to cattle ranching and agriculture results in a legacy of environmental and economic problems at many scales. For example, the municipality of Santo Tomás, Chontales, in Nicaragua, originally part of largest Neotropical rainforest north of the Amazon and now 80% active/abandoned cattle pasture, is currently experiencing widespread household water and forest product shortages caused by deforestation/degradation. Nicaragua's current forest management policy requires annual management plans too cumbersome for small-scale forests on farms, indirectly contributing to continued conversion of forests to cattle pasture so that Nicaragua now has the highest deforestation rate in Central America. Cattle ranching is supported by the current sociopolitical climate but employs few people relative to agriculture, forestry and industry and requires massive amounts of land causing severe economic disparity as well as long-term environmental disservices.

Sustainable forest management is a goal of the Nicaraguan government, but is clearly not being implemented on the ground. Forest policy can adapt to on-the-ground realities by understanding existing household behavior affecting the environment, examining public preference for sustainable management, and analyzing and adjusting policy to reinforce sustainable management preferences with incentives for conservation behavior. This study investigates the socioeconomic distinctions between groups of respondents professing different preferences and household behaviors related to sustainable forest management. This study used 100 survey questionnaires to develop a household behavior index and forest management preference index in order to explore the questions: What causes conservation behavior in households? How are behavior and stated sustainable management preferences related?

The results of this study suggest that younger people in Santo Tomás tend to favor more sustainable forest management practices. This may be due in part to the fact that the limits of Nicaraguan forest resources are much clearer now than for previous generations. Alternatively, young people tend to be more educated and have households in urban areas and so may have more confidence in securing alternative livelihoods. In addition, the sociopolitical history surrounding the 1979-90 Sandinista revolution and ensuing civil war may influence older residence to be more cautious in adopting innovative practices for managing forest fragments on private land. Larger households, on the other hand, tended to behave in less sustainable ways, possibly out of necessity. Rural households strongly favored conversion of forest to cattle pasture and differed significantly from urban households in terms of lower education and employment and larger household size.

CHAPTER 1
INTRODUCTION

The dilemma of human population growth and the finite natural resources on this planet has troubled philosophers throughout the ages. Specific applications depend on physical delineations, temporal scales and the subjective measures of quality of life. Developing countries such as Nicaragua have traditionally relied on vast expanses of territory to relieve social pressures caused by increased population, natural disasters and political crises[1] (Utting 1993). Sustainable management of forest resources,[2] once considered limitless, currently challenges both tropical and temperate countries. Global interest in collective benefits from environmental conservation has also made sustainable management a priority in countries receiving significant amounts of foreign aid.[3] Expansionist attitudes popularized during the "Green Revolution" are giving way to a mantra of sustainable economic development and environmental conservation.

The increasing human population exacerbates pressure on limited natural resources worldwide. The human population currently stands at 6.15 billion and is projected to grow to 7.18 billion by the year 2015 (UNDP 2003), while forest cover is decreasing at a

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[1] Recent crises include Hurricanes Joan (1988) and Mitch (1998) as well as restitution to Sandinista and *Contra* fighters and repatriated wartime refugees (Ortega 1991), some of whom continue to lobby the government for land grants to this day.

[2] Although precise definitions of sustainable forest management are open to debate, the term here refers to the definition by the Center for International Forestry Research (CIFOR), "a set of objectives and outcomes consistent with maintaining or improving the forest's ecological integrity and contributing to people's well-being both now and in the future." Definition by the Nicaraguan government appears later in this chapter.

[3] The latest available figure indicated that in 1990 Nicaragua's official development assistance comprised 30% of the Gross Domestic Product (UNDP 2003).

rate of 0.38% annually (FAO 2003). General equilibrium models have shown that limits to economic growth and prosperity may be based on renewable and non-renewable natural resources (Ricker 1997), warranting concern for sustainable growth based in natural resource management.

In Central America and the Brazilian Amazon region increased human pressure has manifested itself primarily as conversion of vast expanses of rain forest to cattle pasture (Buschbacher 1986, Kaimowitz et al. 2004), in many cases irrevocably interrupting the forest ecosystem functioning on a local and watershed level (Maass 1995). Large-scale or industrial agriculture operations (e.g., soy) limit soil recovery potential while under-developed infrastructure makes chemical nutrient replacement impracticable (Buschbacher 1986). Pasture reclamation techniques represent imminent concern for the region's environment and depend on technological and socioeconomic factors, especially government subsidies and price controls (Serrão and Toledo 1992).

Rapid conversion of tropical forests to cattle ranching and agriculture, however, also results in a legacy of environmental and economic problems at smaller scales. For example, the municipality of Santo Tomás, Chontales in Nicaragua was originally part of the largest contiguous Neotropical rainforest north of the Amazon and is now 80% active/abandoned cattle pasture (PEP 2001). As a result it is currently experiencing widespread household water and forest product shortages caused by deforestation and forest degradation. A context for effecting change to these watershed-level problems can be established by examining household behavior and attitudes toward sustainable forest management practices. Existing public policies, both "explicit" and "implicit",[4] also

[4] Johnston and Lorraine (1994) portray explicit policies as "laws, regulations and technical standards" giving examples such as: pesticide subsidies, protected area demarcation and declaration, idle land tax and

influence how heads of household perceive the importance and feasibility of forest conservation. This chapter discusses household behavior and stated management preferences in rural Nicaragua in the context of global and regional natural resource conservation and the theoretical structure supporting the tenuous connection between people's self-reported actions and expressed preferences.

Theoretical Basis for the Study

The extent of moist tropical forests disappearance for economic development has been well established (e.g. Brooks et al. 2002, Faris 1999, Kaimowitz et al. 2004). Although the conundrum of integrated conservation and development projects has been addressed by non-governmental organizations, regulatory agencies, as well as academics, deforestation for cattle ranching continues to be the primary source of biodiversity and forest cover loss in Latin American biodiversity hotspots (Brooks et al. 2002). Schmink (1987) argues that while an impoverished country, such as Brazil, destroying its greatest natural assets appears irrational from a long-term planning perspective, the small institutional steps resulting in massive deforestation are actually state policies responding to constituent pressure, corporate interests combined with the impoverished masses. This phenomenon appears to be widespread in Latin America (e.g., Collins 1986). The rational result of the state satisfying large corporations that need sizable tracts of land to be economically profitable and assuaging the wrath of the disadvantaged are to permit the immediate exploitation of forested land. Resolving the environmental conservation versus economic development conundrum in particular developing country sites requires

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a minimum diameter for trees harvested for timber. Implicit policies, on the other hand, are described as the "absence of a policy, practice or institutional characteristic [or a] value." Examples of implicit policies include generally accepted agency corruption, law enforcement permitting "squatting" or poaching (trees or animals) on an individual basis by and the attitude that "natural resources are plentiful and unlimited" or that "poor people need and deserve land."

"creative problem solving" on the part of policy-makers (Seely et al. 2003). Current Nicaraguan forest policy has been criticized for neglecting on-the-ground realities (Elizondo 1997, Larson 2000). Considering these realities within the following theoretical frameworks may help prescribing policy changes to better achieve both conservation and development goals.

Needs Hierarchy

Poverty has been strongly linked in many recent studies to natural forest degradation (Nduma et al. 2001, Swinton and Quiroz 2003). Therefore, a theoretical understanding of need-based human behavior is pivotal to dissecting the complex relationship between humans (i.e., residents of the Santo Tomás municipality) and sustainable management of forest resources. Maslow, in his classic work *Motivation and Personality* (Maslow 1970), describes the difference between basic needs, higher needs and self-actualization. This scale can be applied on a personal level where an individual is concerned with survival needs such as food and shelter, and has higher needs such as serenity in the road to self-actualization. Several studies have addressed the link between asset levels, household behaviors and natural resource results (e.g., Bahamondes 2003, Parkins et al. 2003, Swinton et al. 2003). These note that policies to alleviate poverty and encourage biodiversity conservation not addressing these links often have perverse effects. Maslow argues that attitudes are often influenced by a cumulative satisfaction or frustration of these needs fulfillments.

Countries or societies can also be placed on this scale, as well. A country's available fair-market capital and combined basic necessities for survival of its human population drives the distribution of wealth, often leaving a small group with a disproportionate amount of wealth and a large group frustrated with less than what would

be their equitable share (Solomon and Richmond 2001). Previous mentioned arguments for the rationality of converting rainforest to cattle ranching in developing countries are an example of this theory put into practice. A government with sufficient infrastructure to deal with social problems or a long-term vision for development will likely find wholesale deforestation a less attractive national option. As Maslow's hierarchy of needs presents the situation, individuals or countries must satisfy their basic needs and then may have steadily increasing concern for the future. Many of the behaviors and preferences exhibited by respondents in this study might seem irrational in their socioeconomic context, but are rational given the state of insecurity faced by citizens of Nicaragua and other developing nations.

Diffusion Theory

The diffusion of innovation has been developed and refined by Everett M. Rogers over several decades (see 4th edition Rogers 1995 and Rogers 2004 for a retrospective analysis), which dissects the process of a new concept being accepted or adopted by an individual, community or country. First introduced by anthropologists to study effects of modern tools and other innovations on traditional societies, the theory was applied by rural sociologists to the spreading use of hybrid corn by farmers in Iowa (Ryan and Gross 1943 as cited in Rogers 2004). Now diffusion of innovation is used to describe the dissemination of and acclimation to new ideas in a variety of fields including policy analysis, marketing and public health, making it transferable to the study of sustainable forest management practices.

Sustainable forest management on a household level can be considered an innovation in Santo Tomás because the culturally accepted norm in the agricultural frontier region of Nicaragua has been to conquer nature (Guerrero and Soriano 1992,

Nygren 2004a). One of the key elements in the diffusion of any innovation is "heterophily" or "the degree to which two or more individuals who interact are different in certain attributes" (Rogers 1995). While communication tends to be easier between two people or groups that are more homogenous, information must flow between groups that are different for innovative ideas or practices to be diffused. Understanding what scocioeconomic factors differentiate groups who accept and do not accept different ideas, preferences or behaviors is a critical step in formulating a strategy to successfully diffuse the innovation throughout the community. A goal of the Nicaraguan government is sustainable forest management (Nicaragua 2000), but this is clearly not being implemented on the ground (Elizondo 1997, Faris 1999, Larson 2000, Nygren 2004b). This study investigates the socioeconomic distinctions between groups of respondents professing different preferences and household behaviors related to sustainable forest management. Under the diffusion of innovations theory,[5] understanding these distinctions may be key to achieving Nicaragua's stated goals.

Nicaragua

Nicaragua's current environmental conservation policy has unintended effects (Alves Milho 1996, Larson 2001) because it fails to take into account on-the-ground realities (Elizondo 1997). New forest laws requiring annual management plans for all

[5] Another perspective is found in psychological studies addressing the theory of planned behavior, which addresses the power of attitudes to predict behavior (Ajzen 1988). Kaiser, Wolfing and Fuhrer (1999) use this theoretical framework to discuss why individuals appear to behave inconsistently with respect to behavior that would support sustainable environmental conservation. The authors propose that factual knowledge about ecological behavior contributes to attitude, which then competes with social norms to create "behavior intention" in an individual, or household, which then leads to actual behavior. This application of the theory of planned behavior complements the diffusion of innovation theory by showing the connection between "knowledge awareness", acceptance and implementation. While some individuals might believe in or understand the importance of sustainable forest management, the social costs may be too high for them to change their behavior.

forests on private land intended to ensure sustainable use are so cumbersome for small-scale landowners that they inadvertently encourage landowners to convert forests to cattle pasture. This is important in the context of both Nicaragua's environmental and economic sustainability. Because cattle ranching employs few people on a per acre basis as compared to agriculture and industry and requires massive amounts of land, severe economic disparity is created between those that own cattle ranches and those that do not. In addition, long-term environmental disservices are caused by loss of forest ecosystem functions (Maass 1995). Deforestation nationwide has produced a severe lack of fuelwood, watershed-level ecosystem degradation due to erosion and wind, as well as diminishing biodiversity (Sabogal 1992). Policy initiatives intended to address sustainable forest management have created certain perverse effects.

Perverse Effects of Nicaraguan Forest Policy

Policies implementing sudden forest management planning requirements and logging bans have been documented throughout Latin America as counter to sustainable forest conservation and management (Pool et al. 2001). In the case of the large-scale forestry operations, rules intended to ensure that timber extraction complies with environmental protection principles involve a bureaucratic process with newly developed and under-funded agencies making full compliance practically impossible in Nicaragua (Larson 2000) and other countries in Latin America, notably Peru, Bolivia and Brazil (Pool et al. 2001). Once adherence to laws is effectively compromised, there remains little incentive to implement any of the sometimes costly, time-consuming measures. In addition, many developing countries ignore the benefits of forests conservation on lands of small-scale producers although they represent a quarter of the total forest lands in these countries, tend to have higher product diversity and more efficient utilization of the

under-employed labor force and marginalized land (Scherr et al. 2004). Required forest management plans are often too cumbersome for the reduced-scale and while large-scale operators might circumvent them through cronyism or bribes, these options are rarely available to farmers with small landholdings (Scherr et al. 2004). Therefore, in cases where sustainable management of forest areas are effectively discouraged by policies emphasizing these bureaucratic regulations, private landowners would rationally chose to convert the land to simpler, more productive agricultural use, such as cattle ranching.

Nicaragua's current forest law (*Ley para el Desarrollo y Fomento del Sector Forestal*) declares that:

> "Sustainable forest management is a forest classification system intended to obtain sustainable production of diverse timber and non-timber forest products into perpetuity with the involvement of stakeholders in design, implementation, evaluation and distribution of costs and benefits, in addition to the policies and actions inherent in their rights." (Nicaragua 2000, author's translation)[6]

Implementation of this sustainable forest management is described in Articles 23-25, establishing that landholders also have the rights to their forest cover and derived benefits, provided that they comply with regulations for creating an annual forest management plan created or approved by the National Forest Institute (INAFOR).[7] Article 39 confers vigilance, control and protection of forests as described in the forest law to municipalities, in collaboration with INAFOR. Article 41 explicitly states that only those conforming to INAFOR's forest management plans as delegated to the municipal government will be eligible for any benefits derived from forests on their land. This

[6] This legislation was probably intended to address crises such as occurred when the state of Nicaragua approved a large-scale forest concession in the Mayagna (Sumo) Awas Tingni community in a case that was argued at the Inter-American Court of Human Rights. Unclear tenure rights for this indigenous community were determined to be the cause of the issue (IACHR 2001).

[7] Article 102 of Nicaragua's constitution states that natural resources represent national heritage and their conservation and rational exploitation is a right of the State.

delegation of national goals to under-funded, under-staffed and under-trained municipal governments has led to the same nearly complete disregard for forest laws on a local level throughout Nicaragua (Larson 2000).

Landowners are then left with the option to illegally, yet possibly still sustainably, exploit their forests at the risk of being penalized. On the other hand, forested areas could remain unexploited by the landowner and permitted to serve the ecological functions of watershed and biodiversity protection noted in the text of forestry law (Art. 40), yet little incentive besides personal altruism exists to follow this path. Finally, a landowner might choose to convert the forest to cattle pasture.[8] If this can be accomplished without attracting the attention of authorities, such as through wildfire or in season where the roads in the countryside are impassible to motor traffic, the landowner can then extract legal monetary gain from this terrain. When the bureaucratic process of legitimate forest management is such a cumbersome option, the rational choice for a landowner is to illicitly log or burn the remaining forested areas on their land and convert them to cattle production. A perverse effect of Nicaraguan forest policy is to facilitate the eastward progression of the agricultural frontier.

The Agricultural Frontier

Nicaragua's agricultural frontier development and expansion has been closely associated with political movements and has been summarized in Table 1-1. Nicaragua's "old" agricultural frontier (see Figure 1-2) is primarily located in the central region of the country and was integrated into the agricultural and market system in the decades

[8] The rationale for this choice being that in small-scale operations, the profit from cattle ranching, even with a one-time penalty for illegal deforestation, may still exceed the profit from forestry with its continuous costs of an officially approved annual management plan.

between the 1940s and 1960s (Maldidier and Marchetti 1996). In contrast, the "new" agricultural frontier is located primarily in the Atlantic region (Maldidier and Marchetti 1996) and agricultural encroachment into forested areas actively continues to this day. The municipality of Santo Tomás spans both epochs of new and old colonization, although most of the municipality has been converted to agriculture and remaining forest is fragmented.[9] Although most of this activity took place fairly recently, the easterly movement of Nicaragua's agricultural frontier is based in the political and cultural structures established throughout the Spanish colonial period from 1524-1821 (Romero 2002), specifically industrial exploitation and the concentration of landholding rights into the hands of few (Deininger and Chamorro 2004).

Exploitation of the country's vast forest reserves began as early as the mid-eighteenth century when British settlers began extracting timber from the Atlantic Coast (Vilas 1989, Ambrogi 1996). In 1777 alone, one million cubic meters of mahogany were exported to London (Ambrogi 1996). The Atlantic region was considered a British protectorate from 1762 to 1860 when the gradual withdrawal of the British from this region was completed, bowing to United States pressure (Incer 2000). Capital investment by the United States soon followed and including Bragman's Bluff Timber Company (a subsidiary of United Fruit) from 1921 to 1931, Nicaragua Long Leaf Pine (NIPCO) from

[9] The Santo Tomás delegation of the Ministry of Education, Culture and Sports (MECD) has observed a phenomenon of encroachment and annexation in which Santo Tomás still has an active role in the eastward movement of the agricultural frontier (Briceño J, personal communication). Colonists from Santo Tomás are reported to move into the neighboring departments, which do not pertain to Chontales, but rather the Southern Atlantic Autonomous Region, known as RAAS (Región Autónoma Atlántica Sur). This encroachment into the forest resources of RAAS for cattle ranching has been so widely documented that it is termed the "Chontalization" of the Atlantic region (Incer 2000). Once families have settled in this area, they begin to petition the Santo Tomás MECD, as well as the Ministry of Health (MISNA) and municipal government for services such as schools, clinics and roads. In some cases, anecdotal evidence demonstrates attempts to legally annex the territory into Santo Tomás (Briceño J, personal communication).

1950 to 1963, then the Atlantic Chemical Company (ATCHEMCO) from 1968 to 1990 (Nuñéz Soto 1996), which were substantial enough to influence national policy decisions. For example, in 1925 Bragman's had the largest number of salaried employees in Nicaragua (Vilas 1989) and its investments played a major role in United States' decision to invade and subsequently occupy Nicaragua from 1909 to 1933 (Connell 2001). Dictatorial governments (1936-1979) reaped significant benefits from the continued exploitation of the forestry sector; Nicaragua's last dictator Anastasia Somosa, for example, was reputed to have received 10% of the profit from all timber and mining exports (Vilas 1989).

What is now known as the "old agricultural frontier" includes Chontales and was colonized in the 1920s and 1930s for wood and rubber, and later converted to cattle pasture after World War II (Maldidier and Marchetti 1996). While the 1979 Sandinista revolution nationalized the forests, along with other natural resources, contra insurgent fighters persistently ambushed timber transports and sawmills (Nietschmann 1990) crippling the sector's infrastructure that has yet to rebound. Reduced access to international markets and cancellation of existing harvest concessions on government forest lands further weakened the forestry sector (Hammett et al. 1999), leaving agriculture the only economically viable land use.

Fighting, however, in the Chontales area and other "frontier" regions led not only to decreased timber transport, but also to a decrease in cattle ranching as many rural people moved to the relative safety of cities and ranchers sold or butchered their animals before they were confiscated by either armed force (Nietschmann 1990). By the late 1980's, the government agrarian reform policy resettled marginalized peoples from over-

crowded regions of the Pacific coast to abandoned agricultural frontier lands to the east (Nygren 2004a, Vilas 1989). This was followed by a wave of settling repatriated wartime refugees from such diverse backgrounds as former national guard, those not accepting the Sandinista government and those who fled for economic reasons (Ortega 1991). At the same time, many former cattle ranchers were returning to their traditional lands placing additional pressure on remaining forest resources (Marin and Pauwels 2001).

Table 1-1. A timeline of generalized regimes and influences of the expansion of the agricultural frontier.

Date	Dominant Regimes	Effects on the Agricultural Frontier
Pre-1906	Colonial and "Conservative Republic"	Political movements of this time promoted industrial exploitation and the concentration of landholding rights into the hands of few.[a]
1906-1979	U.S. military occupation and dictatorships	A government-led effort organized the consolidation of large-scale private land holdings to increase agricultural exports.[b]
1979-1990	Sandinista revolutionary government[c]	Agrarian reform made former *haciendas* communal property later informally redistributed to families. Many ranchers retreat from farming to the relative safety of urban areas.[d]
1990-present	Electoral democracy	Sandinista and contra fighters granted land for subsistence.[f] Farmers displaced by fighting also attempt to return to frontier lands. Neoliberal government policies favor national production over dispute resolution.[g]

[a] See Deininger and Chamorro (2004) and Romero (2002).
[b] See Gibson 1996.
[c] Shocks to the economy created by Sandinista government policies were augmented by the negative burden of the *Contra* insurgency covertly sponsored by the U.S. who also enacted a trade embargo against Nicaraguan exports (Connell 2001, Gibson 1996).
[d] See Nietschmann (1990).
[f] See Gonzales (2000) and Ortega (1991).
[g] Interest payments on the accruing national debt equaled 124% of exports in 1996 posing a risk of placing creditors in charge of environmental and development sustainability (Gibson 1996). The debt remained three times the nations GDP with service payments of half the nations exports in 2004 (Mora 2004).

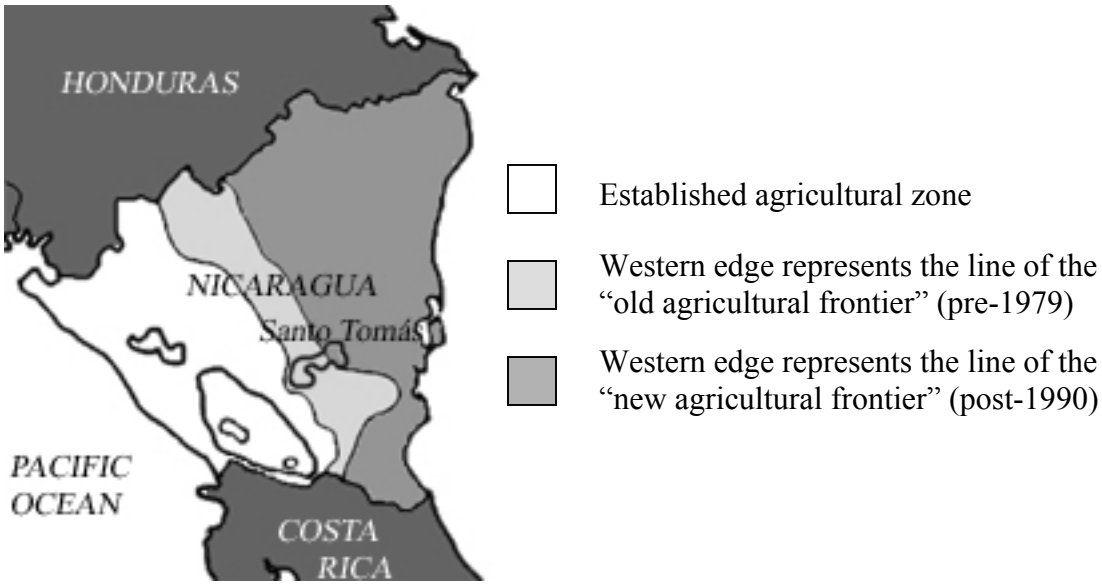


Figure 1-1. Graphic representation of the eastward progression of Nicaragua's agricultural frontier (see Chapter 2 for more specific maps related to the study). The Santo Tomás municipality is outlined in the southern central region of the country.

The convergence of people from disparate social and political backgrounds, each with what appeared to be legitimate claims to the same land led to many and occasionally violent land tenure disputes. As previously discussed in the section on perverse effects of forest policy, legislation created by the Ministry of Environment and Natural Resources (MARENA) have made it often more profitable to deforest and raise cattle than exploit forest resources (Larson 2000) and ambiguous land tenure makes potential investors uneasy (Castilleja 1993). As a result, those cultivating the land had very little real incentive to implement any sustainable forest management practices on their property.

Social Issues and Sustainable Forest Management

Nicaragua's government forestry sector has developed a set of guidelines for monitoring and evaluating forest management on a nationwide scale, but clearer and more attainable policy goals are needed (McGinly and Finegan 2003). Of the Central American countries with significant forest cover (Bermúdez Rojas 1996), Nicaragua has

by far the lowest population density (CIA 2003), yet despite high per capita natural resources, the country remains the second poorest in the western hemisphere (UNDP 2003). In an attempt stimulate the Nicaraguan economy the recent Alemán and Bolaños administrations (1996-present) have focused on increased productivity and land titling[10] rather than equitability issues (Nygren 2004a). Inadvertent results of this unqualified development emphasis have included increased disparity of wealth in cattle ranching regions and disregard of forest services in terms of environment and microeconomic contributions to society.

The Gini index[11] (or disparity of wealth, 0 being perfect equity and 1 being perfect inequity) on the agricultural frontier is 0.81, indicating that resources are concentrated in the hands of a few (Vilas 1989). In a 2000 study of nearly 2,500 Nicaraguan households, land with forests was highly significantly correlated ($p<0.01$) with lack of secured tenure, as compared with land entirely under agriculture (Deininger and Chamorro 2004). This suggests that forested areas do not fit into the national land-tenure scheme. This thesis is further supported by the fact that Nicaragua's forests suffer from the highest rate of deforestation in Central America (Romero and Reyes Flores 2000), the primary cause of which is clearing land for cattle pasture (Bermúdez Rojas 1996). While many engage in cattle and agricultural enterprises to expand economic prospects, 50% operate on land better suited for forest especially in Chontales and neighboring Boaco (Alves Milho 1996). Natural forests and forest remnants, as opposed to plantations, however, still

[10] Land titling in Nicaragua has been linked to on-farm investments and land tenure security (Deininger and Chamorro 2004).

[11] The Gini Index is the standard statistical measure used by development agencies to demonstrate how far the average household income distribution differs from perfect equality; the Nicaraguan national Gini index was 0.63 as of 1998 (UNDP 2003).

provide fuelwood, fence posts, and construction materials to most people in the tropics (Fredericksen and Putz 2003). Both the macro-economic potential of industrialized forests and the micro-economic role of forests on a household level have been largely disregarded in favor of the traditional cattle ranching production.

The Chontales region has a long tradition of cattle ranching (Guerrero and Soriano 1992). A study recently carried out in the neighboring department of Río San Juan indicated that if presented with higher income, the majority of the representative group surveyed preferred to invest in more cattle and clear more area since increased cattle ranching is a cultural symbol of wealth and affluence in the central region of Nicaragua (Faris 1999). This suggests that forest conservation is a fairly new innovation in this society. Therefore, its adoption can be examined using Roger's theory that attitude and behavior are influenced by communication between groups with different socioeconomic characteristics. Understanding the complex factors determining household actions and preferences helps isolate implicit and explicit policy failures and guide future policy action.

Research Questions

Problem Statement and Rationale

Exploring human population and limited natural resources constitute a global concern, one manifestation of which is the conversion of rich lowland forest reserves in the rural Neotropics into cattle ranching and commercial agriculture operations. Existing explicit sustainable forest management and conservation laws combined with implicit enforcement policies and circumstances have failed to control deforestation in Nicaragua, leading to biodiversity loss and localized basic needs crisis as water and fuelwood become increasingly scarce. Understanding behavior and attitudes toward forest

conservation through self-reported behavior and stated preference for management options will enable policy makers to adapt incentives and penalties to better fit natural and economic realities.

Research Objective and Questions

The primary research objective is to investigate the socioeconomic distinctions between groups of respondents professing different preferences and household behaviors related to sustainable forest management. This objective was broken down into two specific research questions most applicable to the study site:

- Which socioeconomic factors influence household behavior in a forest and environmental conservation context?
- What is the relationship between households exhibiting certain behavior and stated sustainable forest management preferences?

Thesis Overview

The present chapter outlines the theoretical basis for this master's thesis and develops the research problem statement in a global, regional and philosophical context. Rationale and justification for the study is provided along with a brief history of Nicaragua's forest conservation policy. The next chapter represents a biophysical, economic and cultural overview of the study site. Chapter 3 covers the data collection and analysis methods, the results of which are then presented in chapter 4 along with detailed interpretations. The final chapter draws conclusions suggested by research findings and details potential directions for future study.

CHAPTER 2
STUDY AREA

The Atlantic coast of Nicaragua is part of the Mesoamerican biodiversity hotspot,[1] the largest tract of contiguous Neotropical forest north of the Amazon (Mittermeier et al. 1999). The immediate threat facing the many endemic species in this area is deforestation, especially for cattle ranching (Brooks et al. 2002). The municipality of Santo Tomás is located within the Department of Chontales and is typical of cattle ranching regions on Nicaragua's agricultural frontier (see Figure 2-1).

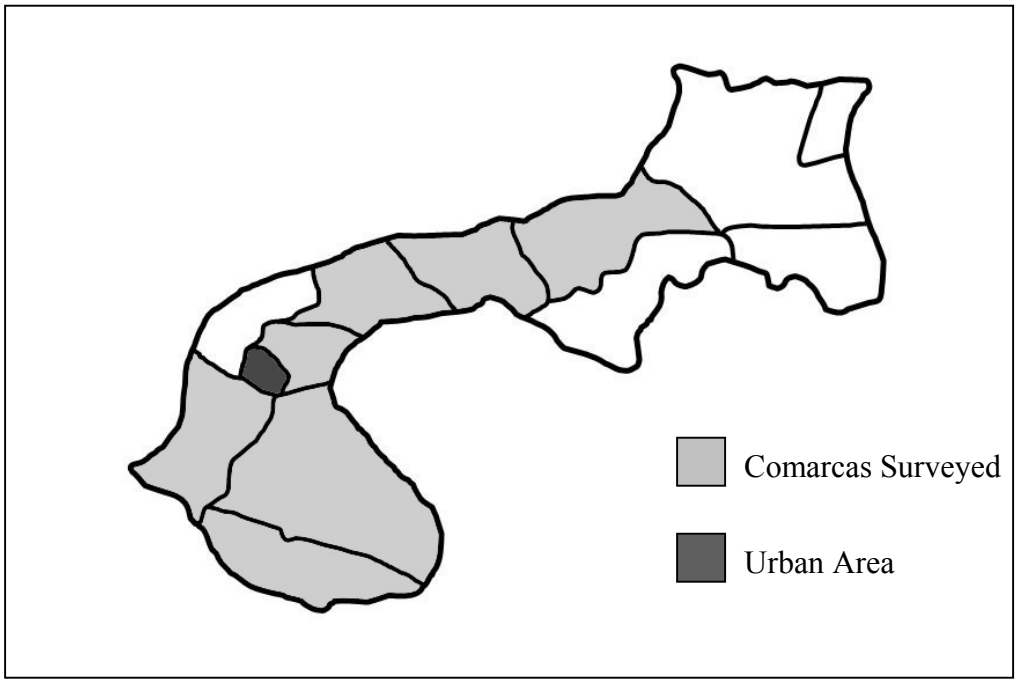
Physical and Biological Description

The municipality of Santo Tomás, Chontales is located 180 km from the national capital of Managua on the eastbound highway known as the Rama Highway (Figure 2-1). The municipality covers an area roughly located between the longitude 84°46'18"W and 85°09'47"W and latitude between 11°58'06"N and 12°16'08". Active and abandoned cattle pastures occupy approximately 80% of the land area with 15% of the land in primary and secondary forests and the remaining 5% devoted to the urban area and subsistence crop fields (PEP 2001). Major watersheds include the Escondido River and its primary tributary the Mico River. Micro-catchments, especially important for household water supplies are the Bulún and Quipor Rivers and Matagua and Caracol Creeks (Anon 2003).

[1] The biodiversity "hotspots" concept was originally published by Norman Myers in the late 1980s (cited and discussed in Myers 2003) and was revised by Myers et al. (2000) as a priority-setting tool for conservation biologists and organizations. The basic argument is that limited conservation resources should be focused on areas with a high numbers of endemic species (those which do not appear elsewhere in the world) and high risk of being destroyed soon.

Central America

Nicaragua



Santo Tomás, Chontales

Figure 2-1. Urban and rural areas surveyed in Santo Tomás, Department of Chontales, Nicaragua. Central America and Nicaragua maps from CIA 2003, Santo Tomás map created by the author based on maps in PEP 2001 and those provided by the Ministry of Education, Sports and Culture (MEDC).

The urban center is located at an elevation of 400 m above sea level (INAFOM-AMUNIC 1997). The remaining territory, however, encompasses a variety of elevation from peaks of over 700 m to valleys below 200 m (INITER 1989a, 1989b, 1989c) and

rainfall zones from 1,400 to 3,000 mm (INITER 1990). The Santo Tomás municipality also includes five distinct vegetation zones and crosscuts three of the four distinct ecological regions in Nicaragua (Salas Estrada 1993). These factors combined with the convergence of brown latisols, black and brown tropical soils and lithisols (Taylor 1963) make the area hospitable to a high number of floral and faunal species. The agricultural frontier advancement through this region followed the 1966 completion of the Rama Highway infrastructure (Ñurinda Ramírez 2000), which linked the Pacific and Atlantic coasts for the first time. The road provided ranchers with a ready transportation to milk and beef markets, indirectly resulting in severe forest fragmentation. Studies of similar cases in Central America show that these networks of forest fragments can be expected to harbor remnant biodiversity (Matlock et al. 2002, Pither and Kellman 2002). As deforestation continues to advance nationwide at an unprecedented pace, the remaining forests in Santo Tomás may be expected to contain samples for flora and fauna representative of a large part of Nicaragua. Understanding the ecology and socioeconomics governing the management of these remaining forests is critical step to conserving the natural diversity of the region.

Ecological Understanding

The ecology of the Chontales region has not been thoroughly assessed since observations made by the ecologist and mining engineer Thomas Belt in 1874 (Belt 1985[2]), but this area is considered to be a point of ecological transition (Incer 2000). Chontales, along with all of Nicaragua, was subject to a remote sensing vegetation analysis by the Ministry of Environment and Natural Resources (MARENA) using data

[2] Reprint edition.

from 1996 and 1999 (MARENA 2003). Characterization of the vegetation by Salas Estrada (1993) indicates a high diversity of flora due to the rainfall and elevation gradients. Geoscientific investigations indicate that the main and secondary watersheds of the Escondido River are among the most contaminated in Central America due to upstream mining operations (Mendoza 2003), and laboratory tests of the Mico River have revealed cyanide and mercury deposits in the sediment (INAFOM-AMUNIC 1997). This localized combination of high biodiversity and severe threat makes the area a strong candidate for conservation efforts. However, like most of Nicaragua, baseline biological information for conservation effort is lacking (Gillespie 2002).

Recent surveys in the nearby Indio-Maiz biosphere reserve have revealed new species of plants (e.g., Taylor 1999), however, only general anecdotal evidence is available for the flora and fauna of Santo Tomás (INAFOM-AMUNIC 1997, PEP 2001). An anecdotal list of trees derived from 100 survey interviews and additional expert contributions for the Santo Tomás region was compiled during the course of this study. The list, found in Appendix C, includes 155 tree species known to exist on farms in Santo Tomás as presented by indigenous knowledge. While indigenous knowledge of trees within farming systems has been shown to be comparable to scientific and laboratory tests (Walker et al. 1999) and has been used to develop species accumulation curves (Kristensen and Baslev 2003) and in conducting rapid biodiversity assessments (Hellier et al. 1999), formal taxonomic and ecological studies including baseline inventories of the flora and fauna in this area are still strongly recommended. An analysis of on-farm tree diversity can be found in Appendix D. The clear diversity and unstudied nature of the

site indicates the importance of these baseline studies in this area where anthropogenic activities are the primary shapers of the landscape.

Socioeconomic Description

Dairy farms have been part of the Santo Tomás region for over 150 years (Guerrero and Soriano 1992). Recently, however, deforestation for new cattle pasture has led to shortages in fuelwood, fence posts and construction materials. This has prompted local interest in and forest conservation largely because natural forests, as opposed to plantations, still provide these products throughout the tropics (Fredericksen and Putz 2003). Farmers and townspeople alike are concerned about the connection between increased deforestation and drying perennial streams, which are the primary water source for both rural and urban residents (PEP 2001). The practice of burning over cattle pastures has been blamed for widespread loss of soil infertility in Santo Tomás (Anon 2003) and has been documented to spark wildfires destroying lowland forests in eastern Nicaragua (Romero and Reyes Flores 2000). As socioeconomic indicators are often strongly correlated with the interrelationship of environmental behaviors and attitudes, the following provides a general context for the research objectives.

History

Prior to Spanish occupation, the municipality of Santo Tomás was settled by the Chontal indigenous group with its capital seat located in Lovigüisca, 12 km from the current urban center in the rural district now known as Los Mollejones (Guerrero and Soriano 1969, INAFOM-AMUNIC 1997). After a series of resettlements by the colonial government, the Nicaraguan republic officially founded the town of Santo Tomás in its current location in 1861 (Guerrero and Soriano 1969, INAFOM-AMUNIC 1997).

Because cattle, unlike most other natural resources and commodities, was neither taken over by dictators, nor nationalized in the communist Sandinista era (Romero 2002), development in Santo Tomás has remained relatively steady since the late 1800s. Highly significant events included the construction of Rama Highway in 1966 (Ñurinda Ramírez 2000) bringing large-scale commercial exploitation and individual transit into the region. The 1979 Sandinista revolution[3] and ensuing conflict which forced many to temporarily give up cattle ranching and farming (Nietschmann 1990). Hurricane Juana/Joan, which struck Santo Tomás in 1988 reduced forest area, introduced refugees from the Atlantic region and set off an economic recession (PEP 2001).

Since Violeta Chamorro's 1990 presidential election, Santo Tomás has responded to the decentralization process with booming economic growth due in part to increased traffic of the Rama Highway and also to increased safety in former military zones permitting farmers to expand cattle ranches and production into more rural areas. As the economy improves and infrastructure develops, more people immigrate to Santo Tomás and more young people remain rather than seeking employment in cities such as Juigalpa (the department capital) or Managua. The increased population has led to greater pressure on diminishing forest and water resources (PEP 2001). In addition, the value of land near Santo Tomás has increased as more people desire to live near its schools and commercial

[3] Unprecedented environmental education campaigns through schools and extension programs were also a product of the Sandinista era. In addition, a 1988 decree gave the RAAN (Región Autónoma Atlántica Norte) and RAAS (Región Autónoma Atlántica Sur) a degree of political autonomy and the ability to elect their own governments (Incer 2000). These areas, formerly known as Zelaya, are also home to the three remaining indigenous groups, Miskito, Sumu and Rama, that comprise 2.7% of the total Nicaraguan population (Incer 2000). While these territories and reserves belonging to these indigenous groups are quite a distance from Santo Tomás, the municipality does share a border with RAAS. The lack of organization in the RAAS government, tensions between mestizo, indigenous and Creole (English-speaking descendents of African slaves) groups and distance from its capital in Bluefields facilitate the encroachment of cattle pastures into the remaining primary rainforests of RAAS.

center during prosperous economic times. Many farmers have sold parcels of land at high prices and purchased greater amounts of forested land farther east for conversion to cattle pasture (Borge R, personal communication). This "Chontalization" of the remaining forested region (Incer 2000) exacerbates forest and water resource shortages and creates a need for more information on sustainable forest management practices.

Demographics

It is important to understand the demographics of Santo Tomás as compared to the rest of Nicaragua to understand how socioeconomic factors influence sustainable forest management preferences and self-reported behavior. The total population in Santo Tomás in 2001 was recorded at 19,778, 64% of whom live in the urban center while 36% are in rural areas (PEP 2001). While there are nominally more women in urban areas (51%), the opposite is true for rural areas (PEP 2001), a discrepancy probably due to the need for manual labor on farms. Children under the age of 15 comprise 47% of the total population (Anon 2003), a phenomenon common to developing countries in Latin America. In urban areas, approximately 53% of school-aged children attend primary school, dropping to 45% in rural areas where the adult illiteracy rate is estimated at 61% (PEP 2001).[4] The 1996 census reported that 85% of the economically active population is employed, a figure that excludes housewives and students, and 53% percent of these economically active individuals hold a formal salaried position (Anon. 2003).[5]

[4] The Nicaraguan national average is 33% adult illiteracy (UNDP 2003).

[5] On a national level, youth (aged 18-24 years) have a 20% unemployment rate (UNDP 2003), and although directly comparable figures are not available, the employment level appears to follow the national average.

Economy and Land-Use

Cattle ranching economy: Deforestation for cattle ranching is the leading cause of biodiversity loss in this region, yet dairy cattle are also the basis of the economy (INAFOM-AMUNIC 1997). The location of the Santo Tomás municipality facilitates commercial trade between the natural resource rich Atlantic zone and the majority of Nicaragua's population located in the Pacific region. Milk production fluctuates between 10,000 gallons/day in the wet season and 2,000 gallons/day in the dry season from an estimated 30,000 head of cattle in the region (Anon 2003). Of these animals, 30% are used exclusively for milk production, 20% exclusively for beef and the remaining 50% utilized for both purposes (INAFOM-AMUNIC 1997). At least three-quarters of the land used for cattle ranching in Santo Tomás is better suited to other purposes (see Figures 2-2 and 2-3)(PEP 2001), which is higher than the national average of 50% (Alves Milho 1996). Over half of the land in Nicaragua cleared for cattle ranching and agriculture that is suitable for reforestation is located in the Departments of Chontales and Boaco (Alves Milho 1996, Núñez Soto 1996).

Other economic activity: Commerce, foreign aid and agriculture comprise much of the remaining economic activity in Santo Tomás. Commercial districts include a variety of cottage industries such as small stores, carpentry shops, mechanics, tailoring and jewelry workshops. Foreign aid to Santo Tomás in 2000 was approximately four times the income from other sources. The largest donations are from Japan, Spain, Finland, Taiwan and France, in order of decreasing contribution (Anon 2003). On average, 5% of farmland is dedicated to agriculture, except in the rural district El Alto, where 20% of farmland is in crops (Anon 2003). The percentage of cultivated area

devoted to each crop is as follows: rice (2%), beans (14%), corn/maize (33%) and plantains/bananas (51%) (INAFOM-AMUNIC 1997). Due to rising transportation prices and deteriorating roads, farmers are increasingly reluctant to plant crops for cash sale, relying on sales of cattle and milk as primary income (Borge R, personal communication).

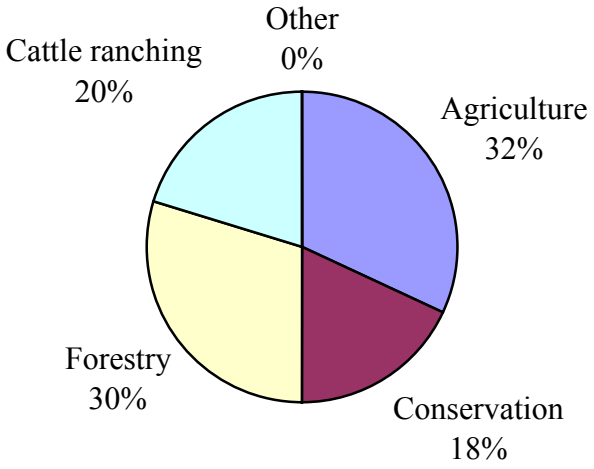


Figure 2-2. Land vocation in Santo Tomás, Chontales (PEP 2001).

Forestry: According to the mayor's office, there are no public forests (parks or productive) in the Santo Tomas municipality (García J, personal communication). Household level forestry does exist, but as demonstrated previously, there is an incongruity between the appropriate and real land use. Although private forest reserves were reported in a Participatory Rural Appraisal conducted by the mayor's office (PEP 2001), many of these areas had already been clear-cut at the time of this study and the mayor's office indicated that no formal protection schemes were planned by the municipality in the near future (García J, personal communication).

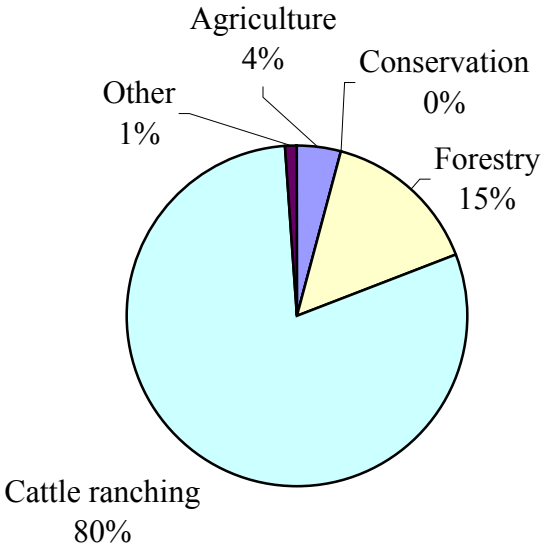


Figure 2-3. Actual land use in Santo Tomás, Chontales (PEP 2001).

Most trees in Santo Tomás exist, therefore, within forest fragments and as individual multipurpose trees on private property both in small urban lots and on rural farmland. The decision to grow trees on private land, which trees and how many, is a personal decision made by individual landowners in this area. As such, household socioeconomic variables, including gender, age, education level, household size, household income and outside employment might be a deciding factor (see Appendix D for a more detailed discussion of on-farm tree diversity). The primary challenge to policies encouraging sustainable management is the lack of information about what factors would influence individuals to choose sustainable management and why. This information gap will be addressed by this study.

CHAPTER 3
METHODS

The primary tool utilized to elicit information from households about sustainable management was a survey questionnaire. It was administered to 100 voluntary respondents selected through a randomized, stratified and quota sampling design. Preliminary aggregated results were reviewed by focus groups to identify potential biases. Student's t-test, bivariate correlation and multiple linear regression analyses were conducted using the interview data to detect significant relationships between variables.

Survey Questionnaire

Development and Pretesting

The survey questionnaire tool was developed at the University of Florida, Gainesville, Florida, USA using sample surveys from similar studies in Central America and other developing countries (e.g., Albertin 2002, Harvey and Haber 1999). A sample-size of 100 was determined to be appropriate.[1] Field tests of the survey were made to include a sample of >15 volunteer respondents from a broad background to identify obvious problems with the survey and modify accordingly before translation into Spanish and submission and approval by the University of Florida Institutional Review Board (Protocol# 2003-U-414). Once tested with additional volunteers in the study site, final refinements were made. The questions presented in the survey fall into four general

[1] A sample size of 100 produces a 92% confidence internal, while a sample size of 411 would be required to raise the confidence interval to 95% (UFSRC 2002). A four-fold increase in sample size would have required costs far outweighing the benefits to this study and was logistically infeasible for this project.

categories, socioeconomics, biodiversity, actions and preferences (See Appendices A and B for English and Spanish versions of the full survey, respectively).

Socioeconomics: Questionnaires commenced with a series of general socioeconomic questions including gender, age, education level, household size and make-up, total household income and contributors, whether anyone in the household had outside employment and amount of fuelwood used in the household. Specific questions about each household property (if applicable) covered land area, tenure and acquisition. Finally respondents were asked whether or not they had received environmental education and through which venues (i.e., via the radio, word-of-mouth, school, church, government or non-governmental organization).

Biodiversity: Each respondent owning land was asked an open-ended question to list woody tree species and animals occurring on her or his property. Unfortunately, no scientific lists were available for this region; therefore a preliminary list was created using a focus group and then presented to respondents.[2] Information compiled on trees is available in Appendix C.

Actions: The survey elicited self-reported household behavior with respect to flora, fauna and water resources. Options included harvesting fuelwood, timber and other forest products for household use and sale. Hunting wild animals for household use and sale, leaving trash and cutting fuelwood in riparian zones when going to the river to wash were also investigated (see Table 3-1).

Preferences: Participants in the survey were asked to express their opinions using a Likert scale (1 = agree, 3 = no opinion, 5 = disagree) on a series of questions about

[2] This list was added to as individual respondents mentioned more tree species, therefore, later interviews had a more extensive list to prompt a present/absent response than earlier surveys.

sustainable forest management practices relevant to the remaining forest fragments in the Santo Tomás municipality. General topics included whether the following activities should be permitted in the remaining forest fragments in Santo Tomás: harvesting fuelwood and timber for household use or sale, harvesting non-timber forest products, hunting wild animals, exploring for gold and silver, deforesting new land for cattle, maintaining forest reserves for the future, as well as recreation, conservation and educational activities (see Table 3-2 for a complete list of topics).

Some data collected was not used in this analysis. Full descriptive statistics on survey responses can be viewed in Appendix E.

Sampling Design

A total of 100 person-to-person surveys were conducted by the author and field assistant, stratified over urban (50%) and rural (50%) inhabitants. While the actual population of nearly 20,000 is distributed over 36% rural and 64% urban habitants (PEP 2001), the equal division permitted direct comparison of responses from urban and rural areas. These two sectors are demographically distinct as rural areas have a much higher illiteracy rate, lower employment rate and the largest forest fragments (see Chapter 2 for more details). Rural areas are divided into 12 *comarcas* or districts and urban areas into 10 *barrios* or neighborhoods. Only nine of these *comarcas* were accessible during the study period due to the deteriorating condition of the road. Using information provided by the Santo Tomás delegation of the Nicaraguan Ministry of Health (MINSA), the number of interviews per accessible *comarca* or *barrio* was made proportional to the actual population distribution in each area. Urban residents were selected randomly within *barrios* using the electronic address lists provided by the mayoral cadastral system. Key informants coordinated by the Santo Tomás delegation of the Ministry of

Education and Culture (MEDC) assisted in rural participant selection based on availability and representation of community views within designated geographical regions. Surveys were conducted between mid-May and early-July 2003. A local field assistant accompanied the researcher implementing the interviews in Spanish to ensure that questions and answers were fully understood. Participation was voluntary and limited to heads of household 18 years and older; information collected on individual surveys was kept confidential.

Data Analysis

Each survey was assigned an interview number and data were transcribed into an Excel spreadsheet, giving number values to categorical data. The transformed data were then imported into the statistical analysis package SPSS, v. 12. Frequency and descriptive statistics were run for all variables. A student's t-test was applied to urban vs. rural data. A standard multiple linear regression analysis and bivariate correlations were performed for the variables described below. Results of the analyses are presented in the following chapter.

Dependent Variables

The dependent variables were selected to address the principal components of the research questions raised in Chapter 1: behavior and attitude. A household behavior index was developed from answers to specific questions about household actions.[3] A stated management preference index was used as a second dependent variable examining the

[3] The number of tree species reported for the property (tree diversity) is used a dependent variable for rural households only as a proxy for forest conservation behavior. The results of this analysis are presented in Appendix D.

heads of household's stated preferences with respect to specific forest management policies that may or may not support conservation.[4]

Household Behavior Index

Each question used to compile the household behavior index elicited a binomial (yes/no) response (Table 3-1), and was given a value of 1 if this action supports conservation policy or 0 if otherwise. The answers on each survey were transformed and averaged to create a continuous value between 0 and 1 used as a dependent variable.[5] Each element of the index was also used as the dependent variable in separate regression models to test whether the relationship represented by the index was actually driven by a particular variable.

Table 3-1. Response values used to calculate the household behavior index.

Does your household…	Response	
	Yes	No
…maintain trees on the property for household consumption?	1	0
…unregulated hunting of wild animals?	0	1
…harvest fuelwood along river/stream/spring?	0	1
…throw trash when visiting river/stream/spring?	0	1

An alternative weighting scheme was also implemented to account for the difference between circumstance determined and active choice behavior. Hunting and

[4] The index is a tool to compare levels of a complex concept in disciplines as diverse as environmental science and psychology. The Pollutant Standards Index, for example, uses the levels of five air pollutants to assess air quality and then relate the index value to potential negative health effects (for a discussion see Wark and Wong 2003). Similarly, the Self Esteem Index (SEI) uses 80 self-response items and a Likert-type scale to assess self-esteem problems in school-children who may require counseling (see Ferrer et al. 2003 for a recent analysis of this method). The household behavior and forest management preference indices consolidate different patterns within answers to behavior and attitude questions to facilitate isolating the socioeconomic factors contributing to a household, or head-of-household, acting or thinking in a way that supports forest conservation scenarios.

[5] Another possible approach analysis would be developing a logit analysis. This would use the mean or some other natural breaking-point to divide the continuous variable into either "high conservation behavior" and "low conservation behavior". The dependent variable would then be re-coded 1 and 0, respectively. This would be effective in cases where there was insufficient variation in the original continuous values, but much of the information contained within the continuous variable would be lost.

harvesting fuelwood may be for survival and maintaining trees on the property may be a decision made by the landlord or size of the property. Throwing trash into the stream, however, is a conscious choice. Therefore, this response was assigned an arbitrary[6] value of four times greater than the other responses to test the effect of the active choice vs. circumstance determined motivation. These alternative results are also presented in the following chapter.

Rationale for Weightings

Maintaining trees on property for household consumption: Keeping trees on the property for multiple-use purposes either by planting or not cutting is a conscious choice made by the household.

Hunting wild animals: Although two hunting clubs exist in Santo Tomás who publicly claim to follow nationally recognized hunting guidelines, focus groups indicated that most hunting is done on an individual basis without the permission of landowner's or regard for season or bag limits.

Harvesting fuelwood and littering in riparian zones: These questions were addressed to households routinely washing clothes in the river (73%), a clear majority. While the decision to wash in the river is largely a matter of necessity, the subsequent decisions to cut fuelwood in the riparian zone (as opposed to elsewhere) or throw trash in the stream (as opposed to carrying it home) have significant conservation impact and could be easily avoided.

[6] The value of four was chosen arbitrarily. Additional iterations could be completed by varying this number, but initial tests with the number four revealed no significantly different results.

Forest Management Preference Index

The Likert scale (1-5) used in the questionnaire was collapsed to simply agree or disagree. In the same manner as described for the household behavior index, response values were tallied and averaged, assigning a continuous value between 0 and 1 to each individual survey. The answers on each survey were transformed and averaged to create a continuous value between 0 and 1 and used as a dependent variable. Each element of the index was also used as the dependent variable in separate regression models to test whether the relationship represented by the index was actually driven by a particular variable.

Table 3-2. Bivariate and alternative values for response used to calculate the forest management preference index.

Should the following activities be permitted in the forests remaining in Santo Tomás…	Bivariate		Alternative	
	Agree	Disagree	Agree	Disagree
…require maintaining forest reserves on private lands?	1	0	1	0
…gathering fuelwood for household use?	0	1	0	1
…harvest timber for household use?	0	1	0	1
…gather non-timber forest products for household use?	1	0	1	0
…hunt wild animals?	0	1	0	1
…harvest timber for sale?	0	1	0	4
…deforest additional land for cattle pasture?	0	1	0	4

Note: Half of the respondents were asked their preference on burning pastures since wildfires are a major concern for forest maintenance. The results were not included in the index, but can be found in Appendix E. This was of special concern because the Department of Forestry (INAFOR) in Juigalpa was attempting to implement a ban on all agricultural burning at the time of this study.

As with the household behavior index, an alternative-weighting scheme was developed. Harvesting fuelwood for household use is often the only energy available for cooking, especially in rural areas without good roads to bring in alternative fuels such as propane tanks or electricity for ironing or cooking. An arbitrary number of four was

assigned to responses in favor of to harvesting timber for sale and deforesting for additional cattle pasture, as these represent a more active disregard for the environment.

Rationale for Weightings

Require maintaining forest reserves on private lands: Trees maintained on private lands can provide public environmental services such as run-off control and wildlife habitat.

Gathering fuelwood for household use: Deforestation and forest degradation due to cutting fuelwood for household use is considered to be the greatest threat to forests and biodiversity in Nicaragua (Van Buren 1990). Often the petroleum energy used to transport the wood material is greater than the energy value provided by the wood itself. Eighty-three percent of those interviewed use fuelwood at least to some extent in their household, largely out of necessity.

Harvest timber for household use: From the perspective of forest conservation, timber harvests for household use have no regulation or monitoring for sustainability. However, it is primarily carried out to escape purchasing substitute materials such as cement and iron, which must be hauled in from Managua and great cost and petroleum energy expense.

Gathering non-timber forest products (NTFPs) for household use: Studies in the neighboring department of Río San Juan indicated that gathering NTFPs would not significantly affect tree growth or biodiversity (Salick et al. 1995) and raises people's

appreciation of the forest, therefore this activity would be considered benign from the perspective of forest conservation.[7]

Hunting wild animals: As discussed in the section detailing rationale for the household behavior index.

Harvesting timber for sale or export: Illegal or unmanaged cutting of timber for sale is one of the most serious problems facing Nicaragua's forestry sector.

Additional deforestation for cattle pasture: The cattle ranching cooperative Ríos de Leche has studied the farming practices of ranchers in the area and concludes that it is unnecessary to cut the remaining forests to maintain current levels of ranching, or even to expand significantly if land use is made more efficient through technology adoption (Miranda A, personal communication).

Independent Variables

The following independent socioeconomic variables are expected to influence behavior and attitude based on similar studies discussed in Chapter 1. Typical social characteristics of respondents (heads of household)[8] included age (*AGE*), gender (*FEMALE*), years of formal education (*EDUCATION*) and whether or not the respondent had been exposed to environmental education (*ENVIEDU*). Household characteristics expected to be influential were income level (*INCOME*), outside employment

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[7] A recent comparative study of Brazil nut harvests does indicate that unregulated and persistent harvests may lead to a forest producing too few juvenile trees to sustain the population (Peres et al. 2003). The central Nicaraguan NTFP markets do not approach the historical or special extent of those in Brazil and this particular constraint is probably not a concern. This study should, however, serve as a caution to those organizations interested in further developing NTFP markets in Nicaragua and other regions.

[8] Heads of household were determined by asking the potential respondent if she or he would consider her or himself the head of household or "household decision-maker". While some individuals did decline to be interviewed because they would not classify themselves as the head of household, there is still room for error. Some households may make decisions as a group, or decisions about the house may be made by a different person than decisions about the land and trees.

(*EMPLOY*), rural location vs. urban (*RURAL*), owning vs. renting (*TENURE*) and number of people living in the household (*HHSIZE*). A Pearson's bivariate correlation analysis was applied to these independent variables to ensure no multi-colliniarity (Tabachnick and Fidell 1996 as cited in Pallant 2001).

Different socioeconomic variables are expected to influence each of the dependent variables differently. The *a priori* results of each analysis are presented in Table 3-3.

Table 3-3. Expected coefficient signs associated with socioeconomic variables when regressed against two dependent variables (signs are expected to remain the same under binomial and alternative weighting schemes).

Independent Variable	Household Behavior Index	Management Preference Index
AGE	–	–
FEMALE	±	±
EDUCATION	+	+
ENVIEDU	±	+
INCOME	+	+
EMPLOY	±	±
RURAL	–	±
TENURE	±	±
HHSIZE	–	±

Note: In the original survey, the area of landholding was also collected. This was not included in the independent variables because it did not apply to all households. Additionally, the cadastral system was currently in the process of being implemented and individuals' understanding of real land boundaries was highly unreliable.

Because older people were raised and established their households when the Nicaraguan government was actively encouraging the settlement of the agricultural frontier through deforestation, it is expected that the household behavior and management preferences exhibited by this group would be less supportive of conservation. There are no *a priori* expectations about how gender and outside employment may affect the dependent variables, although other studies have shown them to be significant in the past. Education and income are both expected to have a positive influence on all of the dependent variables since these respondents would be higher up on Maslow's hierarchy

of needs. While environmental education should have a positive affect on respondents' sustainable forest management preferences, it may not have a significant affect on behavior dependent variables because many of these questions are circumstance determined. It is likely that rural respondents will have a lower score on the behavior index due to subsistence activities such as hunting and fuelwood collecting, but an undetermined effect on preferences. Finally, larger households will use more natural resources and therefore the behavior index should be negative, while the preference might depend more on other socioeconomic factors in the individual family.

CHAPTER 4
RESULTS AND DISCUSSION

The data from 100 survey questionnaires was subjected to a series of analyses. Descriptive and frequency statistics provide an overall picture of the municipality through averages and ranges of socioeconomic variables. A student's t-test was used to compare responses from urban and rural samples. Bivariate correlation analyses reveal significant relationships between variables. Multiple linear regression analyses assess the relationship between a dependent and independent variables by controlling for other variables and an overall relationship between a set of independent variables and a dependent variable. Detailed interpretations of the analyses results are discussed.

Descriptive Results

Socioeconomic Characterization

The sampling design was stratified 50% urban and 50% rural. Of these respondents, 60% were women and 40% men. Ages ranged from 18 years old to 82 (mean age 41), while education level ranged from no schooling to university degrees (average education level was completion of 4th grade). An impressive 82% of the respondents reported that they had received some type of environmental education, whether formal training through governmental agencies or non-governmental organizations, or by word-of-mouth, the church or the radio. Descriptive statistics from the complete data set are presented in Appendix E.

Households ranged from one person to 14, with an average size between six and seven, including a mean value of 2.59 children (ranging from no children to 9). Although

household income spanned all categories, the average income was low at approximately 1,000 Córdobas (US$66) monthly,[1] with an average of 2.3 people assisting with household income (includes remittances). Among those surveyed, 43% of all households had a member with outside employment.

Table 4-1. Data was sorted by rural (n=50) and urban (n=50) respondents and a student's t-test was used to determine whether the detected variation was significant. Numbers not followed by a percentage symbol are averages.

Socioeconomic Characteristic	Data Type	Rural	Urban	T-Test Probability	Significance
AGE	continuous	42.34	39.92	0.450	
FEMALE	dummy	48%	72%	0.022	**
EDUCAT	continuous	3.38	6.14	0.002	**
ENVIEDU	dummy	92%	72%	0.011	**
INCOME	categorical	0.90	1.25	0.118	
EMPLOY	dummy	28%	58%	0.002	**
TENURE	dummy	84%	82%	0.799	
HHSIZE	continuous	6.52	5.4	0.028	**
Index Value					
Household Behavior				0.554	
Management Preference				0.002	**

* Significant at $\alpha = 0.1$
** Significant at $\alpha = 0.05$

The average respondent had lived in the present property for 18 years, but answers ranged from 0 to 76 years. Only 15% of those interviewed were living on inherited land, but 83% said that they owned the property where the household was located.[2] The survey design was stratified between rural (n=50) and urban (n=50) residents, and several significant differences were revealed between these respondents. Socioeconomic

[1] The Nicaraguan Córdoba was valued at approximately C$15 to US$1 at the time of this study.

[2] A 2000 World Bank study of 2475 Nicaraguan households indicates that approximately 80% of farmers with agriculture production land and 70% of households with little land have formally registered documents of land ownership (Deininger and Chamorro 2004). The study notes, however, that some respondents may have misunderstood the questions distinguishing between titles recognized by the current administration, those issued by the Sandinista regime and informal documentation.

information and final index results were sorted over these two categories and subjected to a student's T-test in MS Excel. The results are reported in Table 4-1.

A significantly lower percentage of women responded to the survey in rural areas. Rural heads of household also tended to have fewer years of formal education and have larger households. Urban residents, on the other hand, are much more likely to have a household member with formal outside employment, but were much less likely to have received environmental education. This is probably caused by the importance of the radio in rural life and recent outreach programs broadcast by Nicaragua's Ministry of Environment (MARENA) intended to reach the rural public. In summary, rural residents are generally less educated and living in larger households with less income and fewer possibilities for outside employment than their urban counterparts. These aspects also contribute to a tendency to continue clearing remaining forest fragments in the hopes of satisfying basic needs.

Both index results were also subjected to bivariate correlation analysis with individual independent variables. There was no significant difference between the household behavior index results, however, there was a highly significant difference between the results of the management preference index between rural and urban respondents. These results will be discussed in more detail in the following sections.

Table 4-2. Response values used to calculate the household behavior index.

Does your household…	Response	
	Yes	No
…maintain trees on the property for household consumption?	85%	15%
…hunt wild animals?	15%	85%
…harvest fuelwood along river/stream/spring?	23%	77%
…throw trash when visiting river/stream/spring?	29%	71%1

Household Behavior

The questions selected to determine the household behavior index elicited a variety of responses. Most people maintained trees on their property, in both urban and rural areas, for household fruit, fuelwood or timber consumption. Fifteen percent hunted wild animals and approximately one quarter of the respondents reported littering and harvesting fuelwood. This number is probably under-reported because some participants may have been aware that these actions are regulated and may be illegal.

Stated Management Preference

Most heads of household surveyed favored permitting the harvest of household use of forest products such as fuelwood, timber and non-timber forest products. Many respondents specifically commented that forests, even on private land, should be used for subsistence, but not for profit ventures. Less than half of the participants supported harvesting wood for sale or export, hunting wild animals or deforesting additional land for cattle pasture. Support for policies to maintain forest reserves on private land was substantial, however the option was presented without potential trade-offs (i.e., would you agree to this policy if overall production in the region were to decline a corresponding 10%?).

Table 4-3. Response values used to calculate the stated forest management preference index.

Should the following activities be permitted in the forests remaining in Santo Tomás…	Response		
	Agree	Disagree	No Opinion
…require maintaining forest reserves on private lands?	96%	1%	3%
…gathering fuelwood for household use?	85%	14%	1%
…harvest timber for household use?	68%	31%	1%
…gather non-timber forest products?	88%	8%	4%
…hunt wild animals?	26%	71%	3%
…harvest timber for sale or export?	9%	91%	0%
…deforest additional land for cattle pasture?	29%	70%	1%

Bivariate Correlations

The bivariate correlations are intended to highlight relationships between independent variables that are significant. The rural/urban dummy variable had a large number of significant correlations justifying its use as a stratification mechanism. Rural areas had significantly lower levels of education, but higher exposure to environmental education, more people in the household and limited outside employment. As previously mentioned, fewer women were interviewed in rural areas. The women interviewed overall were likely to be younger than the men, represent households with lower income and have less exposure to environmental education than men. These households were more likely to have a member with formal outside employment.[3]

Table 4-4. Significant relationships between independent variables used in regression analysis.

Socioeconomic Characteristic	Significant Correlates and Signs
RURAL	*FEMALE* (-), *EDUCAT* (-), *ENVIEDU* (+), *EMPLOY* (-), *HHSIZE* (+)
AGE	*FEMALE* (-), *EDUCAT* (-), *INCOME* (-)
FEMALE	*AGE* (-), *ENVIEDU* (-), *INCOME* (-), *EMPLOY* (+), *RURAL* (-)
EDUCAT	*INCOME* (+), *RURAL* (-)
ENVIEDU	*FEMALE* (-), *RURAL* (+)
INCOME	*FEMALE* (-)
EMPLOY	*TENURE* (-)
HHSIZE	*RURAL* (+)

Respondents with higher education also reported heading households with higher income. Those who owned land generally had less of a chance of having a member with fulltime employment, probably because landowners tend to work on the property either in ranching or a cottage industry. Years of formal education decreased in rural areas and for older people, but increased in higher income households. Most of these results suggest

[3] These surveys are ones in which the female head of house hold was available and willing to be interviewed and does not indicate the female is the only head of household.

that Santo Tomás is a typical rural community in a developing nation and highlight some of the real challenges to forest conservation. In addition, the fact that outside employment in rural areas is lower than in urban areas, creates a strong economic incentive to continue cattle ranching.

Respondents who preferred clearing forested lands for additional cattle pasture also tended to favor policies that would permit cutting timber for export and sale and hunting wild animals. This indicates a set of participants who strongly favor the exploitation of natural resources. Those who preferred clearing forested lands significantly differed from the average population in that they were primarily older.

Respondents who agreed with harvesting fuelwood for household use also tended to be those who agreed with harvesting timber for household use. These respondents varied significantly from the general population in several ways. They tended to be more urban and have received less environmental education. A possible explanation is that urban dwellers generally live farther from the fuelwood source and have to pay transportation costs and use public roads rather than footpaths. Woodfuel, therefore, has a greater monetary value for town residents than rural residents, and since road traffic is more susceptible to inspection and enforcement than foot traffic, urban dwellers might face heavier penalties if customary collection rights were regulated. The correlating lack of environmental education is more likely an effect of environmental education reaching the rural community via radio programs, rather than a relationship between environmental sensitivity and woodfuel use.

Regression Analysis

The goal of the regression analyses is to test the relationship between socioeconomic characteristics and the behavior and attitude of respondents. Two dependent variables were used to test these research questions: the household behavior index compiled from self-reported habitual household actions and the management preference index compiled of responses to forest management that can be interpreted as either sustainable (given the value of 1 or higher)[4] or not sustainable (given a value of 0). Independent variables used in both regression analyses were age, rural/urban, gender, household size, years of formal education, income level, outside employment, owning household property and having received environmental education.

Table 4-5. Unstandardized coefficient signs associated with socioeconomic variables when regressed against two dependent variables.

	Household behavior index			Management preference index		
Independent Variable	Predicted	Actual	Sig.	Predicted	Actual	Sig.
AGE	–	–		–	–	*
FEMALE	±	+		±	–	
EDUCATION	+	+		+	+	
ENVIEDU	±	+		+	+	
INCOME	+	+		+	+	
EMPLOY	±	–		±	+	
RURAL	–	–		±	–	**
TENURE	±	–		±	+	
HHSIZE	–	–	*	±	–	

* Significant at α = 0.1
** Significant at α = 0.05

The results of the regression analyses are illustrated in Table 4-5. All of the signs for the unstandardized coefficients were as expected. Household size was the only

[4] The weights of certain activities were manipulated higher than 1 to determine if weighting had a significant effect No significant effect was observed.

significant factor for the household behavior index (at α=0.1, p=.090), resulting in a final model with a very low adjusted[5] R^2 of 0.014:

Household behavior index = .862 - .011(HHSIZE)

The household behavior supported sustainable forest management more in smaller households. It is logical that larger households would inevitably impact the sustainability of forest use in Santo Tomás as they use more fuelwood for cooking[6] and ironing. Larger families also generally indicate more young children under less supervision who might engage in detrimental practices such as littering or hunting without obeying regulations.

The management preference index was used as the dependent variable for a regression analysis using the same independent variables as the household behavior index analysis. Given the strong correlations cited in the literature between ecological behavior and attitude (Ajzen 1988, Kaiser and Keller 2001) a similar model might be expected. Indeed, age was a significant independent variable (p=.062) accompanied by the rural location dummy variable (p=.033), rather than household size. The resulting final model with an adjusted R^2 of .210 is as follows:

Management preference index = .857 – .003(AGE) - .103(RURAL)

There are several reasons why households with younger decision makers might prefer more sustainable behavior. It has been documented in other parts of the Nicaraguan agricultural frontier that the pioneering or "conquer nature" spirit promoted

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[5] The adjusted R^2 accounts for the effects of multiple independent variables isolating the influence of only the significant variables and more accurately reflects the model fit than the unadjusted R^2.

[6] This survey found that 85% of all household use fuelwood for at least some of their cooking energy. Most heads of household commented that beans, if nothing else, were cooked over a wood fire. This is probably due to the time necessary to cook beans thoroughly and the relative cost of propane gas. Larger families would generally use more beans, a staple food throughout Nicaragua, and the use of fuelwood would be more prevalent.

in the 1950s and 19060s Green Revolution is more prevalent among older residents of the region (Nygren 2004a). The bivariate correlation between age and education also showed that older people in this sample group had a significantly lower number of years of formal education. In other areas of Central America, household surveys have shown that years of education have direct correlates to preservation of old growth forests and sustainable forest management within an agricultural setting (Godoy et al. 1998). This may be partially due to traditionalism complicated by a political polarization of conservation and sustainability issues in Nicaragua.[7] Household size may not be as influential since preference represents an ideal state without necessarily considering the realistic demands of a large family. The respondent's stated preference tended toward sustainable management with not only younger, but also urban heads of household.

The time-preference theory offers another possible explanation for why age is a factor in both household behavior and sustainable management preference. Time-preference describes the phenomenon of changing behavior based on an individual's age and relative capacity for enjoyment of goods now as compared to the future. Although it has long been held that older people have learned the importance of saving resources for the future, recent econometrics research indicates that tendency to save money is negatively correlated with age, suggesting that the probability of instant and loss of saved resources death steadily increases with age (Senesi 2003). Another study used empirical

[7] In Nicaragua, in particular, environmental education was first introduced by the Sandinista regime following the 1979 revolution creating a gap between those growing up pre- and post-revolution. Younger heads of household educated under the Sandinistas may have been exposed to conservation and sustainability values, but many older farmers were embittered by the collectivization of private lands and state control of agricultural prices (Nygren 2004a, Vilas 1989). Since forest conservation and sustainable management rhetoric are associated with the Sandinistas, older residents may still react against their adoption on principal. This challenge exacerbates the inherent difficulty of changing traditional farming practices.

evidence to propose that people perceive their ability to enjoy goods and services as decreasing with old age, and therefore they actually accelerate their use patterns as they age (Trostel and Taylor 2001).[8] Current time-preference theory offers an explanation why younger households seem to favor sustainable forest management more strongly than those households led by older decision-makers.

The previous discussion on rural vs. urban household concluded that rural people were less educated and poorer overall. For these reasons, rural respondents may be lower on the overall hierarchy of needs, still focusing on basic survival such as food and shelter. Even those who have accumulated enough wealth to not only survive, but also begin investing in the future may not be so far up on the hierarchy of needs that they would consider sustainability over immediate gain. This potential explanation has been supported by empirical studies in neighboring Río San Juan where the majority of rural household surveyed indicated that they would invest in expanding cattle operations if they had an increase in income (Faris 1999). Investing in cattle in considered a solid fiscal option in rural Nicaragua from a cultural (Guerrero and Soriano 1992) and realistic from a financial standpoint. In a country where wages have been frozen for five years while utilities have being privatized as part of the Highly Indebted Poor Country (HIPC) Debt Initiative (Mora 2004), it may be more rational for those already involved in agriculture to invest in cattle than in banks. Since trees are technically property of the state until a cumbersome management process is followed, it is unsurprising that rural households might express a preference for short-term rather than sustainable forest management, given the historical and current political economy of the region.

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[8] Trostel and Taylor (2001) also suggest that previous research showing opposite trends were biased because the studies excluded the infirm, an increasing percentage of the aging population.

CHAPTER 5
CONCLUSIONS

Several robust socioeconomic influences on self-reported household behavior and stated preference with respect to forest management and conservation in Santo Tomás, Chontales are indicated from the survey data analysis. These significant factors are synthesized in the following section followed by general policy implications suggested by the data. The many lessons learned through the process of administering surveys and focus groups, as well as developing indices are compiled here to assist those who might apply such research methods to address their own questions. In addition, although some questions were addressed during this process, many more were created. Directions for future research both in Nicaragua and on thematic questions are also suggested.

General Synthesis

The results of this study indicate that socioeconomic factors influence self-reported household behavior and stated sustainable forest management preferences in the context of forest conservation. Older respondents' overall management preference index decreased significantly away from sustainability and conservation. In particular, further analysis indicated that deforestation to convert land into additional cattle pastures was strongly favored by this group. As a policy, deforestation for cattle pasture was affiliated with the exploitation of timber (for profit) and hunting animals (for household use). Younger respondents, however, were those more inclined to prefer hunting. In addition, younger people were potentially driven by subsistence rather than profit motivation since

hunting was only for household consumption and was also significantly correlated with the number of people in the household.

Although rural areas had received overwhelmingly more environmental education than urban area (predominately via the radio), necessity and custom probably urged these households to state a preference for timber harvest for household use. These households typically had also lived in their current location longer, contributing to the adherence to traditional building materials. Factors related to tradition probably also contributed to rural people's preference for deforestation for additional cattle pasture. In addition, formal planning requirements of current forest policy[1] make deforestation a more rational economic choice for some rural residents. Figure 5-1 represents a synthesis of stated preferences organized by their significant socioeconomic independent variables.

The significance of age and strong correlation between several activities that impact conservation potential reveal a more complex situation. Young people may be likely prefer more sustainable forest management options because the limits of Nicaraguan forest resources are much clearer now than for previous generations, reflected conversely in the preferences indicated by older respondents. Younger people also grew up in a socio-political environment that endorsed sustainability and conservation of forests as a national heritage. On the other hand, they have higher education and are more employable, which may make them less dependent on and less connected to forests. Both implicit and explicit policies in Santo Tomás should consider these relationships for increased effectiveness.

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[1] See Chapter 1.

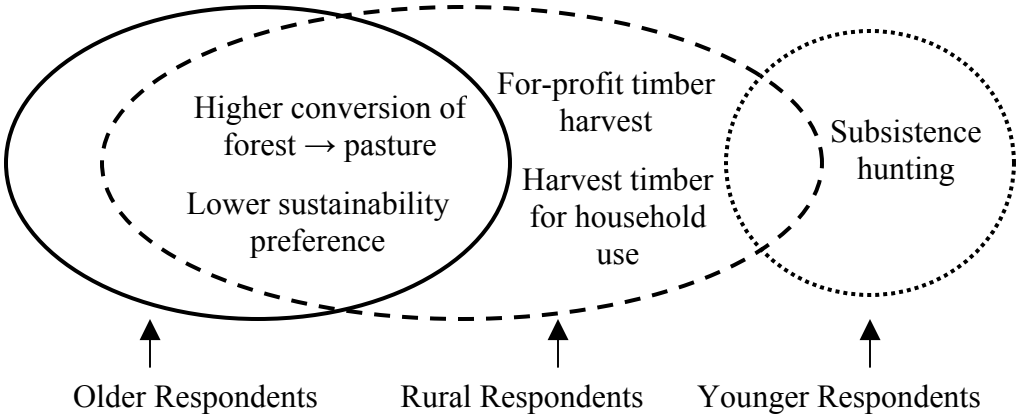

Figure 5-1. Significant relationships revealed by regression analysis and bivariate correlation can be synthesized into a single figure based on common links.

Research Findings

Data from this study demonstrate that certain policies might affect sustainable forest management in Santo Tomás. A strong relationship exists between increasing age and decreasing preference for sustainable forest management. Households with older decision makers also exhibit behavior less conducive to sustainability. This may be a product of the sociopolitical context surrounding the older people as compared to younger people in this area. The research suggests that increasing adult and rural education might alter the general tendency of older heads of household causing them to prefer and act of the preference for more sustainable management practices. Appropriate venues for adult education should be carefully considered since the average member of the population may not be initially predisposed to participating.[2]

Increasing household size was a significant factor in whether or not households behaved in a manner that supported sustainable forest management. These results imply

[2] See earlier discussion on older residents, especially cattle ranchers' prejudices against concepts introduced by the Sandinistas. This would likely include adult education and outreach in addition to environmental education. Technical assistance and agricultural extension may be more readily received.

that advocating family planning now could impact the way the average household behaves toward forest remnants in the next 10 to 20 years. Smaller households use less energy to cover basic needs and often can afford more education for children, and both of these factors are likely to increase sustainable forest use. Because larger households were also associated with increased hunting, family planning policies could benefit wildlife populations, as well.

Rural residents exhibited a much lower preference for sustainable forest management. Some of this reticence may be related to lower education levels in rural areas, suggesting that increase rural education, which has been shown to have positive effects on conservation elsewhere in Nicaragua (Godoy 1994), and might address some of the discrepancy between urban and rural preferences. Additionally, there may be a perceived disconnection between predominantly urban policy makers and enforcers and the rural families largely responsible for implementing sustainability measures. As discussed in the introductory chapter, the annual forest management plan requirement for forests and forest fragments on private land creates an undue burden on small-scale landowners. This is especially true for older, generally less educated farmers accustomed to managing their land without governmental interference. Enforcement authority delegated to municipal governments in unlikely to raise confidence in the rural farming community. Addressing the perverse effects of well-intentioned conservation laws may help bridge the gap between urban and rural residents, making sustainable forest management a more plausible possibility.

Comments on the Survey Questionnaire Tool

The survey questionnaire tool was an effective way to generate replicated information for quantitative results. One of the challenges implementing any study,

however, is the temporal factor: many of the confusing aspects of the survey were ironed out with practice, so the experience of the 99th interviewee was inevitably different than that of the 3rd respondent. Although analysis eliminated survey order as a statistically significant factor, it was still significant in a practical sense. In addition, weather and logistics played a defining role in initial site selection in rural areas. Some sites that would have remained accessible for a longer period of time quickly became unsafe to travel in an unusually rainy June. Finally, the structured questionnaire data would be strengthened by randomly conducted in-depth interviews with a few respondents, although care would have to be taken to avoid biases.[3] The data collected, however, were sufficiently robust to address the research questions.

Limitations to Self-Reported Behavior and Stated Preference Analyses

Focus group discussions indicated that many respondents probably under-reported actions that might be interpreted as deleterious toward the environment or illegal, such as harvesting fuelwood for sale. Self-reported behavior information is always limited by the respondent's honesty, understanding of the questionnaire and willingness to ask for clarification. More independent observational studies might have reduced this bias, but also would be better suited to a smaller community or more limited number of households. For example, a study observing people's actions while washing in the river or monitoring household fuelwood consumption might provide more detailed insight on household behavior, although there would still be a risk of influencing the data through the researcher's presence. Remote sensing data could also be used to correlate actual land

[3] While focus groups were used to check for biases in existing data, it is still likely that the sample was skewed toward a sub-sample of potential respondents who understood the process of conducting surveys, the concept of sustainable forest management and felt comfortable giving information to and discussing issues with a foreign researcher.

cover with stated preferences, eliminating the bias of the researcher's presence, but potentially increasing costs and time and skills needed for effective data analysis.

Stated preferences may have been influenced to some degree by the participant's desire to give an answer that was pleasing to the interviewer. Care was taken not to discuss conservation issues in advance of conducting the interviews and to maintain an interested indifference to responses throughout the process, but bias in inevitable.

Index Development

The greatest challenge to index development is selection of inputs since no index tool currently exists for addressing conservation issues in Santo Tomás. The stated management preference index seemed to be much tighter and conclusions generated by this data seemed to have more practical meaning than the household behavior index. This is probably due to many of the same weaknesses discussed in the self-reported behavior section. A checklist of observable qualities may have been more effective. Nonetheless, the process of creating the index offered an opportunity to explore the data in detail.

Directions for Future Study

Santo Tomás, Chontales represents a cultural and biophysical transition between Nicaragua's Atlantic and Pacific coasts and central mountain region (Incer 2000). Its geographical location and transect of geophysical zones make it likely that the network of forest remnants harbor a large percentage of the flora and fauna native to Nicaragua. A microcosm of the agricultural frontier in Latin America, Santo Tomás also offers opportunities to study economic and social aspects of natural resource limitations.

While the Pacific coast region has been well studied, little is known about the flora and fauna of the rapidly decreasing habitat of the lowland tropical rainforests. Taxonomic and ecological studies would increase understanding of these ecosystems and whether the

forest fragments in Santo Tomás and similar municipalities have a role as a refuge or corridor for endangered and threatened species. This might generate interest and funding for projects from conservation, ecotourism or agroforestry organizations. It would certainly strengthen any proposals made by the municipality or private organizations such as the cattle ranching cooperative for funding sustainable forest management initiatives.

These biological surveys should also tap into existing indigenous knowledge and markets for timber and non-timber forest products. Of the 155 species of trees respondents acknowledged on their land, most had household uses including, but not limited to timber, posts, fuelwood, fodder, food and medicinal purposes. Many cattle ranchers understand the benefit of on-farm trees and institutions should take care that this knowledge is conserved for future generations of farmers. Technical assistance and extension programs can capitalize on these traditions to illustrate the importance of sustainable forest management. While one cooperative in Santo Tomás sells natural remedies[4] made from predominantly forest products, a wider market is likely available. Market feasibility studies and cost benefit analysis of integrating non-timber forest products as a cash crop on farms and in home gardens would likely expand economic opportunities and the perceived value of forest fragments.

Economic assessments of various other aspects of sustainable forest management would also aid in reducing the perverse effects of existing forest policy. An economic assessment of the impact of current forest policy on the cost/benefit ratio for small-scale landholders would evaluate monetary value derived from forests vs. the cost of

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[4] The "Cooperativa Naturista" was located one and a half blocks north of the mayor's office at the time of this study. Initiated by a Finnish development agency, FINNADA, and supported with technical assistance by a syndicate based out of Managua, the cooperative sells locally collected and imported herbal remedies, honey and homemade wines and syrups.

implementing annual management plans. The results of such a study might demonstrate the need for change to policy makers.

An environmental economic analysis of tree products and environmental services of trees on farms on a watershed level would place a different perspective on the management of forest fragments in Santo Tomás. While forest conservation was listed as a matter of critical environmental importance by the municipality in the 2001 participatory rural survey, no government funds were appropriated to conservation activities or incentive programs based on the argument that not enough people would be affected (PEP 2001). The environmental economic analysis would demonstrate the services such as water conservation and erosion control provided by sustainably managed forest fragments and would likely provide a basis for allotting public funds to some of the policy initiatives outlined in the previous section.

For some of these policy initiatives to be successful, more extensive interviews should be conducted with older rural residents and wealthier landowners who appeared to be the most resistant to sustainable management practices. These interviews may elicit a wealth of information about effective outreach strategies and even traditional forest products. By investigating primary information from older residents, researchers may overcome some of the prejudices generated by the political conflicts of the last four decades. Anecdotal evidence about the expansion and contraction of the agricultural frontier in response to policies and armed conflict could be contrasted to remote sensing data from the region. This investigation might offer an interesting insight on the relationship between socioeconomic factors on a macro-level and sustainable forest management.

APPENDIX A
SURVEY OF THE SANTO TOMÁS MUNICIPALITY INHABITANTS ABOUT THEIR RELATIONSHIP WITH THE ENVIRONMENT

Note that currency has been converted to US dollars using the exchange rate of June 15, 2003 and measurements have been converted to the metric system.

Interview Date: __/____/_____
Barrio / Comarca: _____
Interview Number _____

I. General Information

1. Gender: ____F _____M Age _____ years

2. Education Level
   a. None _____
   b. Elementary School _____ grade
   c. High School _____ grade
   d. Technical Degree _____ years
   e. University Degree _____ years
   f. Other _____

3. Occupation _____

4. How many people live in this household at least 6 months/year? _____

   a. Among these, how many are children? _____
   b. Among these, how many contribute toward household expenses? _____

5. What is the average total monthly income of this household?
   a. Less than US$33 ____
   b. US$33 - $67 ____
   c. US$67 - $333 ____
   d. more than US$333 ____

6. Does someone in your household have outside employment?

   Yes ____
   No ____

7. This home is: owned, _____
   borrowed, or _____
   rented? _____

8. How long has your household lived here? _____ years

9. Does this household own another property (such as a house or farm)?
No: *Skip to question number 11*
Yes: a. Where? _____

b. How many hectares total?
Less than 0.7 ha ____
Between 0.7 – 14 ha ____
Between 14 – 35 ha ____
Between 35 – 70 ha ____
Between 70 – 350 ha ____
More than 350 ha ____

10. The following questions refer only to the property your household owns within the Santo Tomás municipality:

a. How many ha of land do you have within the Santo Tomas municipality?
Less than 0.7 ha ____
Between 0.7 – 14 ha ____
Between 14 – 35 ha ____
Between 35 – 70 ha ____
Between 70 – 350 ha ____
More than 350 ha ____

b. Of this land, how many ha are forested?

c. Of these, how many did you plant?

d. How long have you owned this or these properties? ____ years

e. How often do you visit this property? _____

f. How did you acquire this property:
agrarian reform, _____
inheritance, _____
purchase, or _____
another way? _____

11. What fuel does your household use to cook?

Source	**How much?**	**How often?**
Gas		
Fuelwood		
Agricultural Residue		
Charcoal		
Kerosene		
Other:		

12. If you use fuelwood, what types of wood do you use?

II: How do you use your environment?

A: Trees

1. What kinds of trees do you have on your property (for example, fuelwood, posts, thatch and other construction material, ornamental, medicinal, handicraft)?

_____

_____

_____

2. What do you use them for?

a. Nothing _____ Household use _____ Sale _____

b. If for sale: ¿How much do you sell, how often?

3. ¿Do you harvest fuelwood, wood, medicinal plants, or tree products from other people's land (either with or without permission)?

a. No __ Yes, for household use _____ Yes, for sale _____

b. If for sale: ¿how much do you sell, how often?

4. ¿How many hours does it take for you to arrive that the site where you harvest wood and other forest products?

B: Animals

1. ¿What types of wild animals have you seen on your property?

_____

_____

2. ¿Does your household hunt these kinds of animals? Yes __ No __
If no, skip to Section C. Water Resources.

a. How often?

b. What type of animal is hunted?

c. Why do you hunt?: food _____ sale _____ sport ___

d. Do you usually hunt on: your own land _____ others' land ___

e. How many hours does it take to get to the place where you hunt?

C. Water Resources

1. Does your household go to rivers, creeks, streams, or springs to wash clothes?
2. All seasons _____ Dry season only _____ No _____

3. When you go to the river, do you carry away plastic (such as detergent or soap bags) or do you throw them on the banks or in the river?
   Carry away _____ Throw on banks on in river _____

4. If your household has land, what water resources do you have?

5. Does your household harvest fuelwood along rivers, creeks, streams, or springs? Yes _____ No _____

III. Forest Area Management

With the following, you will tell me if you are in agreement (1, 2), not in agreement (4, 5), or have no opinion (3).

In the forests which remain in the municipality of Santo Tomás, it should be permitted to...					
Cut timber for household use.	1	2	3	4	5
Cut timber for sale.	1	2	3	4	5
Hunt wild animals.	1	2	3	4	5
Harvest fuelwood.	1	2	3	4	5
Deforest to plant new cattle pasture.	1	2	3	4	5
Explore for silver and gold.	1	2	3	4	5
Harvest non-timber forest products such as medicinal and ornamental plants or fruits.	1	2	3	4	5
Recreational activities such as fieldtrips, picnics, and hiking.	1	2	3	4	5
Conservation projects to protect soils and water quality.	1	2	3	4	5
Educational activities such as farmer trainings and student fieldtrips.	1	2	3	4	5
A multi-use management plan where farms are required to use only part of their land for cattle pasture and part in forest reserve.	1	2	3	4	5
Burning for cattle and agricultural production.	1	2	3	4	5

Have you ever received any kind of environmental education?

For example, from...
An international organization (Ex., FADES, Paz y Tercer Mundo, etc.) _____
The Nicaraguan government (Ex., INTA, police, mayor's office, at school) _____
Chatting with friends _____
Your church _____
The radio or television _____

APPENDIX B
ENCUESTA SOBRE LOS HABITANTES DEL MUNICIPIO DE SANTO TOMÁS Y SU RELACIÓN CON EL MEDIO AMBIENTE

Fecha de la Entrevista: _____/____/_____
Barrio / Comarca: _____
Numero de Entrevista _____

I. Datos Generales del Entrevistado

1. Sexo _____ F _____ M Edad _____ años

2. Nivel Académico
   a. Ninguno _____
   b. Primaria _____ grado
   c. Secundaria _____ año
   d. Técnico _____ año
   e. Universitario _____ año
   f. Otro _____

3. Actividad que realiza _____

4. ¿Cuántas personas viven en su casa por lo menos 6 meses del año? _____

   a. ¿Entre estas personas, cuantas son niños? _____

   b. ¿Entre estas personas, cuantas ayudan con los gastos de la casa? _____

5. ¿Cuánto es el ingreso promedio de su casa cada mes?
   a. Menos que C$500 ____
   b. C$500-C$1000 ____
   c. C$1000-C$5000 ____
   d. mas que C$5000 ____

6. ¿Alguien en su casa tiene empleo fuera de la casa?

   Sí ____
   No ____

7. ¿Esta vivienda es: propia, _____
   prestada, o _____
   alquilada? _____

8. ¿Cuánto tiempo ha vivido aquí? _____ Años

9. ¿Posee otra propiedad (como casa, finca, o terreno)?
No: *Pase a la pregunta numero 11*
Si: a. ¿Adonde? _____

b. ¿Cuántas manzanas tiene por total?
Menos que 1 manzana ____
Entre 1-20 manzanas ____
Entre 20-50 manzanas ____
Entre 50-100 manzanas ____
Entre 100-500 manzanas ____
Mas que 500 manzanas ____

10. Se pregunta lo siguiente solamente sobre las propiedades que tiene en Santo Tomas:
a. ¿Cuántas manzanas tiene dentro el municipio de Santo Tomas?
Menos que 1 manzana ____
Entre 1-20 manzanas ____
Entre 20-50 manzanas ____
Entre 50-100 manzanas ____
Entre 100-500 manzanas ____
Mas que 500 manzanas ____

b. ¿De este terreno, cuantas manzanas son bosque?

c. ¿De estas, cuantas sembró Usted?

d. ¿Por cuánto tiempo han sido dueños de esta(s) propiedad(es)? ____años

e. ¿Cada cuanto visita esta propiedad? _____

f. ¿Esta propiedad la consiguió por medio de: reforma agraria, _____
herencia, _____
compra, o _____
de otra manera? _____

11. ¿Qué usa en su casa para cocinar?

Fuente	**¿Cuánto?**	**¿Cada cuanto?**
Gas		
Leña		
Desecho Agrícolas		
Carboncito		
Queroseno		
Otra:		

12. ¿Cuáles tipos de árboles usan para leña?

II:¿Cómo usa el medio ambiente?

A: Árboles

1. ¿Qué variedad de árboles tiene en su propiedad (por ejemplo, leña, madera y otro material para la construcción, ornamentales, medicinales, frutales, artesanía)?

_____

_____

_____

2. ¿Para que lo utilicen?

a. Nada _____ Consumo Propio _____ Venta _____

b. Si se vende: ¿cuánto se vende, cada cuanto?

3. ¿Acostumbra a sacar leña, madera, plantas medicinales o productos de los árboles de terreno ajeno?

a. No __ Sí, para consumo propio _____ Sí, para venta _____

b. Si se vende: ¿cuánto se vende, cada cuanto?

4. ¿Cuántas horas requiere para llegar al sitio de donde saca la madera o otros productos del bosque?

B: Animales

1. ¿Qué variedad de animales silvestres tiene en su propiedad?

_____

_____

2. ¿Acostumbra a cazar este tipo de animales? Sí __ No __
Si no, pase a Sección C. Las Aguas.

a. ¿Cada cuanto?

b. ¿Qué tipo de animal caza?

c. ¿Porque caza: comida _____ venta _____ deporte _____

d. ¿Acostumbra a cazar en: terreno propio _____ ajeno _____

e. ¿Cuántas horas requiere para llegar al sitio de la caza?

C. Las Aguas

6. ¿Acostumbra ir a lavar a los ríos, quebradas, cañitos, criques u ojos de agua? Todo el Año _____ Solamente Verano _____ No _____

7. ¿Acostumbra recoger los desechos plásticos (como bolsas de ace o jabón) cuando salgan al río o los dejan botados?
   Se recoge _____ Se deja botado _____

8. ¿Si tiene terreno, qué fuentes de agua tiene en su terreno?

9. ¿Acostumbra recoger leña o cortar madera a la orilla de los ríos, quebradas, u ojos de agua? Sí _____ No _____

III. Manejo de áreas forestales

Con lo siguiente Usted me va a decir si esta de Acuerdo (1, 2), no está de acuerdo (4, 5), o si no tiene ninguna opinión (3).

En los bosques que hay todavía en el municipio de Santo Tomás, se debe realizar...					
Corte de madera para el uso propio.	1	2	3	4	5
Corte de madera para la exportación.	1	2	3	4	5
La cazaría de animales.	1	2	3	4	5
Recoger leña.	1	2	3	4	5
Despale de los bosques para sembrar nuevo pasto para la ganadería.	1	2	3	4	5
El busque de oro y plata.	1	2	3	4	5
Recoger productos del bosque no-maderables como plantas medicinales, ornamentales, y frutas.	1	2	3	4	5
Actividades recreativas como día de campo, paseo, picnic.	1	2	3	4	5
Proyectos para proteger los suelos y la calidad del agua.	1	2	3	4	5
Actividades educativas como capacitaciones para los finqueros, campesinos, y estudiantes.	1	2	3	4	5
Un plan de manejo donde los finqueros dejan una parte de su terreno para la ganadería y otra parte en bosques.	1	2	3	4	5
La quema de los potreros y terreno de siembras.	1	2	3	4	5

¿Usted ha recibido alguna orientación acerca de la conservación del medio ambiente?

Por ejemplo, departe de ...
Un organismo internacional (Ej., FADES, Paz y Tercer Mundo, etc.) _____
El Gobierno Nicaragüense (Ej., INTA, la policía, la alcaldía, en la escuela) _____
Platicando entre amigos _____
A través de su iglesia _____
Por medio de la radio o televisión _____

APPENDIX C
VARIETY OF TREES SELF-REPORTED ON FARMS IN SANTO TOMÁS, CHONTALES.

Common names of trees collected from interviews were matched to scientific names based on known distribution. This is not a vouchered list and should be cited with caution. Extensive botanical studies are recommended for this region.

Common Name	Scientific Name	Family	Source	Notes
Acacia	*Acacia pennatula*	Mimosaceae	4	
Acetuno	*Simarouba glauca*	Simaroubaceae	1	
Achote	*Bixa orellana*	Bixaceae	4	
Aguacate	*Persea americana*	Lauraceae	4	
Aguacate de Monte	*Persea coerulea*	Lauraceae	4	
Agüegüe/Espavel	*Anacardum excelsum*	Anacardiaceae	2	
Almendro	*Terminalia catappa*	Combretaceae	2	
Anona	*Annona purpurea*	Annonaceae	4	
Areno	*Homalium racemosum*	Flacourtiaceae	4	
Babayan	*Rehdera trinervis*	Verbenaceae	4	
Bálsamo	*Myroxylon balsamum*	Fabaceae	4	
Bambú Amarillo	*Babusa vulgaris*	Poaceae	2	
Barazón	*Hirtella americana* (?)	Chrysobalanaceae	4	
Cacao	*Theobroma cacao*	Sterculiaceae	4	
Café	*Coffea liberica*	Rubiaceae	4	
Caimito	*Chrysophyllum cainito*	Sapotaceae	2	
Camibar	*Copaifera aromatica*	Caesalpiniaceae	4	
Canela				
Canelo Amarillo	*Arbutus xalapensis* (or below)	Ericaceae	4	
Canelo Negro/Quinina	*Nectandra reticulata* (or above)	Lauraceae	4	
Caña agria	N/A			
Caoba del Atlantico	*Swietenia macrophylla*	Meliaceae	1	D
Caoba del Pacifico	*Swietenia humilis*	Meliaceae	1	D

Common Name	Scientific Name	Family	Source	Notes
Capirote	*Miconia podecandra*	Melastomataceae	3	
Capulín	*Muntingia calabura*	Elaeocarpaceae	3	
Caraño	*Bursera graveolens*	Burseraceae	4	
Carao/Caról	*Cassia grandis*	Caesalpinaceae	1	
Castaño	*Artocarpus heterophyllus*	Moraceae	4	
Cedro Macho	*Carapa nicaraguensis*	Meliaceae	4	C
Cedro Real	*Cedrela odorata*	Meliaceae	1	D
Ceiba	*Ceiba pentandra*	Bombacaceae	1	
Cerito	*Casearia corymbosa*	Flacourtiaceae	4	E
Ciprés	*Cupressus lisitanica*	Cupressaceae	1	
Coco	*Coco nucifera*	Arecaceae	4	
Coloradito	*Cnestidium rudescens*	Connaraceae	4	
Cordoncillo	*Piper tuberculatum*	Piperaceae	4	
Cornizuelo	*Acacia collinsii*	Mimosaceae	4	
Corozo	N/A			
Corroncha de Lagarto	*Farmea occidentalis*	Rubiaceae	4	
Cortéz Amarillo	*Tabebuia chrysantha*	Bignoniaceae	2	
Coyol	*Acrocomia vinifera*	Arecaceae	4	
Coyolito	*Bactris balanoides*	Arecaceae	4	
Coyote	*Plartmiscium pleiostachyum*	Fabaceae	4	
Cuarsa	N/A			
Chaguite	N/A			
Chaperno	*Lonchocardus* sp.	Fabaceae	4	
Chicharrón Blanco	*Rehdera trinervis*	Verbenaceae	4	
Chilamate	*Ficus* sp.	Moraceae	4	
Chiquirín	*Myrosperma frutescens*	Fabaceae	4	
Ébano	N/A			
Escoba Lucia	N/A			
Escobillo	*Myrciaria floribunda* or *Phyllostylon brasiliensis*	Myrtaceae/Lilmaceae	4	
Espadillo	*Yucca elephantipes*	Agavaceae	4	
Eucalypto	*Eucalyptus camaldulensis*	Myrtaceae	1	
Flor de Avispa	*Hibiscus rosa-sinensis*	Malvaceae	4	

Common Name	Scientific Name	Family	Source	Notes
Flor de Jamaica	N/A			
Genízaro	*Pithecolobium saman*	Mimosaceae	1/2	
Granadillo	*Dalbergia tucurensis*	Fabaceae	4	
Guaba (con vainas)	*Inga* sp.	Mimosaceae	4	
Guaba blanca	*Inga* sp.	Mimosaceae	4	
Guaba cuadrada	*Inga sapinoides*	Mimosaceae	4	
Guaba pachona	*Inga tonduzii*	Mimosaceae	4	
Guaba rellera	*Inga* sp.	Mimosaceae	4	
Guabo	*Inga vera*	Mimosaceae	1	
Guácimo de Ternero	*Guazuma ulmifolia*	Sterculiaceae	1	
Guácimo Molenillo	*Luehea candida*	Titliaceae	4	
Guanábana	*Annona muricata*	Annonaceae	4	
Guanacaste de Oreja	*Enterolobium cyclocarpum*	Mimosaceae	1	
Guapinol	*Hymenaea courbaril*	Caesalpinaceae	1	
Guarumo	*Cecropia insignis*		3	
Guayaba	*Psidium sp.*	Myrtaceae	4	
Guís Coyol	N/A			
Guyabón	*Terminalia oblonga*	Combretaceae	4	
Higualtíl	*Genipa cartuto*	Rubiaceae	2	
Hoja Chigue	*Curtella americana/Petrela volubilis*	Dilleniaceae/Verbenaceae	4	
Hoja Tostada	*Licania arborea*	Chrysobalanaceae	2	
Hombre Grande	*Quassia amara*	Simaroubaceae	4	
Huevo de Burro/Cachito	*Stemmadenia donnel-smithii*	Apocynaceae	4	
Jicaro de Cumba	N/A			
Jicaro Grande	*Cersentia* sp.	Bignoniaceae	4	
Jicaro Sabanero	*Cresentia alata*	Bignoniaceae	2	
Jiñocuabo/Indio Desnudo	*Bursera simaruba*	Burseraceae	1	
Jobo Lagarto	*Sciadodendron excelsum*	Araliaceae	4	
Jocote	*Spondias* sp.	Anacardiaceae	4	
Jocote Sabanero/Inviernero	*Spondias purpura*	Anacardiaceae	4	
Kerosén	*Tetragastrius panamensis*	Burseraceae	4	

Common Name	Scientific Name	Family	Source	Notes
Laurel	*Cordia alliodora*	Boraginaceae	1	
Laurel del Indio	*Ficus* sp.	Moraceae	4	
Limón Agrio/de castillo	*Citrus aurantifolia*	Rutaceae	4	
Limón Dulce	N/A			
Limón Mandarina	N/A			
Limonaria	*Murraya paniculata*	Rutaceae	4	
Madero Negro	*Gliricidia sepium*	Fabaceae	1	
Madroño	*Calycophyllum candidissumum*	Rubiaceae	1	
Majagua	N/A	Malvaceae	4	
Malinche	*Delonix regia*	Caesalpiniaceae	2	
Mamón	*Melicoccus bijugatus*	Sapindaceae	4	
Manchón	N/A			
Manchón Cola de Pava	N/A			
Mandarina	*Citrus nobilis*	Rutaceae	4	A
Manga larga colorada	*Xylopia aromatica*	Annonaceae	4	
Mango	*Magifera indica*	Anacardiaceae	4	
Manzanita	*Ximenia americana*	Olacaceae	4	
Marañón	*Anacardium occidentale*	Anacardiaceae	4	
Matapalo	*Ficus obtusifolia*	*Clusiaceae*	4	E
Matorral	N/A			
Morán	*Chlorophora tinctoria*	Moraceae	2	
Morisca	*Cordia sp./Croton xalapensis*	Boraginaceae/Euphorbiaceae	4	
Muñeco	N/A			
Nancite Agrio	*Byrsonima crassifola*	Ebanaceae	2	
Nancite Dulce	N/A			
Nancitón	*Hyeronima alchomeoides*	Euphorbiaceae	1	
Naranjo Agrio	*Citrus vulgaris*	Rutaceae	3	
Naranjo Dulce	*Citrus sinensis*	Rutaceae	2	
Nispero/Chicle	*Manilkara achras*	Sapotaceae	4	B, E
Ñámbar	*Dalbergia retusa*	Fabaceae	4	
Ocote	*Pinus oocarpa*	Pinaceae	1	C
Ojoche	*Brosumum alicastrum*	Moraceae	1	

Common Name	Scientific Name	Family	Source	Notes
Palanco	*Saptanthus nicaraguense*	Annonaceae	4	
Palo de Agua	*Vochysia hondurensis*	Vochysiaceae	1	
Palo de Arco	*Apoplanesia paniculata*	Fabaceae	4	
Palo de Chocoyo	N/A			
Palo de Hule	*Castilla elastica*	Moraceae	4	E
Palo de Piedra	*Minquartia guianensis*	Olacaceae	4	C
Palo de Plomo/ Desposado/ Huevo de Burro	*Zuelania guidonia*	Flacourtiaceae	4	
Panchíl	*Daphnopsis seibertii*	Thymelaeaceae	4	
Papaya	*Carica papaya*	Caricaceae	4	
Peine Mico	*Apeiba tibourbou*	Tiliaceae	4	
Pera	N/A			
Pijivay	*Bactris gasipaes*	Arecaceae	4	
Pino	*Pinus patula var. tecunnumanii*	Pinaceae	1	
Pipilacha	N/A			
Pochote	*Bombacopsis quinata*	Bombacaceae	1	D
Quebracho	*Pithecellobium arboreum*	Mimosaceae	1/2	
Quelite	*Cnidoscolus aconitifolius*	Euphorbaceae	4	
Quitacalzón	*Astronium graveolens*	Anacardiaceae	4	
Roble	*Tabebuia rosea*	Bignoniaceae	1	
Roble Negro	*Quercus* sp.	Fagaceae	4	
Sancuajoche	*Plumeria rubra*	Apocynaceae	4	
Sangregrado	*Pterocarpus rohrii*	Fabaceae	4	
Sotacaballo/Manglar	*Pothecellobium longifolium*	Mimosaceae	4	
Tamarindo	*Parkinsonia aculeata*	Caesalpinaceae	1	
Tatascame	*Lacistema aggregatum*	Asteraceae	4	
Tempisque	*Mastichodendron capiri var. Tempisque*	Sapotaceae	1	
Toronja/Grapefruit/Naranjgela	*Citrus paradisi*	Rutaceae	4	
Tuno	*Castilla tuno*	Moraceae	4	
Uña de gato	*Marchaerium biovalatum/M. marginatum*	Fabaceae	4	
Varilla Negra	N/A			

Common Name	Scientific Name	Family	Source	Notes
Vivorilla	N/A			C
Yema de Huevo	*Morinda panamensis*	Rubiaceae	4	
Zapote	*Pouteria sp.*	Sapotaceae	4	
Zapotillo	*Pouteria sapota*	Sapotaceae	4	
Zopilote	*Vochysia ferruginea*	Vochysiaceae	1	
Zoroncontíl	N/A			
Zorro	*Zanthoxylum panamensis*	Rutaceae	4	

Sources:
1 MARENA 2003
2 Observations made at Zoológico de Chontales "Thomas Belt"
3 Observations made a Paz y Tercer Mundo, Tierra Blanca comarca, Santo Tomás.
4 Salas Estrada 1993

Notes:
A = One of the few citruses remaining in Santo Tomás after the citrus blight
B = Locally extinct in La Libertad and Santo Domingo because used to hold up mine tunnels
C = Trees which will not regenerate once primary forest is cut
D = Precious woods valued for timber
E = Known to be limited to the Atlantic region

APPENDIX D
ON-FARM TREE DIVERSITY

Another way to judge the effectiveness of conservation policy is through on-farm tree diversity. Tree diversity is closely linked to biodiversity in general (Kelly and Bowler 2002), and this species richness also leads to increased ecosystem productivity (Vila et al. 2003). Diversity of woody tree species has been correlated with abiotic factors such as rainfall, soil fertility, latitude, altitude, seasonality and catastrophic events (Givnish 1999), as well as human disturbances (Bhuyan et al. 2003, Gillespie et al. 2000). The decision to grow trees on private land, and which trees and how many, is a personal decision made by individual landowners in this area. As such, household socioeconomic variables might be a deciding factor.

Because no vouchered specimens were collected, caution has been used applying this data. Regional names appeared to be assigned to the same tree in some cases (e.g., *chicle* and *nispero* both referred to *Manilkara achras* and *agüegüe* and *espavel* both referred to *Anacardium excelsum*, Salas Estrada 1993). Therefore, rather than calculating species richness or diversity indices, the number of different species on individual farms was used as the dependent variable (see Ramirez Marcial et al. 2001 and Lopéz Portillo and Ezcurra 1989 for similar treatment of data). In this way tree diversity is used as an additional indicator for a society's orientation toward forest conservation and analyzed for significant socioeconomic influences.

Of those interviewed, a total of 45 respondents reported to own farms in the Santo Tomás municipality. The descriptive statistics of the sub-sample compare favorably to the general population statistics of the entire study. While the actual population of Santo Tomás is 51.5% women and 49.5% men (PEP 2001), this subset of interviews included 42% women and 58% men, while the overall survey was comprised of 40% women and 60% men. The average age and educational level of this interviewed subset was exactly the same as those for the entire survey. This comparison indicates that the answers for the farm owning subset were as reliable and representative as the entire survey. Focus group meetings held with local institutions after the results were tabulated indicated that the survey results generally reflected the population overall.

Table D-1. Independent variables and their expected and actual effect on tree diversity.

Independent Variable	Expected	Actual	Significant
AGE	±	+	
FEMALE	±	–	
EDUCATION	+	+	
INCOME	+	+	**
EMPLOY	±	+	**
TENURE	+	–	
HHSIZE	–	+	

** Significant at α = .05.

Independent variables for the purposes of this regression analysis were: age, gender, household size, education and income levels, outside employment and owning household property. After insignificant variables were removed listwise, an equation with tree diversity as the dependent variable and income and outside employment as independent variables was derived:

Tree Diversity = 12.54 + 7.88(INCOME) + 16.12(EMPLOY)

This indicates that households with a higher income and outside employment are more likely to choose to maintain a higher diversity of trees on their farms. Maslow's

hierarchy of needs offers one possible explanation for this phenomenon. Once farmers have satisfied their basic needs, they can afford to look to the future with conservation indicators.

APPENDIX E
DESCRIPTIVE STATISTICS FROM QUESTIONNAIRE DATA

	N	Minimum	Maximum	Mean	Standard Deviation
Rural	100	0	1	.50	.503
Barrio (Urban Neighborhood)					
Bella Vista	100	0	1	.03	.171
Héroes y Mártires	100	0	1	.03	.171
Jaime López	100	0	1	.03	.171
Pablo Úbeda	100	0	1	.03	.171
Pancasán	100	0	1	.05	.219
Reinaldo Jirón	100	0	1	.03	.171
San José	100	0	1	.07	.256
Sandino	100	0	1	.09	.288
Santiago	100	0	1	.07	.256
Javier Guerra	100	0	1	.07	.256
Comarca (Rural District)					
Oropéndola	100	0	1	.09	.288
Mollejones	100	0	1	.05	.219
Las Mesas	100	0	1	.03	.171
El Zapotal	100	0	1	.04	.197
El Jicarito	100	0	1	.10	.302
Cerca de la carretera	100	0	1	.06	.239
El Zurrón	100	0	1	.05	.219
Tierra Blanca	100	0	1	.05	.219
El Alto	100	0	1	.03	.171
Location					
Year-round access to urban center	100	0	1	.77	.423
Cost of travel to town	100	$0	$118	$28.42	$37.476
Socioeconomic characteristics of respondent					
Female	100	0	1	.60	.492
Age	100	18	82	41.13	14.920
Years of Formal Education	100	0	16	4.76	4.699
Farmer	100	0	1	.29	.456

	N	Minimum	Maximum	Mean	Standard Deviation
Merchant	100	0	1	.15	.359
Housewife	100	0	1	.40	.492
Journeyman	100	0	1	.13	.338
Day laborer	100	0	1	.04	.197
Student	100	0	1	.09	.288
Socioeconomic characteristics of the household					
People in Household	100	1	14	5.96	2.741
# Children	100	0	9	2.59	2.060
# People assisting with expenses	100	1	8	2.34	1.689
Household income (continuous)	53	$200	$7,200	$1,480.38	$1,325.749
Household income (categorical)	96	0	3	1.06	.949
Member of household with outside employment	100	0	1	.43	.498
Own house	100	0	1	.83	.378
Time in current location	100	0	76	18.28	14.931
Own land	100	0	1	.46	.501
Inherited land	99	0	1	.29	.457
Monthly cost of fuelwood (C$)	94	$0	$1,125	$216.32	$230.755
Percent cooking energy supplied by fuelwood	98	0	100	67.78	40.792
ornament	100	0	1	.18	.386
Trees present on property					
Fruit	100	0	1	.95	.219
Hardwood	100	0	1	.54	.501
Tree Product Use					
Household consumption	100	0	1	.85	.359
Sale	100	0	1	.08	.273

	N	Minimum	Maximum	Mean	Standard Deviation
Collected property owned by others	100	0	1	.21	.409
Animals seen on property					
Common to human settlements	100	0	1	.88	.327
Wild	100	0	1	.38	.488
Household behavior					
Hunting	100	0	1	.15	.359
Occasionally wash in river	100	0	1	.73	.446
Always wash in river	100	0	1	.39	.490
Throw trash in river	99	0	1	.29	.457
Harvest fuelwood near river	100	0	1	.23	.423
Environmental Education					
Received via any venue	100	0	1	.82	.386
NGO	100	0	1	.19	.394
Government (school or agency)	100	0	1	.31	.465
Radio or Television	100	0	1	.70	.461
Word-of-mouth	100	0	1	.25	.435
Church	100	0	1	.25	.435
Preferences (Do you agree the following should be permitted in the forests that remain in the Santo Tomás municipality?)					
Harvest timber for household	100	1	3	1.63	.928
Harvest timber for sale	100	1	3	2.82	.575
Hunt wild animals	100	1	3	2.45	.880
Harvest fuelwood for household use	100	1	3	1.29	.701
Deforest to	100	1	3	2.41	.911

	N	Minimum	Maximum	Mean	Standard Deviation
expand cattle ranching					
Exploit gold and silver	100	1	3	1.75	.869
Harvest NTFPs	100	1	3	1.20	.569
Recreational activities	100	1	3	1.18	.575
Conservation projects	100	1	1	1.00	.000
Educational activities	100	1	1	1.00	.000
Mandatory forest reserves	100	1	3	1.05	.261
Permit burning for agriculture	53	1	3	2.42	.908

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BIOGRAPHICAL SKETCH

Jensen Reitz Montambault was born in 1976 and raised near Charlottesville, Virginia. She graduated from the University of Virginia in 1995 with degrees in environmental science and English literature and composition. As a U.S. Peace Corps volunteer from 1996-1998, Jensen served as a community environmental promoter in the town of Santo Tomás, Chontales. Returning to the U.S., Jensen worked for non-profit organizations in Washington D.C., including the National Fish and Wildlife Foundation and Conservation International where she managed Rapid Assessment Program scientific expeditions to Latin America and Africa. In 2002, she started the master's/PhD program in interdisciplinary ecology at the University of Florida; first as a Tropical Conservation and Development Fellow and currently as a National Science Foundation Graduate Research Fellow.