
Project Head:

Dr. Kymberley A Snarr  
Environmental Anthropologist  
Laurentian University, Barrie Campus  
ksnarr@laurentian.ca

Director of Conservation and Research  
Canadian Organization for Tropical Education and Rainforest Conservation  
http://coterc.org

Contributors:

Luc Boileau, Laurentian University, Sudbury Campus  
Laura Broadley, Laurentian University, Sudbury Campus  
Mitch Harrow, Laurentian University, Barrie campus  
Amber Heckelman, Washington State University  
Erica Johnston, Laurentian University, Barrie campus  
Katherine Main, Laurentian University, Sudbury Campus  
Jamie Simmons, Laurentian University, Barrie campus  
Amelia Smandych, University of Manitoba  
Katelyn Weel, Lakehead University

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All findings and recommendations in this report are expressly those of the researcher’s involved and not of any institution or organization involved in this specific project. Research protocol and methods reviewed and approved by COTERC.
EXECUTIVE SUMMARY

This study focuses mainly on the state of natural resource management concerning the species of palm *Manicaria saccifera* in the Tortuguero region. It attempts to represent the voices and opinions of local community members, for whom the use of *Manicaria saccifera* for thatching purposes is a long-standing tradition. In order to provide a more holistic and multi-faceted point-of-view, an applied environmental anthropological approach which combines both biological and sociocultural perspectives is used.

There are many factors affecting the health and sustainability of *Manicaria saccifera*. This palm species has a very specific habitat as it thrives only in poorly drained soils in lowlands and depressions. Since *Manicaria saccifera* only grows in these swampy areas, the destruction of this habitat by commercial and agricultural drainage impacts the population negatively. The main threat to the *Manicaria saccifera* seems to be the creation of plantations. Plantations, the most common being banana plantations, are created by drying and clearing land using slash and burn style techniques that clear large tracts of forests and drain wetlands. A permit system was put in place by MINAET in 1992 to control the use of natural resources, but it does not address large-scale threats such as agricultural development and habitat destruction. There is a long history of palm-thatched roofing in the Tortuguero area due to its resistance to the corrosive effects of the salty ocean air and the accessibility of the palm fronds. The leaves or fronds of the *Manicaria saccifera* are especially prized for their large size and suitability for thatching. However, there has been a recent change in attitude toward using palm fronds for thatching. This change has been attributed to health and safety issues; advantages of other roofing materials; difficulty in procuring the palm leaves; a shift in knowledge involving the harvesting and thatching process; and lastly the permit system which restricts the harvesting of the palm. This research indicated that the two most prominent reasons for decline were found to be the loss of knowledge of how to harvest and thatch and the implementation of MINAET’s permit system. As knowledge of thatching is passed down through both observation and participation, and as less people are thatching, the knowledge is being lost. The permit system, as per Law 7317, regulates the appropriation and trade of natural resources within Costa Rica and ensures that any extraction is done in a sustainable way. This is arguably the main reason for the declining usage of *Manicaria saccifera* for thatching as applicants must provide proof of ownership or right of possession of the property where the palm will be harvested and the majority of people in the Tortuguero region, particularly the former squatter’s settlement of San Francisco, do not have such legal documentation.

This study indicates an increase in *Manicaria saccifera* density in the Tortuguero region occurred over the 30 years. Currently there is a healthy density that could be harvested sustainably if done properly. Local communities are well aware of the manner in which palm should be harvested for it to regenerate. The permit system seems to provide an effective degree of monitoring and prevents commercial exploitation of the palm, but it also succeeds in restricting the use of this sustainable resource by the local people who live in these lowland areas where *Manicaria saccifera* is plentiful. This system does not serve the needs of the people and creates an imbalance between conservation efforts and the quality of life for locals. The favouring of manufactured goods over natural resources and the economic benefits the Costa Rican government enjoys through the creation of plantations and commercial agriculture is a real danger to its natural ecology, including *Manicaria saccifera*. 
ABBREVIATIONS

ACTo - Area de Conservación Tortuguero
BCWR - Barra del Colorado Wildlife Refuge
COTERC - Canadian Organization for Tropical Education and Rainforest Conservation
CPBS - Caño Palma Biological Station
DBH - Diameter at Breast Height
GPS – Global Positioning System
MINAET - Ministerio del Ambiente, Energia y Telecomunicaciones
SINAC - Sistema Nacional de Areas de Conservación
STC - Sea Turtle Conservancy
ACKNOWLEDGEMENTS

This report could not have been completed without the help and contributions of many. First and foremost, thanks to Juan Zuloaga, York International Intern Summer 2010, for being engaged in the interviews while simultaneously translating. Juan showed extraordinary leadership during the focus group, as well as garnered the respect and trust of the community through exhibiting genuine humility, compassion, and sensitivity when interacting with community members. Essentially, Juan helped to be both our voice and bridge to the community and proved to be incredibly effective at both. We have many thanks to Mario Garcia for his insight and guidance, as well as his willingness to lead and translate interviews with key informants. His deep knowledge of the community and of Manicaria sacciﬁera helped to develop a framework in which to carry out our research. Thank you also to Carla Acosta and Andres Vargas for your time, effort, and assistance with translations. A special thank you goes out to the Canadian Organization for Tropical Education and Rainforest Conservation [COTERC] for allowing our research team to utilize the Caño Palma Biological Station. Finally, we wish to express our deepest gratitude to the San Francisco community for answering all of our questions, inviting us into your homes, and allowing us to conduct research in your community.

PREFACE

This report will be delivered to three organizations: the Canadian Organization for Tropical Education and Rainforest Conservation (COTERC), the Area de Conservación Tortuguero (ACTo), and the Ministerio del Ambiente, Energia y Telecomunicaciones (MINAET).

COTERC (n.d.) was founded in 1991 and is a registered Canadian non-proﬁt charitable organization that is committed and working actively to protect tropical rainforests in Costa Rica. COTERC operates in both Canada and Costa Rica. The Board of Directors operate out of Canada and are comprised of anthropologists, biologists, accountants, educators, environmentalists, zoo professionals, and media professionals. In Costa Rica, COTERC is based at the Cano Palma Biological Station located in the Tortuguero region. COTERC’s (n.d.) mission is to provide “leadership in education, research and conservation and the educated use of natural resources in the tropics”.

ACTo (n.d.) is the regional office of Sistema Nacional de Areas de Conservación (SINAC). SINAC is a branch of MINAET that is in charge of three main environmental issues: Forest State Administration, Protected Areas, and Wildlife Management. ACTo serves as a territorial and administrative unit that regulates private and state development activities in Guacimo, Pococi, and Sarapiquí. These territories together make up 355.375 hectares and a population of 150,000 inhabitants (ACTo, n.d.). Tortuguero National Park, Barra del Colorado
National Wildlife Refuge, Acuiferos Guacimo – Pococi Protected Zone, Archie Carr Private Wildlife Refuge, and Tortuguero Protected Zone are the most important protected areas that ACTo oversees. ACTo’s (n.d.) vision is to develop “a sustainable program of management and conservation of the natural resources in order to improve the quality of life” for inhabitants.

MINAET (n.d.) oversees all matters concerning the environment, energy and telecommunications in Costa Rica. MINAET utilizes and coordinates several public organizations to generate and implement policies, strategies and actions that fulfill national and international objectives. The overall mission of MINAET (n.d.) is to “contribute to the improvement of the quality of life of the inhabitants of the country by means of the promotion of the handling, conservation and sustainable development of the elements, goods, services, and environmental and natural resources of the country”. Moreover, MINAET’s (n.d.) vision is to establish a system of environmental management that puts Costa Rica in a position of “international competitiveness (political, environmental and commercial), and that simultaneously responds to the requirements of the handling, conservation and sustainable use of the environmental and natural resources”. Essentially, MINAET aims to create and maintain “total harmony” between development activities and conservation efforts.
INTRODUCTION

As countries and regions around the world continue to experience environmental degradation and natural resource depletion, it is becoming increasingly important for researchers, anthropologists, scientists, environmental organizations, and governments to engage in efforts that mitigate this destruction by managing natural resources and protecting ecosystems. Although well intentioned, it is becoming widely recognized that many natural resource management and conservation programs are either ineffective or have negative implications on local inhabitants. The tension that arose after the establishment of the National Park System in Costa Rica is a prime example how conservation efforts have consequences on local communities. In this instance, villages and communities who have relied heavily on flora and fauna within the forests, were restricted from extracting anything from forests that fell within the seven National Parks. Such environmental restrictions put many people and entire communities into a dire state, leaving them with little to no options for survival. Certainly there is a need for conservation and natural resource management, but there is also a need to develop programs that are both effective at maintaining healthy ecosystems and ensuring the wellbeing of respective communities. Such a need is recognized and supported by COTERC, ACTo, and MINAET. Ticktin (2004) also recognized the complexity and interdisciplinary nature of conservation and resource management: “ecology of any resource used by humans cannot be considered in isolation from political, socio-economic and cultural factors, and indeed is intricately linked to them”. Moreover, research has shown that even if a species is protected, harvesting will often occur illegally in an unsustainable fashion, hence it is often better to find ways to establish regulations that work with both people and the environment (McKean, 2003). With all of these challenges in mind, this report aims to contribute to the efforts being made to improve current conservation and natural resource management programs.

The main purpose and focus of this study is to analyze and evaluate the state of natural resource management concerning *Manicaria saccifera* in the Tortuguero region. To do this a combination of biological and sociocultural research methods were used and synthesized to provide insight into the biological and social dynamics impacting the palm and its future sustainability from a holistic applied environmental anthropological perspective. As stated above, Ticktin (2004) highlighted the dangers in isolating ecological issues from political, socio-economic, and cultural factors stressing the intricate link between these fields. This study, with this concept in mind, will attempt to combine the data collected from each research method to glean a complete understanding of the state of the *Manicaria saccifera* and its changing role in the local community.

There are several key areas of interest in this project including:

1. The health of the species via density and threat assessments using quantitative and comparative methods such as transecting.
2. The effects of government legislation and enforcement of conservation policies with a
focus on the current permit system and legal status of the village of San Francisco.

3. The influence of social and economic forces, including immigration, accessibility of alternative materials for roofing such as plastic and tin, the impact of a burgeoning tourism industry, etc.

4. The implications that such changes have for the sustainability of the *Manicaria saccifera*, and for the future of the thatching tradition in the area, as well as the implications that a growing conservation mentality favouring manufactured goods over natural resources will have on the local environment and on Costa Rica as a whole.

**BACKGROUND TO THE STUDY**

In order to assess the natural resource management of the *Manicaria saccifera* it was necessary to establish two research teams. The biological team examined the health of the *Manicaria saccifera* by measuring its density and contributed to formulating appropriate questions related to ecology and sustainability. The socio-cultural team explored the local use and harvesting practices of the *Manicaria saccifera*, as well as all other socio-cultural dynamics that affected this particular palm. Although each team carried out their research objectives separately, the findings were combined in this report as part of the holistic applied environmental anthropological approach.

The biological research portion of this study was conducted at the southernmost tip of the Barra del Colorado Wildlife Refuge. The socio-cultural research was primarily conducted in the same region, and mainly within and around San Francisco, a small village which lies adjacent to Barra del Colorado Wildlife Refuge (BCWR) and falls within the corridor between BCWR and Tortuguero National Park (see Figure 1 below). The BCWR was established in 1985 and is made up of 92,000 ha consisting of several habitats including lowland tropical rainforests, beaches, blackwater canals, wetlands, and lagoons (Tortuguero Information, n.d.). Tortuguero National Park was established in 1970, largely due to the efforts of biologist Archie Carr and the Caribbean Conservation Corporation (Tortuguero Information, n.d.). The park is comprised of 19,000 ha with 11 ecological habitats, such as high rainforest, herbaceous marsh communities, low alluvial floodplains, volcanic hills, creeks, palm swamps, beaches, mixed rainforest, and blackwater canals (World Headquarters, 2007). As stated in Kricher (1999:17), a blackwater canal drains “geologically ancient soils ... depleted of minerals”, and are dark due to dissolved organics. According to COTERC (2010), Tortuguero region is an ancient flood plain with a rainfall exceeding 6,000 mm annually and an average daily temperature of 26 degrees Celsius. This area is aseasonal (Myers, 1981) and is considered among the most biologically diverse regions in the country (Koens et al., 2009; World Headquarters, 2007).
There are two organizations conducting research, engaging in conservation efforts, and facilitating environmental awareness in the region – the Canadian Organization for Tropical Education and Rainforest Conservation (COTERC) and Sea Turtle Conservancy (STC, formerly the Caribbean Conservation Corporation). COTERC had managed Caño Palma Biological Station (CPBS) since 1992, providing infrastructure for researchers, and baseline data to aid in conservation management decisions. CPBS lies at the southern tip of Barra del Colorado Wildlife Refuge, and close to the corridor between Barra del Colorado Wildlife Refuge and Tortuguero National Park. CPBS has developed a relationship with the San Francisco community and meets regularly with residents to address concerns, interests, and other matters. Moreover, the station was utilized by the researchers for the fieldwork portion of this study. The
STC (n.d.) is located within the town of Tortuguero and is the world’s oldest sea turtle research and conservation group.

Lefever (1992) provides an excellent historical overview of the flow and fluctuation of both migrants and immigrants in the region, as well as their use of thatch. Pre-Columbian settlements have been discovered in the area by the existence of burial sites and middens. According to Lefever (1992), the respective region was dominated by the Suerre people prior to the 16th century. He states that the Suerre were related to the Talamancan tribes from South Costa Rica, and used *Manicaria sacifera* to thatch cone-shaped ranchos. In 1502, Columbus encountered 50-80,000 people living in the area. Further to this, as time passed, the area gained new immigrants and residents. The Miskito from Nicaragua immigrated into the area and primarily used palm thatch for their homes. Tortuguero village became a well used shipping port for coconuts and bananas sold by local plantations. The researcher further stated that by 1930-1940 Walter Martinez, along with his children and two or three other families settled into the Tortuguero area and constructed four poled ranchos using palm. In the 1950-1960's, industry such as sawmills and agriculture came into the Tortuguero area, which brought in many immigrants and workers in a boom/bust cycle. Hardwood lumber became a major industry and funded Tortuguero until the 1970’s. Finally, in 1995, the settlement of San Francisco emerged at the base of Tortuguero mountain, known as the Cerro.

There are a few important socio-cultural dynamics which are important to highlight in order to contextualize San Francisco and the Tortuguero region overall. Formerly an illegal squatter settlement, the San Francisco community is presently going through the motions necessary to establish itself as a legal settlement. Given its location, San Francisco is considered to lie within the Tortuguero region; although, currently it is not officially recognized by the Costa Rican government. Overall, Tortuguero is well respected for its turtle conservation and ecotourism, however environmental issues are visible and are of a growing concern among residents (Meletis & Campbell, 2009). Meletis and Campbell (2009) state that some of the environmental burdens residents are coping with are bank erosion, canal siltation, water quality issues, habitat disturbance, noise pollution, declining wildlife, legal and illegal deforestation, illegal harvesting and construction, sewage-related problems, and more. Many of these environmental issues are related to a dramatic increase in both tourists and residents. In 1996, Tortuguero had an estimated 9,000 tourists (Boza, 1993), and in 2004, this number grew to an estimated 80,000 (Meletis & Campbell, 2009). According to Meletis & Campbell (2009), prior to the 1990s the population was under 200 residents and composed of Afro-Caribbean immigrants from Colombia and Nicaragua. By 2009, more than 1100 people were living in Tortuguero, and this number does not include the residents of San Francisco.

Although Tortuguero has seen a tremendous increase in tourism over the past 20 years, it remains an economically depressed part of Costa Rica. According to COTERC (2010), lodges are the true beneficiaries of tourism in the area, and although they do provide some employment opportunities for residence, little money filters down to the surrounding settlements. A closer look into the dynamics of the tourism industry in Tortuguero reveals the likelihood of class and
race-related inequities between residents, tourists, and lodge owners. Meletis & Campbell (2009) found that the majority of the tourists are North American or European and the majority of the lodge owners are North American or European expatriates or non-resident Costa Ricans. Moreover, van Oudenhoven (2007) states that much of the land in the Tortuguero area is owned by a few wealthy landowners, most of whom are from outside the area. All of these aforementioned dynamics play into the existing tension between residents and MINAET. van Oudenhoven (2007) argues that this tension is the result of the heavy ecological restrictions enforced upon residents, which effect their access to food, resources, and ability to practice cultural traditions. This study explores present day sentiments of these ecological restrictions, focusing primarily on how such restrictions have impacted the ecology, harvesting, and use of Manicaria saccifera for thatch in the region.

**BIOLOGICAL ASPECTS OF THE MANICARIA SACCIFERA**

Palm trees, scientifically known as Palmae, belong to a family of monocot flowering plants. "There are over 1,500 species of palms in the world and 550 in the Americas" (Kricher, 1997:28). Palms are a very important plant species for humans, as they can be used for many purposes. Palms can be used for "thatch for houses, wood to support dwellings, ropes, strings, weavings, hunting bows, fishing line, hooks, utensils, musical instruments, and various kinds of food and drink" (Kricher, 1997:28). Most palms grow in the tropics and their diversity is highest in wet, lowland tropical forests. There are 32 species of palm in the Tortuguero area of which the Manicaria saccifera is one (COTERC, 2006). "In the humid environments of the neo-tropics there is an increase in the abundance of understory palms" (Myers, 1981:24). Tropical forests generally have a larger number of palms than those of upland forests, and palms thrive better in poorly drained soils than those of well-drained soils (Myers, 1981). Palms can have two types of leaves: palmate or pinnate. Palmate leaves are fan shaped and resemble a human hand, whereas pinnate leaves are feather shaped (Sayed 2010).

Manicaria saccifera is a member of the family Arecaceae, and the tropical and subtropical family Palmae (Zuchowski, 2007; Cronquist, 1961). In the Tortuguero region of Costa Rica, local people know this palm as Palma Real, or Royal Palm, and its heavy, large leaves are valued over other palm species as the best material for roof thatching. Manicaria saccifera, as with all palms, is a monocot and thus shares some characteristics with grasses, arums, lilies, and orchids (Kricher, 1997). Unlike most other monocots, palms have woody stems and appear similar to trees but are not true trees, since the leaves grow in fronds and the plant does not form branches (Chase, 2004). The Manicaria saccifera can be identified primarily by its enormous, stiff pinnate leaves that are shaped like large serrated feathers (see Figure 2 below). Myers (1981) states that Manicaria saccifera is an obligate swamp species which forms in freshwater swamps that are frequently flooded by rain or ocean tides. They can often be located in estuarine areas where a river feeds into the ocean, so the rivers or canals along which Manicaria saccifera can be found often contain brackish water. This palm tends to dominate the
middle strata with its broad leaves, and can often be found mixed with *Raphia taedigera* (another species of palm) in depressions, bordering waterways, and in mixed dicotyledonous swamp forests (Myers, 1981). Our study has confirmed that the *Manicaria saccifera* grows only in depressions and not on slopes, hills, or mounds.

*Figure 2: The vegetative stages of Manicaria saccifera*

![Image of Manicaria saccifera stages](http://upload.wikimedia.org/wikipedia/commons/thumb/a/a8/Manicaria_saccifera2.jpg/220px-Manicaria_saccifera2.jpg)


The fruits of the *Manicaria saccifera* grow in large bunches throughout the year, forming in shells that contain two or three seeds each (see Figure 2 above). The pods fall from the tree and form mounds at the base. Eventually the spiked pod breaks away, revealing the smooth round seed underneath. Mammals, such as peccaries, eat the white flesh found inside seeds that have fallen and emerged from the tough outer shell, but human consumption is not common (Myers, 1981). Since the seeds can float for extended periods of time, water is the main seed distribution method for the *Manicaria saccifera*. Seed dispersal by animals is not effective, as Myers (1981) found that seeds that were partially consumed or damaged by animals were not likely to germinate (the stages of germination are captured in Figure 3 on the following page). Where mammal activity was high, seed and seedling predation were also very high, so the *Manicaria saccifera* tends to thrive only in swampy regions that are less frequented by mammals.
Figure 3: Stages of germination

- Exocarp (outer shell)
- Seeds
- Endocarp (inner shell)
- Radicle
- Hypocotyl
- Eophyll
- Coleoptile
- Root
- First leaves
- Stem
BIOLOGICAL METHOD

The main purpose of the biological portion of this study was to determine the density of the *Manicaria saccifera* palm in designated locations and record other information relevant to harvesting and sustainability. The methods used during the biological portion of this study were a modification of the distance method used by Myers (1981). The method was simple and efficient and, by following a similar process and approach as a previous study, the data acquired by the biological team can speculatively be compared to the data acquired 30 years ago. Other reasons for utilizing the distance method were accessibility to the study areas, safety precautions, and time constraints.

To determine palm density, a mark was placed every 10 meters and the distance from the 10 meter mark to the nearest adult *Manicaria saccifera* was measured, but never counted twice. The distance from the transect line to juvenile palm, sapling, and seed was also determined. Only viable seeds were recorded. A sapling was determined to be any *Manicaria saccifera* that was under 1.3 meters Diameter at Breast Height (DBH), whereas a juvenile was determined to be any *Manicaria saccifera* taller than 1.3 meters but with no established stem, and mature palms were all those with an established stem at or above 1.3 meters. These transects were established in certain routes in order to determine the density of present, past, and future generations of *Manicaria saccifera*.

A GPS reading was also taken at every 20 meters for possible future studies. DBH was also collected at a height of 1.3 meters above ground surface. If the DBH was below 10 cm or if only fronds were present without an established stem, they were considered juveniles and DBH was not recorded. A Haga clinometer was used to collect the palm height. Once data was collected in the field, calculations were used to determine the average density of the *Manicaria saccifera* adults, juveniles, saplings, and seeds in each location. Health related data was also considered by counting the number of fronds which were alive and dead. Harvesting data was also collected by counting the fronds which have been cut. The following calculation, adapted from Myer (1981) and Barbour et al (1999), was used to determine the density of the *Manicaria saccifera*:

Density calculation explanation:
Density = 10,000/0.7 x (Average distance in meters$^2$)

Density is defined as the amount of plants per square hectare. 10,000 represent the amount of meters in a square in a hectare. The average distance in meters$^2$ represent the average of all distances of a specific life stage on a specific ecosystem transect multiplied by itself to get a meter square value (m$^2$). Whereas, 0.7 in the denominator is a constant correction factor and is used in this study due its limitations. This was selected due to minor alterations in the field work due to working conditions and researcher experience resulting in not counting individuals backwards from the previous transect sampling point and limiting the search for individuals not to exceed beyond 20 meter maximum.
Three transect locations were selected to represent the *Manicaria saccifera* population in the Tortuguero region. At each location, 200 meters of transects were conducted for a total of 600 meters of representation. The three locations of choice were the Raphia Trail (a riverine swamp), a Manicaria palm swamp, and the base of the Cerro (a slope forest habitat). The Raphia Trail was conveniently located on the CPBS property. The Manicaria palm swamp transect was located on a previously cleared property line north of CPBS. Finally, the Cerro transect was located close to the village of San Francisco. All raw data related to this data collection can be found in Appendices 1–8.

The researchers encountered some limitations and challenges. If a *Manicaria saccifera* has an established stem, it was found that the DBH was always greater than 10 cm, so this method of determining maturity was found to be ineffective in this study. Instead, juveniles were determined by whether or not there was an established stem at breast height (1.3 meters). However, this presented a challenge, because some palms that would be considered juvenile grew taller than ones which would have been considered mature. It was found that some *Manicaria saccifera* had enormous leaves reaching the canopy, but the fronds started low to the ground, with no established trunk or stem. On the other hand, there were *Manicaria saccifera* that grew very tall stems with smaller leaves starting at a much higher elevation. These palms would have been competing for the sunlight, whereas those with no established trunk or stem did not need to. This challenged the definition of “juvenile” versus “mature”. In future research, total overall height or frond size may be a better indicator of maturity in the *Manicaria saccifera* palm. Another limitation or bias which occurred during this study was that definitive harvested areas were not included in the transects. If a transect had been conducted within an area where a harvest had occurred, the values for the density per hectare would have been much lower than the ones which were collected. For determining the height of the palm another method should have been used. In retrospect the height of the palm from the base to the top of the trunk should have been measured, although the base to the tip of the frond was measured. If a mature, juvenile, sapling or seed was further than 20 meters, from a 10 meter section, it was considered that there were none in that section. In the density calculations, if a *Manicaria saccifera* was not present within a 10 meter section, a distance of 20 meters was recorded.

**BIOLOGICAL FINDINGS**

As seen in the data below, the density of *Manicaria saccifera* per hectare (Histogram 1), average numbers of fronds for mature and juvenile *Manicaria saccifera* (Histogram 2), average number of palm fronts per palm (Histogram 3), and average height for mature and juvenile *Manicaria saccifera* were calculated (Histogram 4). These numbers are compared between the Raphia, Swamp, and Cerro locations giving a snap shot of how each location’s environment affects the growth of the *Manicaria saccifera*. This data was then used to obtain an overall average density for *Manicaria saccifera* in the Tortuguero area (raw calculations can be found in Appendices 9-11).
Figure 4: Average density for Manicaria saccifera

<table>
<thead>
<tr>
<th>LIFE STAGE</th>
<th>TRANSECT</th>
<th>Per hectare (10,000 m²)</th>
<th>Per hectare (m)</th>
<th>/PLANT</th>
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</thead>
<tbody>
<tr>
<td>Mature</td>
<td>Raphia</td>
<td>465</td>
<td>4128</td>
<td>11.697</td>
</tr>
<tr>
<td></td>
<td>Swamp</td>
<td>732</td>
<td>6038</td>
<td>9.470</td>
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<tr>
<td></td>
<td>Cerro</td>
<td>344</td>
<td>3320</td>
<td>10.520</td>
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<tr>
<td>Juvenile</td>
<td>Raphia</td>
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<td>7831</td>
<td>2.211</td>
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<tr>
<td></td>
<td>Swamp</td>
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<td>8989</td>
<td>3.751</td>
</tr>
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<td></td>
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<td>5071</td>
<td>3.887</td>
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<td></td>
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</table>
Histogram 1: Number of *Manicaria saucifera* per hectare

Histogram 2: Average number of *Manicaria saucifera* fronds per hectare
SOCIO-CULTURAL STUDY DESIGN

Sample Design

A combination of key informants, opportunistic interviews, demographic work, and a focus group were used to gather socio-cultural information regarding *Manicaria saccifera* and its usage. Translators were used for four out of five the key informant interviews, three out of five opportunistic interviews, and the focus group. Questions were prepared in advance and these were used by the translators to help facilitate the interviews (see Appendix 12, Section A). Additional questions were asked by interviewers to illicit more detailed responses or to address any new questions that arose during the interviews. One of the key informant interviews was voice recorded and later transcribed in full. Other interviews were recording by hand and transcribed by interviewers directly following the interview, in order to retain as much detail as possible. The focus group, which was conducted entirely in Spanish, was voice recorded and translated afterwards. Notes were also taken throughout the focus group by an interpreter.

Participants were selected based on knowledge, experience, number of years in the area, and recommendations (see Appendix 13). Key informant interviews were more formal than opportunistic interviews, and typically covered more of the prepared questions. Key informants had good knowledge and some experience of harvesting and thatching. All were local residents, and had knowledge of the area and its history.

Opportunistic interviews were conducted when walking through Laguna Quattro and Tortuguero. Essentially, directed conversations were initiated with residents that were approachable (usually outside). Interviews, facilitated by a translator, were less formal than key informant interviews. They tended to cover fewer of the prepared questions and allowed for more detailed discussion on particular issues. Furthermore, interviews often brought up additional issues that were of particular concern to the interviewee, for instance sea turtle conservation. All those approached appeared happy to be able to share their knowledge and voice their concerns.

The focus group was conducted near the end of the field study with local residents of San Francisco after introductions and community permission was obtained from recognized leader groups in the village. The purpose of the focus group was to address contentious and varying responses that were obtained through the interviews. The questions used for the focus group derived from the questions used for the key informant interviews, however they were revised to facilitate discussion and illicit further detail in regards the main points of contention that arose during the interviews (see Appendix 12, Section B). Focus groups are an increasingly popular qualitative research technique which gathers information through group discussions on a topic determined by the researcher (Morgan, 1996). According to Morgan (1996) and Umana-Taylor & Bamanca (2004), some advantages include: group interaction, which produces insights that individual interviews would not; they are less time consuming and less costly than one-on-one interviews; they are an efficient way to gather a large amount of exploratory data in a new or
unfamiliar area of study; and finally, it is easier to establish trust, rapport, and respect.

Demographic work was also conducted in San Francisco to obtain information in regards to number of households, the layout of the town, and its future growth. A map was made using hand sketches and GPS technology (see Figure 4). Demographic work found there to be 103 houses in San Francisco, of which only three made use of thatch. A number of houses along the beach edge and further along Playa Norte did have small thatched covered sitting areas for shaded rest. Some of these thatched resting areas utilized *Manicaria saccifera*. The map of the village clearly illustrates that future growth will need to be in density, not area, due to it being surrounded by natural land barriers: the Canal del Tortuguero, the Caribbean Sea, and the Cerro del Tortuguero (the highest land point in the area). Not only this, portions of the village also lay within the Barra del Colorado Wildlife Reserve and Tortuguero Managed Area, making further expansion illegal.
Analysis

The data and information collected through the key informants, opportunistic interviews, and focus group sessions were assessed and analyzed using grounded theory. Grounded theory was developed by Glaser and Strauss (1967) and has since become a popular qualitative research method in many fields, particularly in the social sciences (Goldkuhl and Cronholm, 2010). According to Goldkuhl and Cronholm (2010), grounded theory deals mainly with qualitative data, and provides a systematic way of gathering, organizing, and conceptualizing data so that valid, reliable theoretical abstractions may be generated from raw data. The key to grounded theory is that it is a strictly inductive approach; conceptualizations should always emerge from the data itself and never be forced by “preconceived interests” (Glaser 1998, p. 122). Essentially, grounded theory methods and strategies for gathering and analyzing data lead researchers in creating “conceptual understandings” from “concrete realities” that are “grounded” in gathered data and not influenced by preconceived ideas and assumptions (Charmaz 2003, p.311).

Grounded theory was particularly useful for this study because it provided a systematized method for gathering, categorizing and conceptualizing the qualitative data obtained in interview and focus group settings. Grounded theory stipulates that research questions must be open and general rather than based on a specific hypothesis, and that the emergent theory should account for a phenomenon that is relevant to participants (Strauss and Corbin, 1990). Further to this, data collection and analysis should be done simultaneously, and initial data analysis used to shape continuing data collection. In this study, interview questions were created to explore the use and knowledge of the *Manicaria saccifera*, as well as existing concerns and sentiments regarding thatching, resource sustainability and related concepts. Questions were developed mindfully so as to not impose the researchers’ perspectives and ideas on the participants. In accordance with grounded theory, interviews were transcribed and analyzed immediately so that new questions could be added and old ones revised to make them more relevant to participants and the emerging concerns.

Analysis of data aimed to follow grounded theory coding methods, as described by Strauss and Corbin (1990). Initial analysis utilized open coding, which is done by carefully reading transcribed text in order to identify, name, and categorize the data. While reading through the interviews, numbers were designated to correspond to each topic. Data corresponding to each number was then grouped together so that patterns and themes began to emerge and saturation became apparent. Further analysis was done using selective coding, the process of choosing core categories. Select coding was carried out by relating all initial categories into the core categories and organizing them so as to generate final concepts. The essential idea is that there are core concepts that all other concepts are related to. The final phase involved discriminate sampling, during which data was gathered specifically to verify the core category and fill in any gaps. For instance, further research was done to learn about the permit system and a focus group was asked questions more directly related to the core concerns which had come up in the interviews. Finally, emergent patterns and concept relationships were illustrated using conceptual mapping and models and used to develop a substantive theory. A
substantive theory is always partial - it can always be modified as more data is compared (Giske and Artinian, 2003). Again, grounded theory does not aim to discover general “truths” or verify any theoretical claims. Rather, it is a flexible and modifiable approach to data collection and analysis, and it aims to develop relevant, credible theories through systematic procedures.

As novice researchers, grounded theory methods were not followed rigorously. Researchers conducting the sociocultural portion of this project were familiar with the basics of the grounded theory and applied coding methods to analyze the data. However, the final discussion and analysis was carried out by pairing members of the sociocultural and biological teams in order to merge the two sets of data and perspectives. Hence, the final analysis did not adhere to the specific requirements of grounded theory analysis. Instead, discussion points were generated by each pair of researchers and subsequently developed into concluding points. Nevertheless, the utilization of grounded theory aided in facilitating the immersion of the researchers into the challenges and complexities of field research. According to Giske and Artinian (2007:78), in order to “carry out a [grounded theory] study one must be willing and able to stay open to the experience of the participants, to live with degrees of chaos until the concepts emerge, and then be able to conceptualize”.

**SOCIOCULTURAL FINDINGS**

**Changing attitudes regarding the use of palm for thatching**

A prominent and important finding that emerged as a result of fieldwork was the apparent change in both attitude and behaviour toward the use of *Manicaria saccifera*. Based on the responses we received, this change in attitude can be attributed to all of the following: health and safety issues; advantages and disadvantages regarding specific roofing materials; difficulty in procuring the palm leaves; a shift in knowledge involving the harvesting and thatching process; and, perhaps most importantly, a permit system restricting the harvesting of the palm.

Lefevre (1992) provides an in-depth look into the development of the area from the early 1920s onward. According to this researcher, Tortuguero at the time was a small village of 150 people living in small clapboard, stilt raised houses, about half of which were covered in palm thatch. Even though much of the interviewing for this study took place outside the village of Tortuguero, this information can be confirmed by some of the interviewees who state that 15 years previous, in 1995, Tortuguero was comprised of mainly thatch housing. The same historical prevalence of thatching was also confirmed for the village of San Francisco.

Based on both responses and demographic work, it was apparent that there had been a dramatic decline in the use of thatch for roofing in the Tortuguero region, including San Francisco. It is critical to highlight that this decline happened in spite of the many advantages of using *Manicaria saccifera* as a roofing material, as expressed by several interviewees.
(Focus Group) The *palma real* is pretty much irreplaceable, it is waterproof.

(Opportunistic Interview 4) ...because of its durability. It is also really available here.

(Key Informant 4) Thatch roof is cooler.

(Key Informant 1) Tin, if you build near the ocean, it will rot in four or five years… They [palm leaves] don’t rot that easy.

(Key Informant 1) If you’re gonna build something near the beach, it’s much better to use the Manicaria.

(Focus Group) The salt corrosion from the ocean doesn’t affect it ...

(Focus Group) A roof with palm leaves is fresh and cheap ...

As previously mentioned, two of the most prominent causes of this decline are: (1) the loss of knowledge of palm harvesting and thatching; and (2) the implementation of MINAET’s permit system which restricts the harvest of the palm. Given their prominence and importance, these two topics will be discussed in their own sections and in detail later in the report. With that said, there are other reasons why people have moved away from thatch as their primary roofing material. Prevalent among many of the discussions was the difficulty of acquiring the palm leaves. The interviewees and the biological assessment of the *Manicaria saccifera* revealed that the palm only grows in wet areas of lowland rainforests – mainly in swamps. Therefore, getting to the *Manicaria saccifera* is both difficult and time consuming.

(Opportunistic Interview 3) People used tin and plastic because you have to harvest and thatch, and it is a lot of labour.

Depending on the size of the home or rancho, this study determined that anywhere from 300 to 2,500 leaves may have to be harvested, and people are unwilling to travel far distances, mainly because the leaves are both large and heavy. For this reason, many people in the Tortuguero area have decided to switch to tin or other materials to roof with. When asked why tin was the preferred roofing material, many responded that tin:

(Opportunistic Interview 4) [was] convenient and using palm is very complicated.

(Key Informant 4) [offered] more protection and quicker to put up.

Health and safety issues and concerns were mentioned as other reasons for why people are no longer using thatch. While most of the interviewees stated firmly that there were no health complications associated with using thatch, they did mention other deterrents such as:

(Opportunistic Interview 4) insects, bats and snakes
(Focus Group) cockroaches, mice, all kinds of bugs, and snakes

(Key Informant 4) insects, bats, scorpions, spiders; must spray.

Regardless, many of the lodges and resorts in the area still use thatch heavily on their property.

(Focus Group) Every lodge has some form of thatch, either a rancho or a small building.

This may be because tourists have an expectation, even in a protected area, to see thatch on lodge property – perhaps as an indication of being on vacation in a tropical area. Some local residents gave inclination that acquiring thatched roofs may be easier for the lodges.

(Opportunistic Interview 4) It is hard to get a permit for harvesting, but for places like Vista al Mar and Turtle Beach Lodge ... it is easy for them to get one. This is why people try and get other materials.

Many lodges own land on which Manicaria saccifera grows. So, when they need to harvest palm fronds, they are granted a permit more easily than local residents, many of whom do not own land. Obtaining a permit is especially difficult for the residents of San Francisco, since the town is not currently or legally recognized by the Costa Rican government.

The permit system

Wildlife conservation permits in Costa Rica were established in 1992 with the Ley de Conservacion de la Vida Silvestre, or the Law on Wildlife Conservation (hereafter referred to as Law 7317) (MINAET 1995). It is possible that another permit system was in place before this law was introduced but no evidence has been found to confirm or deny this. According to Article 1 of Law 7317 (World Law Guide n.d.), its purpose is to regulate and monitor the appropriation and trade of natural resources within Costa Rica and to ensure any extraction is done so in a sustainable fashion. All natural resources are declared of the interest of the State and any extraction, anywhere in Costa Rica, requires a permit. More specifically, if a resident of San Francisco wants to harvest Manicaria saccifera, they will need to obtain permission from MINAET to do so legally.

All informants indeed acknowledged the permit system as a first step towards the acquisition of palms.

(Key Informant 2) Must get a permit from MINAET; permit is only for harvesting palm for your own home/rancho, but must have an environmental assessment.

(Key Informant 3) There are a lot of palms around the regions but a MINAET permit is required.
(Key Informant 4) First, you must have a permit anywhere you are.

(Key Informant 4) There is a permit system, which is the first step in building a thatch roof.

(Key Informant 5) You have to know a guy who owns property, has papers, then go to MINAET."

Many highlighted the permit system as one of the more influential instruments of the Manicaria saccifera’s declined usage while some dismissed the idea.

(Key informant 5) How have the attitudes toward the use of thatch changed? Attitudes changed because people don't want to get permits.

(Opportunistic Informant 2) Why have people stopped using palm? MINAET regulations and permits since 2005 probably...need permit for the wood, everything...difficult to get permit...

(Opportunistic Informant 3) Is the permit the main reason people don't use palm anymore? No, it's because you have different materials now, and it is more expensive and labour intensive to use palm.

One key informant specifically expressed the desire to use the palm but said he or she would be afraid to do so without a permit.

(Key Informant 5) Has the permit system affected your decision to not use thatch? Yes. Wants to use palm, but is afraid.

This trend was consistent with most informants who simply maintained that since harvesting without a permit was illegal they would not do it. Most sources interviewed for this project related similar stories of how a few people in the area also harvest palms illegally. During the focus group some informants even joked about the inability of MINAET to enforce their own policies, and admitted to secretly harvesting palms without permission at one point or another. There was an informant, however, that personally admitted to harvesting palms without permits.

(Key Informant 1) Even though when we built this rancho we didn't get a permit, nothing. We were gonna do it the right way, you know, and the rangers they came. We told them, 'Look, we're building this. You know we know we didn't get any permit...' and they're like, 'no worries'.

From a legal perspective these permits are virtually impossible for residents of San Francisco to acquire. In accordance with the Sistema Nacional de Areas de Conservacion (2002) (World Law Guide n.d.), which describes the protocols in applying for the various permits introduced by Law 7317, the applicant must provide proof of ownership or right of possession of the property where the Manicaria saccifera will be harvested. Being that San Francisco is an illegal settlement, residents have not been granted any official rights of possession for their
“property”. So, the only alternative is to obtain written permission from a landowner who has *Manicaria saccifera* on his or her property; however, several key informants stressed that no commercial sale of the palm is permitted by MINAET.

*(Key Informant 2)* It's illegal to harvest now (for profit).

*(Key Informant 5)* Are there any instances where the palm in this area is harvested by outsiders for use outside the area? Yes. Not long ago a truck was intercepted by MINAET and they took 500 leaves illegally. Many people ask others to pick up palm for them (illegally). You can only legally harvest palm for personal use, never for commercial.

For all granted permits, an official management plan is drafted by an expert and an environmental impact assessment is carried out by a MINAET official. Several informants mentioned how MINAET sends a representative to assess where the applicant is permitted to harvest, which is presumably where an extraction would have the smallest environmental impact.

*(Key Informant 2)* ...must have an environmental assessment. MINAET comes and checks.

*(Key Informant 5)* Must own land, give [MINAET] the number of palms you need, how you're going to transport it, registration number for the boat, and [they] come to show you where to harvest and how many leaves to harvest.

*(Opportunistic Informant 2)* You ask and [MINAET] has to come here and look, see if that tree is good.

*(Opportunistic Informant 3)* MINAET comes to see what trees you want to cut.

Getting to this stage is the greatest difficulty for most locals and it is clear that the current permit system provides the residents of San Francisco with the means to legally harvest palms.

Despite the wide acknowledgement of the permit system there appears to be a remarkable variation of information and understanding regarding its nature within the community. If Law 7317 is indeed the authoritative legislation concerning permits then no report from any of the key informants, opportunistic interviewees, or the focus group can be considered accurate concerning the date established or the scope of its provisions. The accounts given date the permit system at anywhere from five to ten years ago to simply many years ago. There was considerable confusion, within the focus group especially, on the purpose and extent of the permit system. Several participants were unsure of the purpose of the permit system and seemed to believe that the system was in place specifically to regulate palm use.

*(Focus Group)* Don't understand why the national park doesn't let them harvest leaves and have a permit system since the trees die naturally anyway.

*(Focus Group)* Why the national park don't let us cut down palms? I don't get it.
This was true of most informants who also apparently assumed that the permits were put in place as a response to local environmental issues relating to past overuse of thatching material or slash-and-burn clearing. There were conflicting opinions on this issue as some informants believed that the lodges and businesses were the cause of the legislation, whereas another believed that San Francisco's rising population was to blame.

(Key Informant 2) 10 years ago primarily thatch at lodges and restaurants. Now MINAET told lodges and restaurants they can no longer use palma.

(Key Informant 3) Was the permit system put in place to stop tourist lodges from using the palm? Because of the population...the families living in San Francisco.

(Key Informant 5) Why is there a permit system? To keep people from harvesting for commercial purposes.

It is possible that MINAET is rejecting permit applications on these bases but Law 7317 shows that permits were introduced simply as a means to regulate the consumption, not only of the Manicaria saccifera, but of all natural resources everywhere in Costa Rica. One key informant, who already recognized that permits have been in place for many years, also knew that wherever one goes in Costa Rica a permit is needed to extract natural material from the environment.

(Key Informant 4) ...must have a permit, anywhere you are.

Conservation knowledge and attitudes

Based on the responses received from key informants, opportunistic interviews, and the focus group, the respective community members exhibited a knowledge and awareness of the Manicaria saccifera and the local ecosystems in which it thrives. Almost all participants stated that they believe the Manicaria saccifera should be harvested in a manner which allows the palm to regenerate. For instance, when harvesting fronds, three to four leaves are left on each tree to ensure the tree survives and regenerates after harvest. Also, harvest locations are changed to ensure the same trees are not harvested before they have time to regenerate.

(Key Informant 1) They cut some of the bigger leaves from the outside part of the palm, and they leave a bunch of leaves, maybe three or four in the center. That way the palm wouldn’t die. And that’s how the villagers used to do here – but people who come from other parts of the country and they learn how to do it, they don’t want to climb up the palm and they just cut the whole thing down.....There’s people who care about the palms...and there’s other people who don’t .

(Key Informant 3) Try to cut just the leaves they need and leave at least three because they think in the future they might need more leaves from the palm. Some people cut all the tree. If you
leave just one leaf, it re-grows but takes much longer than if you leave three.

(Key Informant 5) Some people cut the whole palm, but it is better not to because the palm can regenerate itself in three to four years and you can harvest it again.

Clearly, some of the participants care about the management and preservation of the *Manicaria saccifera*. This in mind, coupled with taking into account the rapid growth and expansion of small farms and settlements within and around San Francisco, it seemed appropriate to explore peoples’ perception of the impact land clearance and drainage could have on the *Manicaria saccifera*. According to a key informant, land clearance and drainage happened in the Guapiles area:

(Key Informant 3) Parents had *palma real*¹, was like 30 years ago. Not possible to use palm anymore because the land in [Guapiles] is dry, no habitat for palm growth, due to clearing the land which caused the land to dry, also drained the areas.

The general belief among participants is that the *Manicaria saccifera* regenerates fast and is abundant in the area. However, if the permit system was not in place, people in the area and outside of the area could harvest palm for commercial thatching purposes, and export the highly prized leaves to areas where palms are unable to grow. Obviously, if *Manicaria saccifera* was allowed to be commercially harvested and exported, the species would likely suffer from over-harvesting and become depleted. Species depletion has occurred in the past in this area and could certainly happen again. As two key informants indicated:

(Key Informant 1) the manwood...disappeared from Tortuguero.....[about] three years ago I was in the jungle, in front of the Cerro on that flat area. I was hiking with a guy....and we were walking and I looked at a tree and I said “isn’t this a manwood tree?” And he looked and he just chopped a little bit of the bark and he said “yes, this is one!”..... I asked him, “can you keep an eye on this tree and when there’s fruit let me know, I will come take the fruits and grow them.” And then like six months later I saw him again and was like “has the tree grown any fruits?” and he [said] “the tree is gone, my friend”

(Key Informant 5) …without a permit might make a commercial business. Saw Laguna do it without permit and they got in trouble. The park throws away palms that are cut illegally.

Thus, the permit system prevents excessive harvesting from occurring. However, participant responses also reveal that there is a widely held perception that, due to the existing density and prevalence of the *Manicaria saccifera* in the area, it would be difficult to over-harvest this palm. There is a need to bear in mind that many of the participants are not long term residents to the area and may be unfamiliar with various aspects of the local ecology.

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¹ Spanish and local name for *Manicaria saccifera*
(Key Informant 3) There are a lot of palms the density of palms is high so not worried.

(Key Informant 4) Regenerates very quickly, you can see a bud one day and two days later it will be a leaf...takes six months to one year to regenerate.

(Key Informant 5) Density is high, but found in patches/sectors.

(Focus Group) The *palma real* will never disappear, but they are changing their ways for an easier way using an easier material (like tin), they are not using any more leaves.

There is no doubt that there has been a shift from using thatch to tin roofing, and such a shift has certainly limited the harvesting of the *Manicaria saccifera*. However, land clearance and drainage continues to take place in the region and poses a threat to the *Manicaria saccifera* and its habitat. Although a major portion of the area studied lies within the Barra del Colorado Wildlife Refuge, regulating and protecting such a large area is difficult. Illegal and unregulated population growth and settlement expansion certainly poses a threat to the *Manicaria saccifera* in the future.

**Traditional harvesting and thatching knowledge**

The process of harvesting and thatching *Manicaria saccifera* is complex and requires a great deal of knowledge and skill. In regards to harvesting, there are specific criteria that need to be met by a tree before it can be harvested. First, both the length of the trunk and the leaves need to be the right size. Second, the palm needs to have enough leaves on it. As many informants indicated, a tree needs to have a trunk that is three to four meters tall before it can be harvested and the leaves should be between two to seven meters, although above four meters is best.

(Key Informant 2) Three or more meters of trunk to get good sized leaves. Tree varies in size, between 3-10 meters; but 10 meter trees are too difficult to harvest.

(Key Informant 3) At least 4m is the best. They used to harvest 4m-9m but prefer the size of the trunk to be 9m for harvest...Size is very important; either 2-3m or 4-5m. Use both, but prefer 4-5m.

(Key Informant 4) medium size, ones you can reach...5-7m, or anything larger.

(Opportunistic Interview 4) They need to be more than 5m in length and 2m in width. This is because when they use leaves of that kind, it covers more area.

The respondents roughly gave the same estimate for: (1) the total leaves needed to thatch a roof; and (2) the amount that a tree is able to yield. Most respondents indicated that the minimum leaves harvested were 10 and could be as high as 20 for each tree. The amount of leaves needed to roof a rancho or house vary, but the most common answer from respondents was around 400-700 for a house and anywhere from 1000 to 2500 for a rancho. Most
respondents indicated that when harvesting a leaf, they need to leave at least three leaves on the tree for regeneration purposes.

(Key Informant 2) (number of leaves harvested) 10-12 leaves from each, very good leaves. Largest is used for sides, and smallest are used for center.... 700 leaves for average house, 400 are big leaves, 300 are small leaves. 900-1000 leaves, mostly big leaves are used (for a rancho), 900 are big leaves, 100 are small leaves are four meters long and overlap.

(Key Informant 3) 1200-1400 (leaves) for a family of four people. Rancho 900 leaves we sit in, 2500 for the bar, 3200 for the restaurant (all at turtle beach lodge).... Try to cut just the leaves they need and leave at least 3 because they think in the future the might need more leaves from the palm.

(Opportunistic Interview 4) (rancho) 2,500 leaves, spent 25 days building and seven days harvesting. For a house with three rooms, 400-600 leaves.

(Focus Group) If the tree is big enough, you can get from 15-20 leaves. Each plant can give you from 10-20 leaves and you must leave about three or four.

The process of thatching a roof also has certain steps that must be followed. First the leaf must be split in half as in Figure 5, and then the leaves must be attached to the wood frame so that they tightly overlap and do not leave any gaps as in Figure 6. The leaves are either tied together using appropriate vines or rope, which is the old way of thatching, or nailed onto the structure’s frame. Both halves of the leaf are used in order to minimize waste, but it is important that only fresh leaves are used in the construction of a new roof.
(Key Informant 1) It’s really simple, once you see it you know. But when it’s harder is sometimes when you don’t use nails, you use rope, then you have to tie it, all the palms together, make a specific knot....You cut the leaves in half and then you have to use them within 3 or 4
days.

(Key Informant 3) use nails to attach leaves to roof frame.... They use two sizes of leaves... Only green ones, because of the construction process. You can use dead, but it is difficult for construction....Usually harvesting and building the rancho happen at the same time so it is rare to have left over leaves. But if you do, they can be kept and used for repairs even if they are dried

(Opportunistic Interview 3) You use the whole leaf, except the 1m stem at base (but 12m of leaf after that used). Cut it down the middle into two sides; it is easy to pull it apart along the shaft when the leaf is green....You start from the bottom of the roof and work up to top. Leaves must be very very close together to prevent leaks.

According to the responses, there are several advantages to using the *Manicaria saccifera* to build thatch. Participants consistently favoured *Manicaria saccifera* for its large fronds.

(Key Informant 1) With Manicaria you can cover a lot more.

(Key Informant 2) Big trunk, 3 or more meters and long leaves.....[Importance of leaf size]Yes, very important. Largest is used for sides, and smallest are used for center.

(Key Informant 3) Use the longest leaves, the oldest, for ranchos and houses...They use two sizes of leaves, 2-3m and 4-5 m. Use both, but prefer 4-5m...Size of leaves which prevent gaps.

Many indicated that when the leaf is harvested at the right time in the lunar cycle, it will produce an insecticide which will help prevent damage to the roof from insects. There were different responses on what time during the lunar cycle that one can harvest leaves. Some indicated that 15 days after the full moon was the best time as the leaves would last longer. Others said that it was three days before and after the full moon that was the best time for harvesting.

(Key Informant 1) Well, there is some interesting stuff that has been said...They found insecticidal compounds in the plant...during those days it intensifies. So three days before, during, or three days after the full moon.....

(Key Informant 3) The only time to harvest is after the full moon, 15 days (doesn't know reason). Never before the full moon.... 6 or 7 years they need to be replaced... Usually you have a chance to repair part of a thatch. You only repair the whole thatch if you see holes all over it.

(Key Informant 4) 15 days after full moon...dry season....The palm will last longer

(Key Informant 5) Size of the leaves, and they are not segmented. 500 *Manicaria* leaves used to 3000 suita (*Asterogyne martiana*) leaves...3-4 days after full moon. If you cut it on other days it will be eaten by worms/bugs.... Generally you can patch; but normally you would replace entire roof.

(Focus Group) When the moon is in menguante (after the full moon), this is the perfect time to
cut palm. If you cut the palm another time the palm might get bugs. After *menguate* phase until a day before the new moon (about 15 days). If you cut the palm after those days, you will lose the palms to bugs. You can use palm cut not in the time, but it will not last as long. If you cut at the perfect time, you can keep the roof for about 15 years. The worms fall off. Cut after the new moon or the worms will get to it and the palm won't last that long. If you cut it during the *menguate* time it last for 15 years.

There are also ways in which the roof can be cared for to slow down deterioration. This could be why participants gave so many different answers for the length of time a roof lasts, as people have different ways of caring for their thatch. Those who did mention care for the thatch roof mentioned that it was necessary to fumigate the roof to remove insects. There were different ways of doing this, one respondent said it needed to be fumigated by a certain plant (name unknown), use of commercial insecticides, and another respondent mentioned that cooking over an open fire prevented insect damage.

*(Key Informant 1)* the hotels, they don’t cook, inside that hut. In the past people used to cook, so the smoke would scare away all the insects. Termites and thins that eat the leaves. That’s one of the ways...of preventing the insects

*(Opportunistic Interview 5)* Her one layer thatch roof lasted 20 years with very little damage, no visible holes or damage to thatch....She fumigates the roof with a plant that is not currently available to kill insects. She burns the plant and uses the smoke to fumigate. The smudging causes bugs and contaminants to fall out of the thatch and she sweeps them up, than disposes of them.

Though the researchers were able to gather an abundance of information surrounding the use of the *Manicaria saccifera* for thatching, the tradition of thatching appears to slowly being lost. This is due to the preference for tin rather than thatch for roofing material. As mentioned previously, this preference may be a result of the permit system. Since less people are using thatch, the knowledge is not being passed down to future generations. Participants indicated that the way in which the knowledge is passed down is through both observation and participation. Essentially, one learns to thatch by watching and helping someone thatch a roof. It was also discussed in the focus group that they do not believe the knowledge will be passed on to future generations.

*(Key Informant 3)* Learned to harvest first, by seeing his father do it. Used to live in Guapiles and he harvested a different palm.....Uncle taught him how to thatch a roof, learned by seeing. Did this both for harvesting and thatching. The same system for harvesting palms based on the species in different areas.

*(Key Informant 5)* Was six years old when he learned, both [harvesting and thatching] at the same time by father. Used other palms too – suita, sugar cane, rice leaves (would bunch leaves together; but rice was much taller a long time ago, GM now has made them much smaller, unable to use rice for thatch now)
(Opportunistic Interview 3) Taught as a young boy.....He taught one son. He’s from the farm, and his father taught him everything about the farm. He even learnt about farming at school

(Focus Group) Very few people actually know how to make a thatch roof. Only three guys in the village. The old generations know more than the new ones about how to make thatch roofs. The new generation is losing knowledge about how to treat palms and how to make thatch. Six people in total know how to thatch. Two are women, one who was taught by her dad and one by her husband. More people use to know how to do it, but now less people know. Don't think the knowledge will be passed onto the children, the knowledge and tradition will be lost.

**DISCUSSION**

Biologically, through the use of the distance method, it was found that not only is there a high density of *Manicaria saccifera* in all three areas of transect that were used, but there potentially has been an increase in density over the last 30 years. It was found that the Raphia trail transect had a density of 465 mature palms per hectare, the Manicaria palm swamp transect had a density of 732 mature palms per hectare, and the Cerro had 344 mature palms per hectare. Whereas, the juveniles were found to be 1062 palms per hectare, 1303 palms per hectare, and 639 palms per hectare. Myers (1981) found a density of 663 mature palms per hectare in the Manicaria palm swamp, which represents a 10% increase in density. The juveniles increased by 53% in density from 850 to 1303 in the same area. These increases took place over the 30 years between Myer’s study in 1980 and this 2010 study. Interpretation of the comparison between this research and Myer’s (1981) must be cautious due to a much smaller sample set in this research project. This project used 200m per ecosystem and as such, the results are not as precise as Myer’s (1981). As well, the same transects were not used as from Myer’s (1981) study and as such, our comparisons are speculative at best. This study has shown, reasonably, that the *Manicaria saccifera* has a healthy density and could be harvested sustainably if done properly. There would be need for further studies to ensure no harm would come to the rest of the ecology if the respective restrictions were lifted, such as the destructive nature of the harvest resulting in loss of habitat from the clearing of dead leaves, the loss of living leaf habitat, and a multitude of other ecological impacts which result from this type of harvest.

Although it was determined through the use of a focus group, interviews and key informants that many of the locals were deterred from harvesting *Manicaria saccifera* due to the restrictive permit system, it was also determined that many people have had a shift in attitude regarding the palm. This shift has caused them to move away from the *Manicaria saccifera* as their main source of material for roofing, due to the physical difficulty of procuring the palm, as well as other issues including a general dislike for the palm as it tends to house fauna such as spiders, snakes and scorpions. Therefore, it would be probable that even without the MINAET permit that the density of the *Manicaria saccifera* in the area would likely not be affected.
Moreover, the local traditions and practices which involve harvesting the *Manicaria saccifera* for roof thatch are not significant enough to have a negative impact on the populations of the palm. The practice of taking only what is needed and leaving a few leaves on each plant to allow for regeneration has allowed the people to use the plant as much as needed while ensuring that there will be a supply for the future. It seems, then, that one of the major threats to the *Manicaria saccifera* could be through the use of commercial agriculture, because through the creation of plantations, the land has to be cleared and dried. There are several known problems, which are associated with commercial agriculture, however the Costa Rican government will continue to create these plantations because of the economic benefits in which they can provide (McCracken, 1998). As the *Manicaria saccifera* thrives in swamp land, this would drastically reduce the numbers of this palm. *Manicaria saccifera* has a very particular habitat, and destruction of that habitat by commercial or agricultural drainage of wetlands can impact the population negatively.

Another important consideration is the potential for and likelihood that the permit system is degrading the wellbeing of local inhabitants. When the local people used thatch roofs, they did not have to pay money for the materials unless they wished to hire others to harvest and/or build the roof. In an economically depressed region, this provided a very affordable and accessible option for low-cost housing. From an ecological perspective, thatch is a far more environmentally friendly material. Palm fronds grow naturally, regenerate fairly quickly, and decompose into rich compost. The removal of leaves does not seriously damage the plant when done correctly, and as locals have stated, the palm is left with some leaves to help it regenerate for future use. Tin, on the other hand, must be sourced, manufactured, and transported to Tortuguero for use. It then rusts within 10-20 years and must be replaced, leaving a much deeper and more widespread environmental footprint than *Manicaria saccifera* thatch. With this in mind, it is unfortunate that tin is the most commonly used roofing material in San Francisco.

Ultimately, there are two main reasons for why local inhabitants no longer use *Manicaria saccifera*: (1) the permit system and (2) a shift in attitude among locals. It is important to note that these two reasons seemed to have very little correlation. In other words, the implementation of the permit system did not appear to directly affect the locals’ opinion about the *Manicaria saccifera*. Many of the locals stated that while the permit from MINAET created somewhat of an obstacle to using thatch, there were a number of other reasons for why they have decided against using thatch. First and foremost, harvesting palm leaves is incredibly physically strenuous and time consuming. They would rather work in employment to gain money for purchasing roofing material rather than manual collection of roofing material. This illustrates a move to a more capitalistic consumer lifestyle, afforded to them by employment in the tourist trade, and exposure to capitalistic lifestyles, and away from subsistence activities. This pattern of moving from subsistence activities to a cash economy was seen during the boom-bust decades when lumber and sawmill companies dominated the Tortuguero region during the middle portion of the 20th century (Lefever 1992). Most people appear to prefer to use other resources, such as tin or plastic to roof their buildings simply because it is easy to obtain and work with. Second, maintaining
and replacing thatch required more effort than tin roofs. Finally, many locals explained how they preferred not to use the palm because it tended to house fauna such as spiders, snakes, scorpions, and other unwanted creatures. As for those who are interested in using thatch, many locals emphasized that if someone wanted or needed to harvest *Manicaria saccifera*, they usually did so without adhering to MINAET’s permit system. Participants of the Focus Group admitted to having harvested and thatched at some point in their lives, yet all stated that they had never acquired a permit to legally do so. Thus, it appears that the shift in attitude had a more significant effect on reducing the use of *Manicaria saccifera* than MINAET’s permit system.

Today there is a scarcity of thatched roofs in the Tortuguero region. Some of the homes in the area, especially those located by a beach have a very small thatched covered sitting area for shade and resting, such as seen in Figure 7. *Manicaria saccifera* is primarily harvested for roofing ranchos at tourist lodges and hotels. The most popular are the “traditional” open-air ranchos where tourists may lounge in hammocks, protected from the sun and rain yet still able to enjoy the nature and wildlife. Due to the decline in use among local inhabitants, very few people have acquired and/or retained the knowledge of proper harvesting and thatching techniques. Ultimately, this traditional knowledge is not being passed down to younger generations and is at risk of being lost.
As informants revealed, the process of harvesting and thatching *Manicaria saccifera* is complex and requires a great deal of knowledge and skill if it is to be done properly. A roof that is not built according to particular standards is likely to deteriorate within a few years, whereas a skilfully built roof can last upwards of 20 years if well maintained. As a renewable resource, as well as a roofing material that has other advantages such as keeping the building cool, softening the sound of heavy rainfall, and resisting the deteriorating effects of the nearby salt water sea, it is unfortunate that the desire as well as the knowledge and ability to utilize *Manicaria saccifera* is likely to disappear in the near future, unless measures are taken to preserve this tradition. The
knowledge is evidently not being passed on to future generations – not one informant mentioned teaching or intending to teach his or her descendents. As a skill that has been passed from generation to generation through observation and participation, there is no written account (to the researchers’ knowledge) detailing the specifics of leaf harvesting and thatching, and traditional techniques are not part of a school curriculum or taught in any organized educational setting. A dilemma arises when the effectiveness of the permit system is analyzed in regards to *Manicaria saccifera*. The permit system is effective in that it provides some degree of monitoring and prevents large scale commercial exploitation of the palm, but it also succeeds in diminishing the availability of a formerly important and useful, not to mention sustainable, resource for the local people who live in these lowland areas where *Manicaria saccifera* is plentiful. A resource that was once used in a sustainable manner, and could possibly continue to be used in such a way today, is now unavailable to those who might benefit from using it the most, i.e. those who do not own land and cannot obtain a permit.

Would people begin using *Manicaria saccifera* again to thatch their dwellings if the permit system was taken away? Perhaps some would, but it seems likely that many would opt for easier materials such as tin or plastic, unless the peoples’ attitudes change and younger generations are taught to thatch and there were less ties to the capitalistic lifestyle. Persons with expert knowledge in the area might be employed to give demonstrations of thatching techniques, or perhaps government or NGO funding might be applied for to revitalize some of its usage in a sustainable and profitable way. Not only would this preserve valuable knowledge, it would also provide a greener alternative to tin and plastic as well as a possible means of income should the current regulations be changed to allow for some local, small-scale commercial harvest. It is evident that changes in the permit system as well as the development of some sort of educational initiative would be necessary for thatch to become a viable and desirable roofing material as it was in the past. Further research is necessary to determine if these suggestions are feasible and whether there is enough interest locally to renew the use of *Manicaria saccifera* as a roofing material.

The village of San Francisco had originally used *Manicaria saccifera* to thatch their homes and ranchos. Tin was not used since it was not readily available at the time, and as this illegal settlement was likely to be removed by MINAET, squatters did not wish to initially invest in capital. According to locals, a tin roof is hot in the sun and rusts easily in the salty air, sometimes within four to five years. A *Manicaria saccifera* palm roof is not only aesthetically pleasing but is also cool and does not corrode. However, with tin becoming more available, accessible, and affordable many locals are opting to use tin over *Manicaria saccifera*, even though a hot and salty climate is not the prime location for metal roofing. The question then remains is how sustainable are tin roofs? Based on the interviews, the *Manicaria saccifera*, can last up to 15 years, four times that of tin. When the thatch is ready to be replaced, the old palm fronds are usually burned, allowing nutrients to be returned to the soil. As for tin, old sheets are sold for scrap metal. What is unknown is how much and often are tin scraps are sold for. If the tin is not sold for scraps where does it go, and how long will it take to biodegrade? Other
environmental factors to consider are the energy and resources that are utilized to produce the tin sheets and transport them. Clearly, *Manicaria saccifera* is a more sustainable product when such factors are taken into consideration.

The study conducted had some weakness which should be addressed in future studies. First, based on interviews, it seemed that lodges were able to obtain permits to harvest *Manicaria saccifera* fairly easily. This was due to the lodges owning the property in which the harvesting and thatching would take place. With this in mind, it would have been beneficial and more holistic to include owners and/or managers of the lodges as another stakeholder in the area, to obtain their opinion of and experiences with the permit system. Second, it would have also been beneficial to discuss with MINAET how many applications they receive annually, the number of permits that are issued, and who (lodges versus residents) are permitted to harvest *Manicaria saccifera* in the Tortuguero region. Thirdly, investigating further attitudes towards thatch and what it may represent in the cultural categorization of class and socioeconomic status needs to be further delved into. A stronger deeper set of interviews and a longer study period is needed to carry out this more delicate work. Fourthly, it would have been interesting and informative to explore how the permit system works in other areas of Costa Rica. This would aid in understanding how much of an effect the permit system has had on thatching around the country – this of course may mean studying other types of palm that are used for thatch. Gathering a broader background of palm, thatch, and the permit system will inevitably lead to a fuller understanding of the perceptions, experiences, and implications of the current natural resource management system. Finally, it might help to do a conduct a cross-cultural study and analyze the differences in natural resource management practices, socio-cultural dynamics, traditional knowledge, and more. Conducting such a cross-cultural study may shed light on whether the conservations efforts within Costa Rica are beneficial for both residence and the environment.
CONCLUSION

Prior to conducting this study, the presumption was that Manicaria saccifera was being overharvested and the ecosystem within the Tortuguero region was being impacted. However, the results of this study proved otherwise. Essentially, the biological assessment showed that the Manicaria saccifera has a high density population within the BCWR. Moreover, the sociocultural research found that the local inhabitants no longer utilize palm for thatch. This change in behaviour is a result of several factors including: health and safety issues; advantages of other roofing materials; difficulty in procuring the palm leaves; a shift in knowledge involving the harvesting and thatching process; and lastly the permit system that restricts the harvesting of the palm.

The two most prominent reasons for this shift in behaviour are attributed to (1) the loss of knowledge of how to harvest and thatch, and (2) the implementation of MINAET’s permit system. Knowledge of thatching is passed down through both observation and participation. As less people are utilizing thatch, the knowledge of how to harvest and thatch Manicaria saccifera is not being passed down to younger generations. As for the permit system, Law 7317 regulates the appropriation and trade of natural resources within Costa Rica and ensures that any extraction is done in a sustainable way. In vain of Law 7317, the respective permit system was developed and implemented, which required applicants to provide proof of ownership or right of possession of the property where natural resources will be extracted (i.e. Manicaria saccifera). Providing such documentation proved to be impossible for the majority of the people in Tortuguero, particularly the former squatter’s settlement of San Francisco. This was mainly due to the region having a large number of non-landowning residents.

Given the abundance of Manicaria saccifera in the BCWR, this study concludes that the local community posses little to no threat to the Manicaria saccifera. Rather, a greater threat to Manicaria saccifera is the large-scale destruction of its habitat and the potential for a commercial market if the permit system was not in place. Given the frequency of land clearing and the scale of plantations in the region, the permit system would be more effective if it directly addressed and regulated the expansion of such developments. Moreover, it is important to note that the respective permit system does not serve the local people and their needs, and in effect creates a disconnect between conservation efforts and ensuring quality of life for locals. Such a disconnect can be easily addressed by making the permit more accessible to non-landowners. Essentially the permit system would be more effective, as well as embody ACTo’s mission to “manage natural resources” while also improving “quality of life” for local inhabitants, if it allowed for responsible and independent use of resources, while continuing to prohibit and regulate the commercial use of the resources and the large-scale destruction of their habitats.
REFERENCES


APPENDICES

Appendix 1

Legend of Charts

X MULTI: Times Multiplier
TIME IN: Time in and out of the transect
DISTANCE: Transact distance in meters
STAGE: Stage of live (M) Mature, (J) Juvenile, (Sa) Sapling, and (S) Seed
SIDE: Side of the transect (R) River and (F) Forest
DISTANCE: Distance (m) from transect marker
LEAVES #: 
  Live: leaves which are green
  Dead: leaves which have died
  Cut: leaves with 45° cut mark
DBH: Diameter at breast height (1.3m level) if no trunk mark as 0, measure in cm
HAGAR: (reading use 20m scale/distance to transect marked use as divided of readings to get height):
  Crown: Measurement to the crown of the Manicaria
  Base: Measurement to the base of the Manicaria
  Comments: Any pertinent information

GPS (reading every 25 meter)
  Error: Error in meters
  North: Northern position
  West: Western position
ACTUAL: Actual transect distance

Palms per hectare: Manicaria palm per hectare
Fronds per hectare: Manicaria fronds per hectare
NUMBER: Number entered
## Appendix 2: Raw data from Raphia Trail, River front part

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## Appendix 3: Raw data from Raphia Trail, Back River

- Biology of seed orientation: Hole in seed if facing down they are hollow, if facing up they seem to geminate.
- Appendix 4: Table of data with columns for transect distance, number of leaves, base, and comments.
### Appendix 4: Raw data from Manacaria Swamp

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### Appendix 5: Raw data from Cerro 5 North 6 Southside

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<th>TRIANGULATION</th>
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47
### Appendix 6: Raw data from Raphia, X123 Raphia Combo

| DISTANCE | LEAVES | COMMENTS | GPS reading every 25 meter | Mature: >10 cm, Juvenile: <10 & > 1.3m, Sapling: <1.3m, na= value not found or no present for ... 0
1 0 0 Se 0.47 na 3 * 40 na 0
0 10 Se 0.62 na 3 * 40 na 0
1 10 Se 0.4 na 3 * 40 na 0
2 10 Se 0.47 na 3 * 40 737 na 0

---

**Check with Myers thesis**
- Mature: >10 cm
- Juvenile: <10 & > 1.3m
- Sapling: <1.3m
- na= value not found or no present for...
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<th>Transect</th>
<th>BASE (M)</th>
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<th>NUM.</th>
<th>SPECIES</th>
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<th>BASE #</th>
<th>TANSECTION</th>
<th>LEAVES #</th>
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<th>WIDTH</th>
<th>FLAP</th>
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<th>RANK</th>
<th>ANGLE</th>
<th>FRACT</th>
<th>GROWTH</th>
<th>AV. DISTANCE</th>
<th>AV. HEIGHT</th>
<th>AV. EFFORT</th>
<th>ALLO.</th>
<th>CONTAMEN</th>
<th>FRONDEED</th>
<th>NUM.</th>
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Appendix 7: Raw data from Manacaria Swamp, X4

- **BASE (M)**: Base measurement in meters from the transect point.
- **DISTRIBUTION**: Distribution of the transect point.
- **NUM.**: Number of observations.
- **SPECIES**: Species of plants observed.
- **FROND. #**: Number of fronds.
- **BASE #**: Base measurement in meters.
- **TANSECTION**: Tansition number.
- **LEAVES #**: Number of leaves.
- **HEIGHT (m)**: Height in meters.
- **LENGTH**: Length in meters.
- **WIDTH**: Width in meters.
- **FLAP**: Flap measurement in meters.
- **AV. BASE**: Average base measurement.
- **RANK**: Rank of the transect.
- **ANGLE**: Angle measurement.
- **FRACT**: Fraction of the transect.
- **GROWTH**: Growth measurement in meters.
- **AV. DISTANCE**: Average distance.
- **AV. HEIGHT**: Average height.
- **AV. EFFORT**: Average effort.
- **ALLO.**: Allocation.
- **CONTAMEN**: Contamination.
- **FRONDEED**: Frondeed measurement.
- **NUM.**: Number of observations.
- **TEAM HC/G**: Team HC/G.
- **PASS**: Pass number.
- **FORAGE**: Forage measurement in meters.
- **RESEARCH**: Research measurement in meters.
- **INTERVAL**: Interval measurement in meters.
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<th>STAGE OF LIFE</th>
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<th>J (JUVENILE)</th>
<th>S (SAPLING)</th>
<th>S (SEED)</th>
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**Appendix 8: Raw data from Cerro, Combination 5 6**

- **Check GPS readings**
- **Raw data from Side R=River F=Forest**
- **Error**
- **Combination 5 6**

- **Leaves #**
- **Hagar, reading use 20m scale/distance to transect marked use as divided of readings to get height**
- **average frond plant**
- **average frond plant per hectare**

- **Notes:**
- **Average frond plant**
- **Average frond plant per hectare**
Appendix 9: Mature *Manicaria saccifera* calculations:

<table>
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<tr>
<th>Transect</th>
<th>Density/ha</th>
<th>Frond Count/ha</th>
<th>Average Number of Fronds for Mature Palm</th>
<th>Average Height for Mature Palm (m)</th>
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<tr>
<td>Riverine Swamp (Raphia Trail)</td>
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<td>4128</td>
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Appendix 10: Juvenile *Manicaria saccifera* calculations:

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## Appendix 11: Palm per hectare, fronds per hectare, average height, average fronds/plant at each stage

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<th>Per hectare (10,000m²)</th>
<th>Average HEIGHT (m)</th>
<th>Average FRONDS/PLANT</th>
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<td>3.751</td>
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<td>Cerro</td>
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Appendix 12: Questions for Interviews and Focus Group

Section A: Interview Questions

Harvest
Where would you go or who would you talk to if you wanted to harvest palma real?
How do you harvest the leaves?
Do you follow a path or not?
How far are you willing to go in order to get the palm leaves?
Where does palma real grow?
Where is the closest palma real swamp?
Is the density of palma real growth fairly steady or are there times when it is more sparse?
Is there a preferred time to harvest leaves?
What size of tree is best for harvest?
When do you consider the palm to be mature enough for harvest?
Does it matter what size the leaves are?
On average how many leaves get harvested from each tree?
Why don’t you just cut down the whole palm to get the leaves?
Is the number of leaves harvested per tree limited by the permit system?
How often, on average, do you need to harvest palm leaves for thatching purposes?
Do you change the harvest location for each harvest?
Are you concerned that palma real might be overharvested in this area?
Are there any instances where the palm in this area is harvested by outsiders for use outside the area?
How long does it take for a harvested palm to regenerate?

Thatching
Did you learn to harvest the palm first or to thatch a roof?
Did your parents use thatch?
Who taught you how to thatch a roof?
How old were you when you first harvested palm leaves?
Does palma real have any other uses?
What advantages does palma real have over other palms for thatching?
Have you ever used another material for thatching? What type of palm is preferred?
How many palm leaves does it take to roof a house?
How many palm leaves does it take to roof a rancho?
Do you use the whole leaves or only part of them?
What do you do with any harvested leaves that were not used for roofing?
Is it possible to repair a thatched roof or must the entire roof be replaced?
What do you do with the materials from an old roof?
What would you prefer your roofing material to be and why? What material do you think looks best?
Would you use palma real more frequently if many trees were located near/on your property?
When land is being cleared are the palm leaves sold or used for thatch?
Was there a time when the majority of the houses in San Francisco were made of thatch?
How have the attitudes toward the use of thatch changed?
Economics
Do you harvest palm leaves to sell or trade?
Is harvesting palm a source of income? If so, how much income is generated and how long does it last for?
How many of you know about the permit system? How many have applied for permits?
Why is there a permit system? Do you think its a good system that serves a good purpose or not?
How long has the permit system been in place?
Has the permit system effected your decision to not use thatch?

Health/Safety
How do palm-thatched roofs fair in tropical storms? Are they susceptible to high winds or fairly resilient?
Are there any health and safety issues with thatch roofs as opposed to other materials?
Do they harbor insects or moisture, and are they susceptible to mold?

Tradition
Who in the community knows the most about palma real, how to harvest it and build thatch?
Is the knowledge about harvesting and thatching endangered of being lost? Do you think it is important?

Section B: Focus Groups Questions

Harvest
Where would you go or who would you talk to if you wanted to harvest palma real?
Is the density of palma real growth fairly steady or are there times when it is more sparse?
Is there a preferred time to harvest leaves?
On average how many leaves get harvested from each tree?
Is the number of leaves harvested per tree limited by the permit system?
How often, on average, do you need to harvest palm leaves for thatching purposes?
Are you concerned that palma real might be overharvested in this area?
How long does it take for a harvested palm to regenerate?

Thatching
Did your parents use thatch?
Have you ever used another material for thatching? What type of palm is preferred?
What would you prefer your roofing material to be and why? What material do you think looks best?
Would you use palma real more frequently if many trees were located near/on your property?
Was there a time when the majority of the houses in San Francisco were made of thatch?
How has the attitudes toward the use of thatch changed?

Economics
How many of you know about the permit system? How many have applied for permits?
Why is there a permit system? Do you think its a good system that serves a good purpose or not?
Has the permit system effected your decision to not use thatch?

**Tradition**
Who in the community knows the most about palma real, how to harvest it and build thatch? Is the knowledge about harvesting and thatching at risk of being lost and do you think it is important?

**Lodges**
How many of you work at a lodge?
How many lodges use thatch?
How do you feel about the lodges being able to use thatch?
Do you think they are maintaining the current thatch roofs or are they going to change the material in the future?
Appendix 13: Participant Information

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<th>Participant</th>
<th>General Information and Selection Reasons</th>
<th>Miscellaneous</th>
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<td>Interviewed in English; voice recorded</td>
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<tr>
<td>Key Informant 2</td>
<td>Male, 30s; Local resident of 2 years in San Francisco; living deeper in BCWR for 9 years prior</td>
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<tr>
<td>Key Informant 3</td>
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<td>Previous history of thatching</td>
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<td>Grew up near Cariari</td>
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<td>Key Informant 5</td>
<td>Male; Local resident of San Francisco; long term resident of Tortuguero region</td>
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<td>Spoken to in Tortuguero</td>
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<tr>
<td>Opportunistic Interview 2</td>
<td>Male; 30s; Local resident of Playa Norte; has been here 2.5 years; partially repaired roof for Key Informant 1</td>
<td>Wants to help protect the turtles</td>
</tr>
<tr>
<td>Opportunistic Interview 3</td>
<td>Older male; local resident of Playa Norte; has been there 6 months</td>
<td>Taking care of a farm for owners who live in Cariari; likes wildlife and wants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>protect the turtles</td>
</tr>
<tr>
<td>Opportunistic Interview 4</td>
<td>Male; helped harvest the leaves for his rancho; his</td>
<td>Rancho is 11 years old and needs repairs; thinks they are</td>
</tr>
</tbody>
</table>
brother and one other man thatched the rancho. His sister is the owner of the dwelling and has lived there for 4 years. He is taking care of the dwelling also, and has lived there for 2 years

going to repair the whole roof

| Opportunistic Interview 5 | Female, in her mid-50s, from Nicaragua; house thatched with Manicaria; has lived in area for over 30 years | Sells refreshments |