LIVELIHOODS, AQUATIC RESOURCES AND NON-MONETARY VALUES OF LOCAL NATURAL RESOURCES IN MEXICO´S LOWLAND MAYA AREA

by

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Dedication

The scholarly effort of this dissertation is dedicated to my former teacher Dr. D.H. Cushing (United Kingdom) for his inspiring academic work and his support and encouragement to Mexican researchers during and after 1987.

The personal effort of this research is dedicated to my family, including my parents Manuel Arce Suárez and Domitila Ibarra Arámbul, my brothers, Ricardo, José Luis and Enrique, and sisters, Ramona, Luz, Hilda, and Beatriz; my sons, MartÍn and Ulises, and my husband, Jorge.

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Abstract

An interdisciplinary study was undertaken on livelihoods of Mayan communities, their aquatic resource use and the non-monetary values of natural resources within The Mayan Zone of Quintana Roo, Mexico. The research used methods from both the social and natural sciences, including development studies, anthropology, economics, ecology and fishery science. With respect to Mayan livelihoods in common property lands (*ejidos*), these were found to be multiple, seasonal and dynamic, relying to a great extent upon the rainforest of the study area. It was noted that the study area is acknowledged as one in which people live under deprived conditions and therefore their livelihoods could not be considered as truly sustainable. The multiplicity of livelihoods is reflected in the finding that fifty-two sources of income were recorded in three Mayan *ejidos*. From the point of view of the field of development studies, income diversity was highest in *ejido* "Junp'éel" followed by "Óox p'éel" and "Ka'a p'éel", whereas from a functional resilience perspective, income diversity was slightly higher in *ejido* "Ka'a p'éel" followed by "Junp'éel" and "Óox p'éel". The contribution of fishing to Mayan livelihoods varied among *ejidos* but it was among the minor livelihoods in all cases. However, it was found that fishing was relevant to Mayan communities because it contributed to traditions, religious observances and recreation. The study results concerning aquatic resource use indicate the artisanal nature of inland fisheries of the study area with the use of hook-and-line as the main gear. Indigenous and non-indigenous people were the users of a fishery for which the fishing season was primarily during the dry season and for which no explicit management regulations were found. In this study, local and scientific knowledge were combined to study the fishing sites. Thirty-nine out of 58 interviewees reported changes related to fishing in 16 traditional fishing sites, some of which registered both relatively low (0.13) and medium (0.42) fish diversity indexes. The thesis also examined the relative importance of the different natural resources based on the stated preferences of the interviewees. All three community groups of a Mayan *ejido* studied considered "soils" (the key natural resource to undertake agriculture) followed by "woodsticks" (materials for hut construction and fuel) as their two most valuable out of seven natural resources. In fact, they emphasized that all their natural resources were important to them, but that "soils" was their most important because slash-and-burn agriculture was the most important activity to their communities. The implications of the overall results to both the Maya in Quintana Roo and conservation of the forests in the study area are discussed.

List of Abbreviations and Symbols Used

MABC - the Meso-American Biological Corridor

UNDP – United Nations Development Program

mS cm^{-1} milliSiemens per centimeter (a unit of measurement of the ability of water to conduct electricity, i.e., its conductivity.)

Glossary

For the purposes of the present dissertation, the following definitions will be used:

Campesino (derived from Latin *campus*). It is a Spanish word primarily used in Latin America to refer to a people whose primary occupation is being a farmer or agriculturist. These people may either pursue subsistence farming or commercial-oriented farming but most usually, pursue a mixture of both.

Cenote (derived from the Mayan word *Ts'ono'ot*) refers to a water body found in lime-stone, nearly circular in shape, the water of which was exposed when the roof collapsed. The water of cenotes may be little or very much interconnected with underground water.

Cluster analysis. It is a statistical technique to build clustering of (similar or dissimilar) items based on some traits. In statistics it is called a classification technique because historically it has been used by taxonomists who classify (group of) species. In this dissertation the traits used to cluster water bodies were limnological data (number of fish species, transparency of water, depth of the site, among others).

Ejido is a local name used in Mexico to designate a common holding or a land entrusted to a group of people by the Mexican government. At every *ejido* there is a General Assembly of "ejidatarios" who decide on the allocation of the natural resources at the *ejido* level.

Emic refers to expressing the views, concepts, categories of classification and measurement, and values of insiders.

Etic refers to expressing the views, concepts, categories of classification and measurement, and values of outsiders.

Equity refers to fairness and particularly to people having similar rights and opportunities to access means and claims, which, among other things, allow them to meet basic human needs. Equity may be intra-generational and/or intergenerational.

Fisheries management [natural resource management] is the integrated process of planning, decision-making, allocation of natural resources, rules of use and enforcement, if appropriate, all directed toward the accomplishment of the fishery objectives.

Karst (the term originated at a lime-stone based area called "Karst" in the Adriatic Sea). It refers to a terrain based in lime-stone in which both waters, underground and rains, produced excavating effects on the soluble lime-stone, resulting in rocky ground, caves, sinkholes, and underground rivers.[Thus, a karstic water body refers to sites resulting from the excavating effects of water upon lime-stone]

Mind Maps. (introduced by T. Buzan). It is a qualitative method of analysis on how several issues can be related. In devising a mind map, people start from simple to complex, either a drawing, sketch, check list or image, most often with an irradiating form, that link similar or related things and from which linking comes up a new outcome or understanding.

Redundancy. It refers to the quality or state of being repetitive or of having repetitive components.

Resilience. The capability to recover from perturbation or change.

Snowball sampling. It is a qualitative research tool mostly used in the social sciences and humanities. It starts with one person who then refers to another which could potentially provide the type of information the interviewer is seeking.

The next interviewee refers to another and so on, until the sample of interviewees increased up, analogous to a "true" snowball.

Species richness. (from ecology) It refers to a count of the number of different species in a given area or specific site. It is also the basic definition of diversity in ecology.

System. This dissertation refers to 'system' to one or more elements having a function and/or structure which altogether form a whole. In systems with two or more elements, the latter are often interacting interrelated parts, functioning either independently or jointly within an environment. The term system has a number of different meanings to describe, among others, ecological, mechanical, and organizational phenomena.

Sustainability is the process of maintaining and often enhancing the components and/or the functions of systems. In this dissertation it is primarily applied to rural indigenous socio-economic systems, and it refers to using the local natural resource base while taking into account both the regenerative capacity and the function of local ecosystems and the maintenance of human benefits and welfare. It includes the concept of generational equity.

Sustainable Livelihood refers to secure rights and reliable access to local resources and/or wage-income such that stocks, flows of food, cash and social justice issues to meet basic needs is maintained and enhanced in the long term. It includes the concept of generational equity.

Subsistence is the production of goods primarily for family consumption. The meaning of subsistence is different for each community because of their ethnic roots, economic histories, and their component families.

Value is the relative importance or worth that people place on an asset in a given context.

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[1] Dr. Lane could not attend my thesis defense because she was sick and therefore, was not able to sign the signature page. Nevertheless, given her full participation during my Ph. D. program, I consider that she was still part of my supervisory committee.

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Chapter 1

Introduction

[An interdisciplinary approach: Linking social and natural sciences methods to study human-nature interactions in Southern Mexico's rainforest]

1.1. Introduction

This chapter presents research undertaken by one trained in natural sciences, particularly in fisheries science, who, upon starting a project on inland fisheries in Mexico's Lowland Maya area, found an interdisciplinary approach indispensable. Thus, willing to cross disciplinary boundaries into the social sciences, the author of this study obtained experiences in the latter sciences as well as support from the Mayan people to pursue her research.

This introductory Chapter is organized as follows. Section 1.2 presents a statement of the research problem. This is followed by section 1.3 which presents the research questions and approach, including the set of general topics and fields of inquiry that were used in the dissertation.

1.2. Statement of the Problem

Studying productive systems in which there is an inherent human-nature interaction is complex and dynamic, and there are many examples in which its research is undertaken with the use of both social and natural sciences methods (e.g., Scoones, 1999).

Research published during the last twenty years by social and natural scientists, addressing human-nature interactions have suggested a proposition: on a global scale, they argue, there exists a considerable overlap between linguistic diversity and biological diversity (Nazarea, 1999; Toledo et al., 2001). Moreover, another proposition asserts that in those highly diverse areas, the preservation of

biological diversity depends upon the preservation of linguistic diversity and *vice versa* (Hunn, 1999; Toledo et al., 2001).

One of the world's richest areas in terms of linguistic and biological diversity is the Mesoamerican region[1].This area is the homeland of approximately 100 ethnic groups settled in rural areas wherein environmental problems, social inequality, and poverty are pervasive (DFID, 1999; Toledo et al., 2001; WRI, 2002). In this area, signs of environmental degradation exist even though there are plants and animals whose species have not been described yet (see Schmitter-Soto, 1998a). In addition, many ecosystems have not been studied because they are located in remote territories but they have been used for decades or even centuries by local people.

In this geographical area are settled the Maya, the descendants of the ancient Mayan civilization. These people are regarded as agriculturalists but also as a rainforest society, located in a diversity of environments grouped into two broad classes, namely the Lowland and the Highland Maya areas (Atran, 1993; Valverde, 2000). Although with some variations among countries, the Mayan people from rural communities are mostly bilingual but, still in the twentieth-first century, there are many elders who are only fluent in Mayan. Moreover, many Mayan communities are located within the limits of common holdings locally known as *ejidos*, located close to tracts of rainforest in which people pursue slash-and-burn agriculture, livestock rearing, hunting, and fishing (Wilk, 1997; Morales Garzón, 2000; Bello Baltazar et al., 2001). Hence, these people depend primarily upon their homeland's natural resource base for livelihood.

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[1] Although the term Mesoamerica has been historically used by ethnohistorians, archaeologists, and ethnologists to designate an area ranging from the center of Mexico to most parts of Central America (excluding Panama), based upon maize diversification coupled with pottery production (Toledo et al., 2001), for purposes of an international initiative the area comprising Southern Mexico and Central America is currently called the Meso-American Biological Corridor (see WRI, 2002).

Human-nature interaction in Mayan communities has been studied by national and international scholars whose interests have been primarily slash-and-burn agriculture and forestry systems (e.g., Hostetler, 1986; Atran, 1993; Velazco-Te, 1999). In contrast, aquatic ecosystems, including the round-shaped sinkholes locally known as cenotes, and their use and management by the Maya have been scarcely studied. For example, in some studies on Mayan productive systems, the diversity in uses of freshwater ecosystems was not reported even though there were conspicuous lakes close to the studied settlements (e.g., Atran, 1990; Jorgenson, 1993).

In Mexico, a literature review about studies in which Mayan fishing was included, undertaken from 1990 to 2005, resulted in only four reports, all undertaken by national scholars; the first one, focused exclusively on Mayan fishing, was reported by Rojas-García (1999); a second co-authored by Bello-Baltazar et al. (2001), and two Ph. D. theses in social anthropology by Bello-Baltazar (2001) and Estrada-Lugo (2005), respectively.

From the point of view of resource management, and specifically common property theory (e.g., Harding, 1968; McCay and Jentoft, 1998), Bello- Baltazar et al. (2001), Baltazar (2001), and Estrada-Lugo (2005) also reported diverse approaches of resource management within a Mayan *ejido* of Quintana Roo. More specifically, those authors showed that a market-oriented activity, such as logging, is managed with centralized or government led management, in which a community quota is set every year. In addition, they showed that the use of agricultural fields are based upon customary rules but surprisingly, no fisheries management strategies or customary management rules were described for the local fisheries depicted in their studies. Furthermore, on a regional level, further surveys of water bodies at 5 Mayan *ejidos* as well as interviewing local people, showed that fishing is not restricted to only one or two *ejidos* but to a yet unknown number of *ejidos* of Quintana Roo (Elías-Gutiérrez and Arce-Ibarra, 2002). The last statement was true especially because in Quintana Roo,

freshwater fishing is neither acknowledged nor reported as a productive activity in regional statistics and therefore, neither the government nor scientists are aware of the existence of this activity.

Thus, scarcely studied freshwater ecosystems interspersed in the forest, both of which are used for livelihoods, together with common property theory issues in indigenous lands, posed several research problems to be addressed by the scholarly community. In the long term, addressing any of these issues would not only benefit science but also the involved communities and governmental agencies dealing with the management of resources at a regional level.

1.3. Research Questions and Approach

1.3.1. Research Questions

Given the preceding description of the gaps in knowledge and therefore of the research needs, the generic framework undertook to address human-nature interaction taking place at Mayan *ejidos* of Quintana Roo. Thus, the study included five research questions as follows:

1) what is the income diversity and relative resilience of Mayan livelihoods in three *ejidos*?

2) what are the natural resource base, ecosystems, users, and general management regulations comprising freshwater fisheries at *ejidos* in Quintana Roo?

3) what are the relative values that Mayan people place upon the various natural resources used for livelihoods?

4) what is the contribution of fishing to Mayan livelihoods in three *ejidos*?. and

5) what are the limnological attributes and the fish community structures of karstic water bodies in Quintana Roo?

Whereas some of the questions (numbers 1, 3 and 4) address topics at a common property (*ejido*) level, others (numbers 2 and 5) did so at a regional level.

1.3.2. Approach

To adequately understand the human-nature interactions taking place in the study area as well as to particularly address the research questions, a combination of natural and social science methods were called for. This interdisciplinary approach is thus one of the principal contributions of the dissertation that follows. Moreover, it provides a model for future research in Mexico's Lowland Maya area.

Besides a conventional or "etic" view of the research problem and questions, the research considers also the point of view and knowledge of the local people, also called an "emic" view (Chambers, 1997). The latter issue was considered relevant for two reasons; first, given the location of the communities and natural resources, they were regarded as data-sparse and hence, social surveys, in which people would provide both expertise and knowledge using their own terms and most likely, their worldviews, would be needed. Second, because in Mexico, once any study on a common holding or rural community is ended, it should be the community which would organize people either to, for example, use, conserve and allocate the local resources, accordingly. Therefore, by taking up multiple research methods and perspectives, and reading them against each other, this research was intended to capture a fuller and more accurate picture of the livelihood strategies pursued by the Maya; the nature and contribution of aquatic resources (including fishing) to rural livelihoods and how local people value the resources used for livelihoods.

Each research question is addressed in a separate Chapter. In all cases (i.e., in all Chapters), the disciplines and topics were integrated through the use of 'Mind Maps', a qualitative method from psychology which uses either a common concept or a framework to link topics (Buzan, 2006). The procedure was as follows. All disciplines and fields of inquiry used from both social and natural sciences, which are described in detail in the next paragraphs, were written as

headings onto a blackboard and, below each, the concepts related to each field of inquiry were listed (in an arbitrary order). Afterwards, similar (or the same) concepts were linked with arrows, resulting in a link or integration of two (or more) fields on inquiry through similar concepts. Lastly, every research question and therefore, the research objective of each chapter, guided the final selection of topics within each chapter. Besides the Mind Maps method, the research used basic conceptualization of systems theory and, when appropriate, ethnoecology. The latter referred to the use of traditional or indigenous knowledge in research (Toledo, 1992). In respect to natural sciences, the study used methods from fisheries science and ecology. The social sciences included development studies, economics and anthropology, most using the framework of participatory research.

The dissertation is composed of 7 Chapters. Chapter 1 is this introductory Chapter. Chapter 2 deals with the first research question (assessing income diversity and relative resilience of Mayan livelihoods). The study addressed the interconnection of concepts from development studies, systems theory and ecology. In particular development studies and ecology were linked through the concept of diversity. In this Chapter, a household survey was undertaken, which in turn, considered the insights of Chambers (1997) related to using local materials and participatory schemes to get information from participants. Results of the study were analyzed using two approaches. First, a conventional approach from development studies was used, including defining the basic concepts and theory on livelihoods; depicting results in graphs and contrasting results with livelihoods studies from other scholars (Ellis, 1998). Second, in respect to systems theory and ecology, livelihood data were analyzed using an interdisciplinary approach, in which both social and natural systems are linked though the use of the ecological concepts of diversity and resilience (Ludwig et al, 1997; Berkes and Folke, 1998; Holling et al., 1998; Peterson et al., 1998; Forys and Allen, 2002; Allen et al., 2005). As far as the author of this study could ascertain, the second form of analysis and interpretation of livelihood data has

not been reported in the literature yet, and therefore it might represent a novel approach to study livelihoods (details are presented in Chapter 2).

In Chapter 3, research question number two (about the natural resource base, ecosystems, users, and general management regulations comprising freshwater fisheries at indigenous and non-indigenous *ejidos*) was addressed. There, both fisheries science and anthropology are linked through the concepts of subsistence and livelihoods. Methods from these two areas of inquiry were used to assess the local freshwater fisheries in terms of the fishery's attributes, including seasonality, the fishing gears used, the users of the resource as well as their underlying motivations for practicing fishing; the target and by-catch species; destiny of the catch, and management rules, if any (after Mahon, 1997). In this assessment, three research tools from anthropology were also used; the first two were a social survey and a qualitative sampling technique ("snow-ball"), respectively, and the third one was systematic observation undertaken during the fishery assessment, from which data were collected in a journal (Bernard, 1995; Cohen, 2001).

In Chapter 4, a combination of both economics and anthropology is used to address research question number three (about the relative values that Mayan people place upon natural resources used for livelihoods). The study was based upon a non-monetary valuation exercise of key local resources, which in turn, were the natural resource base of the livelihoods of one Mayan *ejido*. The key concepts linking these disciplines were subsistence, livelihoods and value.

In particular, a non-monetary valuation has been suggested as an alternative to the contingent valuation method by Rutherford et al. (1998). The valuation was undertaken with the use of the paired comparison method, which is used in anthropology, in the area of "cultural domain analysis" to rank objects (Bernard, 1995, p. 280). Alternatively, as the valued resources belonged to a non-Western economic system or because they were part of an indigenous economic system,

a valuation of this kind could also be grouped into the field of economic anthropology (Wilk, 1996). This study was novel in two aspects; first, because this type of valuation apparently had not been undertaken within indigenous settings previously and, second, because the survey used new material, such as color pictures to represent the assessed resources.

In Chapter 5, research question number four was addressed (about the contribution of fishing to livelihoods in three *ejidos*). It presents a second review of livelihood data, but in this case, they were analyzed highlighting the contribution of fishing to the overall livelihoods in three *ejidos*. This Chapter builds on previous Chapters. The study's approach included development studies, anthropology, ethnoecology and fisheries science methods, with the concepts of subsistence, livelihood and knowledge being common among them.

Chapter 6 contains results of the research question number five (about the limnological attributes and the fish community structures of karstic water bodies in Quintana Roo). It addresses this topic with theory, concepts and methods from anthropology, ecology and ethnoecology, with the concept of knowledge being the common issue among them. The study included a social survey wherein local knowledge was systematically recorded. Additionally, it used biological surveys to analyze species diversity and the fish communities' trophic structures.

Finally, Chapter 7 of the dissertation contains both conclusions and a general discussion and implications of the overall research. In contrast to the specific discussion of each individual chapter, it focuses on more general aspects, including a discussion of the approach used and an effort to integrate results of the remaining 6 chapters.

In respect to the time period in which the research was undertaken, most of it was undertaken from January 2004 to June 2006. Nevertheless, unpublished data - both qualitative (Ql) and quantitative (Qn), from previous research grants

undertaken from 1998 to 2001 were also included. A summary of the research period for each research question is presented in Table 1.1.

Table 1.1. Time periods of the research.

Research question	Chapter	Time period (mm/yy)	Additional information (Qualitative, Ql, Quantitative, Qn)
1	2	09/04- 01/05	04/98 (Ql); 08/99-08/01 (Ql); 03/06 (Ql)
2	3	01/04- 09/04	04/98 (Ql); 08/99-08/01 (Ql and Qn)
3	4	02/04- 06/05	04/98 (Ql); 08/99-08/01 (Ql)
4	5	09/04- 01/05	04/98 (Ql); 08/99-08/01 (Ql)
5	6	01/04- 06/05	04/98 (Ql and Qn); 08/99-08/01(Ql and Qn)

In respect to the people who participated in the research, in Mexico, the research period from 2004 to 2006 had the participation of two teams of people; one encompassing the author, her research assistants and field guides, and a second one which was a local advisory team including two anthropologists and a scholar from the humanities, all three living in the study area. Two persons of the latter group were native Mayan speakers, one from Quintana Roo and the other from Yucatan. Nonetheless, all persons of this advisory team had their own work to do at their home institution (CONACULTA, a public institution dealing with the promotion of culture). In this respect, and because this study demanded intensive fieldwork in the communities, they were not able to have full-time participation in the research. Thus, they participated in introducing the research team to three *ejidos'* authorities and on occasions, they interviewed people at the same three *ejidos*, especially during the first six months after the project had started. In spite

of this partial fieldwork participation, the three people were able to provide advice and guidance to the research team along the course of the research, especially when doubts and conflicts had arisen in the Mayan communities. In addition, several community groups, including local authorities and other inhabitants, all working on a voluntary basis, were backing up the research project in their communities. Hence, as the number of *ejidos* and communities involved in the research varied across the research questions, a summary of the study sites and their communities per research question is presented in Table 1.2.

The degree of participation varied from very enthusiastic to none, with the latter occurring in 1 out of 9 *ejidos*. In total 16 communities supported the research project (see Table 1.2).

The research was undertaken under challenging circumstances for several reasons. First, in Mexico, even in the twenty first century, many rural and indigenous peoples, including the Maya, are marginalized people for whom the degree of literacy is extremely low, public services such as sanitation, electricity and potable water in the communities are scarce, and people live in crowded conditions (see INEGI, 2000; SEDESOL, 2002), all of which were observed during several years of fieldwork – in 1998,1999, 2001; 2004, 2005 and 2006 - by the author.

Second, except for one period, during the last four federal governmental periods (from 1988-2001), the Mexican government has attempted to provide relief to the poorest of the poor Mexicans, including most indigenous people, through small monetary grants delivered at their communities periodically (e.g., Skoufias et al., 2001).

Unfortunately, apart from a few isolated cases in capacity building, those monetary grants are not part of programs geared towards improving the long-

term welfare of people as could be, for example, programs on both capacity building and human rights awareness.

Table 1.2. *Ejidos* and communities involved in the research.

Ejido #	Research questions*					# communities studied	total # comm. in the *ejido*
	1	**2**	**3**	**4**	**5**		
1	X	X	X	X	X	5	6
2	X	X		X	X	1	1
3	X	X		X	X	1	1
4		X		X	X	1	1
5		X		X	X	2	4
6		X		X	X	1	1
7		X		X	X	3	3
8		X		X	X	1	1
9		X				1	1
Total 9						16	19 .

* The research questions: # 1 about livelihoods; # 2 about inland fisheries; # 3 about non-monetary valuations; # 4 about the contribution of fishing to livelihoods and # 5 about water bodies.

And third because as a result, the degree of marginalization of these people from 1988 to date has not been reduced; rather, as it was observed during fieldwork, people continue living in one or a mixture of the following scenarios: a) they decide to stay in their communities, living under deprivation; b) in order to survive, they practice illegal activities (e.g., overusing their natural resources), and/or c) they migrate to touristic centres or to richer neighboring countries, seeking a better livelihood (A.C.C., local authority, 2004, personal communication). In general terms, it is known that migration, of both the youth and married males, had resulted in a disruption of their Mayan culture (A.C.C., local authority, 2004, personal communication; M. Collí Collí, anthropologist, 2004, personal communication). Thus, this is a particular setting wherein

undertaking research was complex and difficult. This, in turn, created challenges in entering the Mayan communities because most often, both distrust toward outsiders and internal conflicts prevailed.

Finally, in respect to the methods used in the research, as was previously described in the preceding paragraphs, there were multiple methods used but this research relied primarily on social surveys. Because the social surveys undertaken provided information for more than one research question, a summary of them, including the number of interviews undertaken per research question and *ejido*, are presented in Table 1.3.

Table 1.3. Summary of the social surveys undertaken from 2004 to 2006.

R. question	Interviews	*Ejidos*	Communities	Languages:		
				Mayan	Spanish	S-M*
1 and 4	103	3	6			
2 and 5	70	9	16			
3	106	1	4			
	279	9	16	159	90	30

* Spanish-Mayan

Note that the above social surveys were undertaken from 2004 to 2006 and therefore, Table 1.3 does not include the data (primarily qualitative data, see Table 1.1) gathered from previous research grants (i.e., from 1998 to 2001).

Chapter 2

Livelihoods I: Income Diversity and Relative Resilience in Mayan Common Property Lands

2.1. Introduction

In many low and middle income countries, the majority of rural people pursue farming or farming-related activities for their livelihood; hence, the rural economy is largely driven by farming activities. In Latin American countries where forests are still well preserved and communities are entrusted to use the forest, livelihoods either fully or partially rely on a combination of agricultural and forestry systems (Atran, 1993; Litow et al., 2001; Armijo and Llorens, 2004; Macario-Mendoza et al., 2004). An inherent characteristic of these systems is seasonality, which imposes a dynamic pattern in rural areas, including an uncertain distribution of household income and employment to people (Bernstein, 1992).

In the last two decades, many studies on livelihoods have been undertaken in the Mayan area; most of these primarily focused on topics such as traditional agriculture, use of the forest, and hunting (e.g., Atran, 1993; Jorgenson, 1993; Hostetler, 1996; Morales-Garzón, 2000; Ramírez-Barajas, 2004). Nonetheless, a few localized studies undertook a more comprehensive analysis of the Mayan people's livelihoods, producing insights into the kind of multiple livelihoods that are being pursued by, for example, the Kekchí Maya in Belize and the Yucatec Maya in Quintana Roo, Mexico (Wilk, 1997 and Bello-Baltazar et al., 2001, respectively).

A thorough understanding of the livelihoods of indigenous people, including the Maya, is important for several reasons. First, since the last two decades structural changes are taking place in Latin American countries which include either a slow removal or a change of the economic support that governments had been providing to farming activities in the past (David et al., 2000). Therefore, a detailed understanding of indigenous peoples' livelihoods might assist in either

backing up or redirecting national and regional public policies in such a way that while policies are supporting livelihoods they do not disrupt the native customs and their traditions. Second, addressing indigenous people's livelihoods would also be useful to both national and international governmental and NGO agencies which, for example, for several years now, have been interested in promoting local development in the Mayan area. This is particularly relevant because as it was observed during our fieldwork and some authors have also reported, very often, those development promotions had been based upon an outsiders' point of view and priorities – including, among others, high technological investments in agriculture, slashing down rainforest to raise cattle on inappropriate (limestone) soils, and the promotion of products and activities opposed to local traditions (Wilk, 1997; Macario-Mendoza, et al., 2004). Thus, this study is in agreement with those livelihood approaches that support a people-centered emphasis including a focus on people's perspectives and concerns as part of both public policies and development initiatives (e.g., Chambers and Conway, 1992; Drinkwater and Rusinow, 1999: Singh, 1999; UNDP, 1999; Wanmali, 1999; Ashley, 2000; Singh and Gilman, 2000; Dorward et al., 2001; Krantz, 2001; Carney, 2002).

This Chapter is about research on livelihoods of indigenous rural people from Southern Mexico. In particular, it addresses livelihoods of Mayan *campesinos* on common property lands of Quintana Roo state. The study provides insights on socioeconomic and ecological systems' interactions based on the approach suggested by several authors, notably Berkes and Folke (1998), Holling et al. (1998), among others. To achieve its research aims, it explicitly uses concepts and methods from both the social and the natural sciences. The Chapter has three aims. The first is to assess the livelihood sources of income of rural households located in Mayan lands locally known as *ejidos*. The second one is to assess an income diversity index at both the household and *ejido* levels to estimate functional income richness, diversity, and relative resilience at the *ejido* level. The third aim is to relate the results found in the two former aims with social

justice issues in such a way as to present a more integrative view of current Mayan livelihoods.

The analyses were undertaken from two complementary scholarly angles, one being the conventional approaches used in social sciences, particularly in development studies (e.g., Chambers, 1997; Ellis, 1998) and the other from the study of social-ecological systems using theory on resilience, which in turn relies upon both systems theory and ecology (see Ludwig et al, 1997; Peterson et al., 1998; Forys and Allen, 2002; Allen et al., 2005).

This Chapter is organized as follows. Section 2.2 introduces a background to the research including a summary of the Mayan *campesino* livelihood strategies with a few examples on rural livelihoods from elsewhere. It also includes the basic concepts of livelihoods and resilience used in the study. Section 2.3 comprises the methods used, including the description of study area and a summary of social justice issues as they exist currently therein. Section 2.4 presents the results of the study and finally, section 2.5 includes a discussion of the results.

2.2. Concepts of Livelihoods, Functional Richness and Resilience

Livelihoods

A livelihood can be studied taking into account the changes in social, cultural and natural capital of a geographical area or it can be studied more narrowly, for example, defining livelihood as comprising income, both cash and in kind, as well as the social institutions and property rights geared to support it (see Lipton and Maxwell, 1992; Ellis, 1998). This study is focusing on the latter perspective of livelihood as considering how people make a living.

Thus, this study considers a livelihood system as one in which with the support of entitlements and institutions, and through natural and/or man-made processes, people's labor and materials (input) will be converted into income and subsistence benefits (output). Again, the income would sustain people, their

households and their supporting institutions to pursue a livelihood. Rural livelihoods most often involve two or more activities, depending upon people's capabilities, assets and entitlements, markets, and availability of local resources (Dorward et al., 2001).

The sources of both cash and in-kind income may vary widely among rural areas. In respect to sources of cash income, some people like the Kekchí Maya (Belize) cultivate rice to get cash whereas the Yucatec Maya Yucatec (Mexico) grow vegetables (Wilk, 1997; and, Humpires, 1993, respectively). Other components of cash income include self-employment, wage salary and migratory work. The in-kind component of income refers, for example, to the non-marketed produce obtained from farming activities and from an orchard; the gatherings, fishing and game obtained within or at the edges of the rainforest, among others.

According to the literature, a rural livelihood includes activities grouped into classes, the following three being the most often referred to: a) farm, b) off-farm, and c) non-farm. A farm's sources of income includes crop and livestock rearing as well as activities associated to farming systems, such as gathering, hunting, forestry, aquaculture, and part-time fishing (Scoones, 1998). Quintana Roo's Mayan farm system is commonly referred to in Spanish as "sistema milpero" ("milpero" system) which, while varying among communities, primarily includes rain-fed agriculture (locally known either as "kool", "milpa" and "roza-tumba-y-quema" in Maya, Nahuatl, and Spanish languages, respectively), orchard, hunting, gathering, freshwater fishing, honey bee production and small scale cattle (Bello-Baltazar, 2001; Estrada-Lugo, 2005; Faust-Wammack, 2005).

Off-farm activities refer to agricultural work undertaken off one's own farm, including wage and exchange labor, and labor payment in kind. Finally, non-farm activities encompass all other non-agricultural work, such as non-farm local employment, self-employment, income derived from other properties (e.g., renting a room), among others (Ellis, 1998).

During the research undertaken in this Chapter, no off-farm activities as referred to in the literature were recorded as part of the Mayan livelihoods. Thus the utilized grouping, which was adapted from Ellis (1998), took into account local activities resulting as follows: "farm", "non-farm", "migratory work", "governmental grants", "*ejidatario*'s income" - including the rights to rely upon both timber and non timber products per *ejido*, as appropriate; and "remittances".

Rural livelihoods most often are exposed to "shocks" and "stresses" (Bernstein, 1992). Stresses refer to temporary or continuous perturbations to livelihoods, which could be cumulative and to some extent predictable, such as declining yields of soils, environmental degradation, declining rainfall, and diminishing natural resources, among others (Chambers and Conway, 1992). Shocks refer to perturbations which are sudden, unexpected, and traumatic, such as floods, extended droughts, hurricanes, epidemics, etc. (Chambers and Conway, 1992). In Mayan *ejidos* of Quintana Roo, the latter two concepts can be readily exemplified as follows. Bello-Baltazar et al. (2002) reported that milpa yields have been declining in the area, resulting in a growing concern of local people; hence, it can be stated that these people's livelihoods are to some extent coping with stress. In addition, fieldwork and observations of the present study registered in 2004, noted that Mayan livelihoods were severely affected by an extended drought, so that in 2004 and 2005, local people's livelihood in Quintana Roo's Mayan communities was affected by a natural shock. Thus, in response to seasonality and abrupt changes in their environment, the Maya and other rural people use coping and adaptive strategies for survival. Coping strategies would be those used to recover from shocks and stresses thus avoiding a livelihood collapse (Scoones, 1998). These strategies would be closely linked with the resilience of a livelihood system, because according to Scoones (1998), a resilient livelihood would be one that is able to cope with and recover from stresses and shocks.

Adaptive strategies are used in response to medium or long-term changing conditions in, for instance, assets, policies, environment, or any other issue important to pursue a livelihood (Singh and Gilman, 2000). For example, in response to changes in rainfall pattern, farmers in Malawi no longer plant or intercrop beans, a crop that 10 years ago represented their most important cash crop; instead, farmers changed to planting barley (Orr and Mwale, 2001).

Another example from Mexico relates to a youth Mayan *campesino* from one of the studied sites in Quintana Roo. During an interview completed in the present study, he commented that because of the uncertainty in *milpa* (agricultural) yields, which in turn depended upon a currently uncertain pattern of rains, he had changed (i.e., he adapted) his livelihood from working the milpa to partially working in the local tourism industry. Generally speaking, this study found that Mayan livelihoods are both adaptive and dynamic, as it was observed that from one year to the next, a head of a household might change any of its multiple livelihoods if a better opportunity is found.

In the case of rain-fed agricultural systems, like those found in tropical and subtropical environments including the Mayan area, a selection of livelihood strategies are usually pursued taking into account the risks associated with them (e.g., García-Barrios and García-Barrios, 1990; Atran, 1993; Wilk, 1997). Risk results from uncertain events, like rainfall patterns, or a potential extended drought and might be defined as combining "the probability and the consequence of a negative outcome" (Charles, 2001, p. 210).

Overall, rural people choose specific livelihood strategies to try to match expected resource availability with local demand and most often, families usually set aside some savings in kind (e.g., crops, pigs, poultry, etc.) to cope with unexpected falls in resource supply but also for future consumption (Shipton, 1990; Dorward et al., 2001).

According to Estrada-Lugo and Bello- Baltazar (in press), domestic Mayan groups (i.e., different categories of production and consumption groups) from the center of Quintana Roo pursue a variety of extractive activities at both farming and forestry systems which in turn were dependent upon the availability of rainforest resources. A key characteristic of these systems was seasonality. More specifically, the "milpero" system leads or sets the schedule to pursue the majority of farming and, to some extent, non-farming income categories (Bello-Baltazar, 2001). In Quintana Roo, the "milpero" system, which varies in working intensity through a year, encompasses between 7 to 9 months of the year (Velazco-Te, 1999).

Working in both farming and forestry systems of the Mayan *ejidos* results in obtaining both market and use value products (Estrada-Lugo and Bello- Baltazar (in press). In addition, in many Mayan domestic groups, migratory work is part of the overall livelihood strategy. In particular, Estrada-Lugo and Bello-Baltazar (in press) reported that some Mayan people use to go out of the community to work in Quintana Roo`s tourism industry whenever cash is eagerly needed in a household. The latter could happen, for example, whenever there was going to be a special event in the community, such as a wedding or a similar party.

Although it was not thoroughly recorded, this study also observed that, at indigenous Mayan *ejidos* and communities, people's livelihoods also include activities that form part of local traditions. Thus, besides the productive activities, a person may be engaged in being a local musician, prayer, dancer, as well as to hold honorary appointments during festivals and religious ceremonies. Nevertheless, people engaged in those activities do not receive any payment, except for free food during gatherings prior to and during festivals. Hence, those traditional appointments only form part of a person's social status.

Income Diversity, Functional Richness and Relative Resilience

The concept of income diversity, as introduced in the field of development studies, refers "to the composition of household incomes at a given instant in

time" (Ellis, 1998, p.5). Nevertheless, an alternative approach to assess income diversity would be the recent literature on resilience theory which has also been applied to economic and natural systems. In particular, this theory pointed out that it is possible to measure a systems' diversity in a more comprehensive and generic form through the use of functional groups (Peterson et al., 1998; Allen et al., 2005).

Presently, there is a growing literature on addressing a system's resilience in such a way as to make it measurable. Some authors have introduced theoretical frameworks wherein surrogates (i.e., substitutes) to assess the resilience of systems are proposed (e.g., Charles et al., 2002; Benett et al., 2005; Carpenter et al., 2005). Another approach has been recently introduced wherein species richness, ecological resilience and scale are related (Peterson et al., 1998). The latter approach, which was adapted for use in the present Chapter, is the one that, together with general concepts of resilience, will be explained in this section.

According to Ludwig et al. (1997), addressing resilience would be specific for every system; its underlying structure; the type and intensity of disturbances and the time scale of interest. In this respect, this Chapter is interested in addressing the relative resilience of rural livelihood systems, the structure and functions of which are poorly understood. More specifically, in this case relative resilience is addressed using a "snapshot" of household income composition derived from a household survey. Hence, this Chapter addresses a system that is both poorly known and data-sparse (i.e., the Quintana Roo's Mayan livelihood system).

According to the literature, resilience "is related to the idea of stability" (Ludwig et al., 1997, p.1). While stability refers to "the tendency of a system to return to a position of equilibrium when disturbed" (Ludwig et al., 1997, p. 1), a resilient system would be one in which internal interactions reinforce one another and dampen disruptions (Peterson et al, 1998). The definition of resilience in which we are interested in this Chapter is the one proposed by Holling in 1973 that was

subsequently referred to by Peterson et al. (1998) as the amount of disruption required to change a system from one specific state to another. The latter definition is known as 'ecological resilience' and is different to what has been called in the literature 'engineering resilience' or the rate of return of a system to a cyclic state once it has been perturbed (Holling, 1996). Another characteristic of Holling's resilient systems is that they possess some degree of functional redundancy which constitutes part of the mutually reinforcing structures and processes that allow a system to persist in the face of disruptions (Peterson et al., 1998).

Peterson et al. (1998) also reported that in order to relate resilience with diversity, species from an ecosystem could be grouped based upon the specific scales - both *temporal* and *spatial* - that they exploit. From the latter approach would result categories referred to as functional groups from which functional richness could be readily assessed. Finally, it has been proposed that the greater the system's functional richness, the greater its resilience (Peterson et al., 1998; Garmestani et al., in press). Generally speaking, it is proposed that within a system, structural patterns promoting resilience are the most likely to persist over time and are replicated across space (Peterson et al., 1998). All the latter ecological theory on understanding a system's resilience has been recently extended by Garmestani et al. (in press) to other economic systems such as production functions or firms (e.g., factories). More specifically, in an analogous way as has been done for ecological systems (see Forys and Allen, 2002), Garmestani et al. (in press) used Peterson and co-authors' conceptual model to assess resilience within and across an industrial sector of the U.S.A. In particular, they used industrial functions for several years of data, and concluded that industries with a certain degree of functional richness were more resilient to employment volatility. Therefore, in an analogous way as it was done in the latter study, the present Chapter introduces the Mayan livelihood system analyzed with the conceptual model of system resilience. Nonetheless, as authors such as Peterson et al. (1998) and Forys and Allen (2002) have shown, their conceptual

approach on resilience needs time series data, which in this case is lacking for Mayan livelihoods. Therefore, in this case the utilized approach was adapted to use data from a household survey. In doing this, the current approach itself is new but also limited in scope, because it was only able to assess relative resilience (i.e., a degree of resilience compared to other local cases) among three Mayan *ejidos*. In particular, the approach started with a grouping of sources of income into functional groups based upon their role at both the household and the *ejido* level. In this case, and as it was described in the methodology section, the criteria to devise the functional income groups were two: the first was the location (e.g., "farm", "non-farm") and status (i.e., with property or without property rights) of a source of income within an *ejido*; and, the second, the purpose (or function) of the income including several categories such as "cash" and "recreation". Generally speaking, this approach contends that assessing relative resilience of households' sources of income (both cash and in-kind) can be used to understand the resilience of Mayan livelihoods.

In general terms, it should be pointed out that the main difference in the present Chapter as compared to the assessments of, for example, Garmestani et al (in press) and Forys and Allen (2002) is that here the gaps or discontinuities among sources of income were not assessed because of data limitations (see methodology section).

2.3. Methods

2.3.1. Study Area

The Population and Landscape

This research was undertaken in Quintana Roo, Mexico. In 2000, Quintana Roo had approximately 874, 000 inhabitants and 755, 400 of them were of 5 years old and up. From an estimate based upon the latter, INEGI (2000) reported that the people who were able to speak an indigenous language comprised 23 % of the total population. Moreover, at the eight municipalities of Quintana Roo (Figure 2.1), over 10% of their population was able to speak an indigenous language.

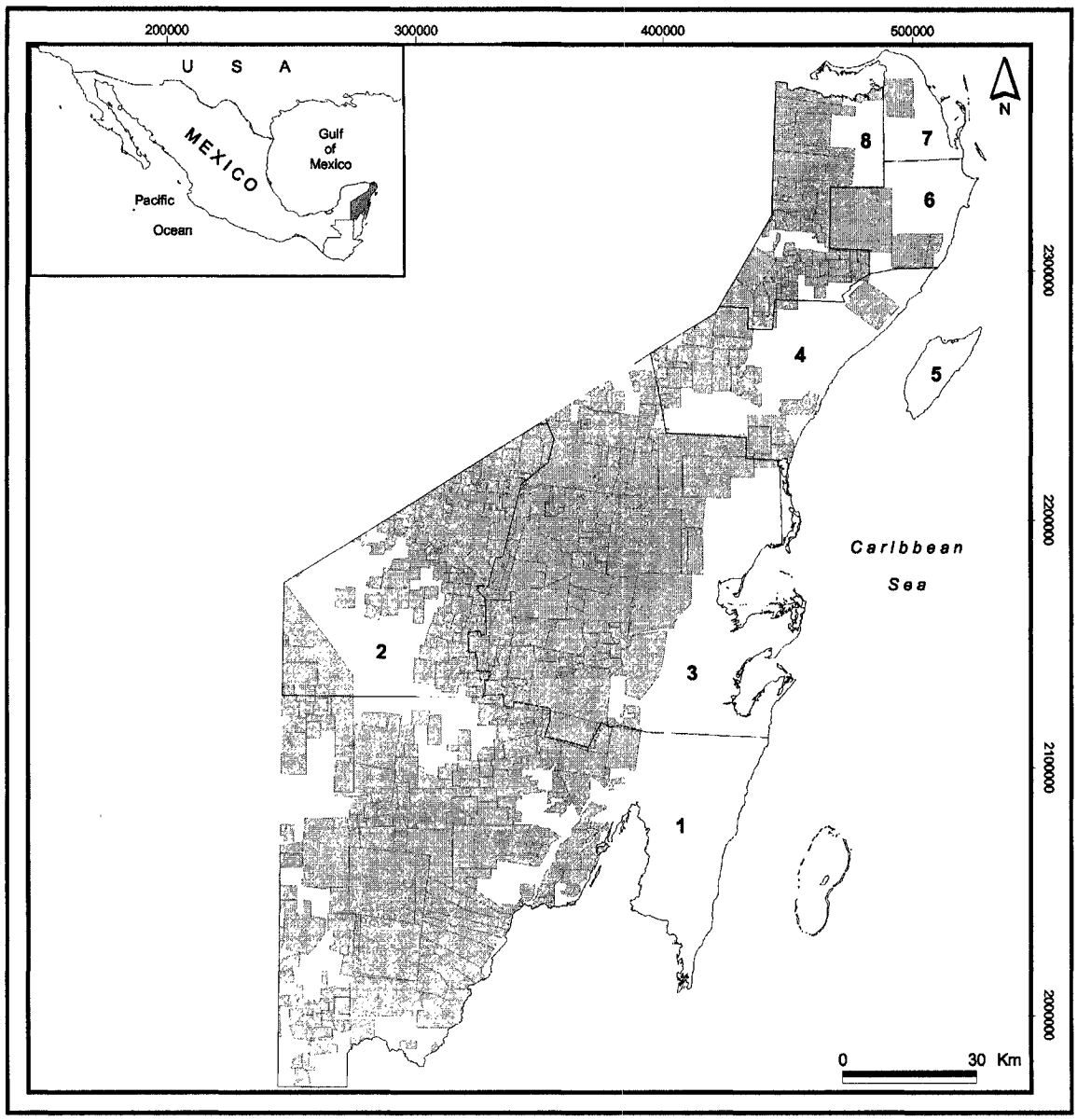

Figure 2.1. Quintana Roo state with its 8 municipalities: 1) Othon P. Blanco, 2) José María Morelos, 3) Felipe Carrillo Puerto, 4) Solidaridad, 5) Cozumel, 6) Benito Juárez, 7) Isla Mujeres and 8) Lázaro Cárdenas. The study area is located in Felipe Carrillo Puerto. Shaded areas represent the common property holdings or *ejidos*.

In this state, about 65 % of the land is under the regime of common holdings (see Figure 2.1) grouped into two categories, "ejidos" and "comunidades"[1].The study area is located in Felipe Carrillo Puerto (number 3 of Figure 2.1) and was undertaken at lands called *ejidos*.

At an *ejido*, a group of people (known as *ejidatarios*) have been entrusted with natural resource use rights (except for oil, gas and minerals); this entity being derived from the Mexican Revolution (Yetman, 2000). An *ejidatario*'s rights are inheritable, usually from father (or mother) to son, but it is also possible to pass on rights to any other relative, as designated by the entitled person. At an *ejido*, the top authority is the General Assembly of *ejidatarios*, which has two councils; the Security Council and the "Comisariado" Council. For organizational and legal purposes, the president of the "Comisariado" is the representative of the General Assembly. *Ejido*'s authorities are in charge of issues and/or resources located within their land's limits (Estrada-Lugo, 2005). In addition, at every settlement or community, there is another authority, a Delegate ("Delegado" or "Sub-delegado") that represents the state government.

The study area was The Mayan Zone (La Zona Maya), which in this case are the municipalities of José María Morelos and Felipe Carrillo Puerto which respectively, had about 75% and 68% of their inhabitants of 5 years old and up being able to speak an indigenous language (INEGI, 2000). This research was undertaken exclusively at the municipality of Felipe Carrillo Puerto because the first reports of fishing were recorded therein but also because its water bodies are located close to wetlands and therefore, they had both diverse and relatively large fish species. The capitol of Felipe Carrillo Puerto is a city with the same

[1] Whereas the "ejido" is a creation of the Mexican revolution, the "comunidad" is a post-revolution entity to whose inhabitants the Mexican government wanted to return property rights upon land and water, provided these people have proved they have had prior, long standing, local community-based use of resources (Alcorn and Toledo, 2000, p.222).

name as the municipality. In 2000, the City of Felipe Carrillo Puerto had 17,500 inhabitants.

In Quintana Roo and at The Mayan Zone, there are currently large forested areas of sub-deciduous tropical rainforest wherein there is a conspicuous geographical characteristic of a lack of rivers as superficial sources of freshwater (Schmitter-Soto et al., 2002a). The only sources of water for this area are karstic (i.e., lime-stone based) water bodies including "aguadas" (ponds), cenotes (round-shaped water bodies) and lakes; most of them interspersed in the rainforest or located in seasonally flooded areas. Local rainforest, primarily precious woods such as mahogany, has been under commercial exploitation since the 1950's (Armijo and Llorens, 2004). In respect to local fauna, this area possesses a high biodiversity, including resident and migratory populations of birds; large mammals, such as jaguar (Panthera onca), deer (Odoicoileus virginianus), peccary (Tayassu tajacu); reptiles, such as crocodiles (Crocodilus spp.), among many other species (CONABIO, 1998; Morales-Garzón, 2000; Ramírez- Barajas, 2004).

Although they overlap to a varying degree, seasons for this area have been reported as "dry" (approximately from February to May), "rainy" (approximately from June to October) and "north winds" (approximately from November to March). Environmental changes at the study area have been noticed primarily by *campesinos* who, based on their traditional knowledge, currently acknowledge a marked delay in the timing of rains (A.C.C., local authority, 2004, personal communication; D.V., *ejidatario*, 2005, personal communication).

The Mayan People and Social Justice Issues

Inhabitants of the study area are mostly Yucatec-Mayan speakers; the majority of them being descendants of immigrants that came to this area from Yucatan state during and after 1847, when a revolt against Spaniards called "The Caste War" took place in the Yucatan Peninsula (Villa-Rojas, 1992).

After 12 *ejidos* had been visited in this research, three Mayan *ejidos* were selected to undertake research on livelihoods, all from the municipality of Felipe Carrillo Puerto. The three *ejidos*, from here onwards, will be referred to using pseudonyms in Mayan language such as "Junp'éel", "Ka'a p'éel" and "Óox p'éel"[2]. The settlements in these three sites are rural in nature, with less than 3,500 inhabitants each.

According to INEGI (2000) and SEDESOL (2002) the municipality of Felipe Carrillo Puerto is under the national category of "high marginalization", which among other things, in this case included that in the year 2000, 57.0 % of people lived in extreme poverty[3]; 47.8 % of households had no sewage system or private toilets and in 76.0 % of households people lived under crowded conditions. But the latter information is pooled data and hence, includes both remote communities and the head town of the municipality which has most of the public services. Therefore, as it was observed and registered during fieldwork, the degree of marginalization of rural people seems to be higher than that reported in the statistics, at least in terms of sewage system and toilet availability and living under crowded conditions.

In respect to health services, except at the capitol of the municipality, these are very scarce in the *ejidos*. Because several settlements are located in remote areas, if people are seriously ill they unfortunately have to move from their community to the main town – incurring expenses of both traveling and getting hospital service. It was observed however, that most often, those are expenses people could not afford to cover. Thus, during several years of fieldwork it was noticeable that many Mayan people are currently ill, especially from diabetes and skin-related illnesses. For example, during fieldwork undertaken in 1998 at a

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[2] The words "Junp'éel", "Ka'a p'éel" and "Óox p'éel" in Mayan language mean, respectively, one, two and three in English (after Gómez-Navarrete, 2002).
[3] Extreme poverty for national (Mexican) conditions meant that people do not earn approximately U.S. $1.40 (Mexican pesos $15.3) per day to cover their daily food needs (SEDESOL, 2002).

Mayan *ejido* by a former project of the author of this study, a disease outbreak of "chicken pox" was witnessed. The fieldwork lasted 5 days at a Mayan *ejido* comprising three communities and unfortunately, during this time, no health representative of the government ever appeared. Thus, most children, youth and elders from the three communities endured the illness alone.

The Mexican government has, through the last 12 years, provided some economic support to indigenous and rural people located in marginalized areas. Currently, the Mayan people from the studied area receive two different types of grants, one to support farming or traditional agriculture called "procampo" and the other to support nourishment to both children attending school and women, called "oportunidades". Unfortunately, all the progress and social justice made in supporting indigenous people all over the world (e.g., through the Indigenous Decade of The United Nations Organization) has not arrived fully to Mexico. In particular, recent studies reported that current development plans in Quintana Roo do not consider the forms of social and traditional organization of the Mayan people (Bello-Baltazar et al., 2002). Another, more sensitive aspect is the form of interaction between government officials and indigenous people. In particular, during our field work, people from one of the studied *ejidos* complained that government officials who deliver the grants "procampo" to support slash-and-burn agriculture, used to yell at them, calling them lazy people, while delivering the economic support (D.V. *ejidatario*, 2005, personal communication).

Generally speaking, some social and humanities scholars perceive that since 1994, when the Zapatista revolt began in Chiapas, this region has received slightly more economic support from the Mexican government than before it had started (M.J.S., 2004, personal communication). But although currently there are several national and international agencies where the Mayan people could submit proposals for community-based arts and crafts production as well as community- based environmentally- friendly projects, there are several problems that preclude them from having access to the funds. For example, some

international agencies, such as the UNDP, require a legal association of people in order for their organization to submit an application for funding. Nevertheless, except for the head of the municipality of Felipe Carrillo Puerto, there is a clear lack of Western literacy among the Mayan people, and their organizational capability within and among *ejidos* is both weak and conflictive. Finally, Mexican anthropologists recognize that the *ejido* system as a socio-political entity in Mexico has been in decline over the last 30 years (M. Molina, 2003, personal communication). Thus, in view of the above situation, it seems as if people in *ejidos* and rural areas more generally were not a priority for the Mexican Government.

2.3.2. Approach

Fieldwork

The first contact with the study sites' authorities was during January and February, 2004. It was during this time when consent to undertake research was granted. Fieldwork to study livelihoods lasted from September 15, 2004 to January 25, 2005. In addition, two days of fieldwork were undertaken during March 10-11, 2006 for resolving a few issues related to missing demographic data of participants including their age as well as if some of them were *ejidatarios* and for getting opinions on the status (sustainability vs depletion) of local rainforest, through open interviews with local authorities and *ejidatarios*.

This research was undertaken in communities wherein potential participants could be considered what is called in the literature as "hidden populations", or people who are very difficult to approach and even more difficult to persuade to be interviewed. One of the essential barriers in approaching people was their non-Western culture and the Mayan language, the primarily day-to-day spoken language at the studied sites.

The author of this study and its research team stayed at two different *ejidos* during the fieldwork. From these places, the research team moved back and forth

to undertake research at other *ejidos* but returned back at nightime. The families that were feeding the research team had been previously contacted by researchers of El Colegio de la Frontera Sur, the home working institution of the author. The houses used for staying were rented for approximately U.S.$ 29.00 (Mexican pesos $ 300.00) per month. The food included local recipes and hand-made "tortillas" (a corn-based flour food).

In view of the difficulty in entering at new *ejidos*, and in order to sort out this and other field problems, a scholarly agreement with a native social and humanities group was devised. Additionally, and in order to be able to greet local people in Mayan, the author of this research undertook a basic course in this language during 2004.

With respect to the scholarly agreement, the social and humanities group had agreed to back up and provide advice to the research team with the only condition being that of receiving a copy of all materials produced at the end of the research (e.g., thesis, pictures, posters and publications), because they work on the promotion of culture and need to have those types of materials to understand the results of the project. The support included many aspects such as explaining, in Mayan, to local people that they knew who the research team was and that the purpose of the study was a serious one. Other advice consisted of, for example, suggesting the research team needed to take into consideration local customs such as knowing both the work and leisure time schedules of potential participants in every *ejido*, previous to the interviewing process.

To address the aims of the research, a mixed methods approach was used, including the use of both social and natural science methods. In particular, to address the aim of assessing household income composition, a household survey was undertaken which considered local community dynamics related to customs and traditions. In particular, during the fieldwork period there were several local rituals and festivals taking place at the studied *ejidos* and

communities – at these times, the research team, which was always advised by the local guide, either stopped working or attended several gatherings, whenever local people had invited them. Thus, previous to the survey, the daily working and leisure schedule of the community's household members was roughly investigated and registered, and the following fieldwork strategy was followed.

Instead of attempting to complete an interview during the first visit to a household, potential participants were contacted at least twice. During the first visit, the research team introduced itself, explained the purpose of the research, commented on the authorization granted by their authority, and asked informed consent to come back another day (i.e., at a date and time suggested by the head of household) to complete a structured interview related to livelihoods. After every participant had agreed to take part in the study, an interview in the form of a questionnaire with 7 closed questions was completed during the next visit.

Thus, field work started smoothly at both *ejidos* "Ka'a p'éel" and "Óox p'éel". Nevertheless, people from "Junp'éel" were clearly shy and reluctant to participate in the study, and for this reason a previously trained local field guide (a native 23-year-old *campesino*) was the person who, using the Mayan language, carried out a thorough explanation of the purpose of the study to most heads of household and, at the end of the explanation, invited that individual to take part in the study. Hence, given the difficulty in persuading people to take part, the field guide primarily contacted people who were part of his reciprocity networks. In this case, the reciprocity networks included a wide and diverse group of persons, including both men and women, with whom the field guide usually pursued several activities such as hunting, fishing, an exchange of work in local native agriculture, and family gatherings to undertake rituals for agricultural activities. The only restriction of the sampling approach was to include households that together included livelihoods based upon a range of different productive activities. For instance, although the field guide did not himself pursue honey production or cattle rearing, he had to contact and invite as many types of different producers

as possible. Given the above field work circumstances, the sampling used was as follows: a census in "Ka'a p'éel"; 30% of households in "Óox p'éel" and 15% of households in "Junp'éel". Thus, whereas in the first of these three *ejidos*, the sampling was quantitative in nature, in the latter two sites it was qualitative (de Vaus, 1995).

In respect to the format of the questionnaire used, besides a demographic component, the format considered Chambers' advice related to the use of local materials whenever working with rural people (Chambers,1997). Thus, an interview was devised in such a way that the annual household income, both cash and in kind, was represented in a standard form by a fixed number of corn seeds. Thus, every participant was given the set number of corn seeds and was asked to allocate their annual household's income (both cash and in-kind), represented by corn seeds, per occupational income category, including activities pursued at farm, non-farm, self-employment, migratory work, among others. Moreover, people were asked to carry out the income allocation for a "normal" year, or not taking into account years wherein their work and income was affected by natural events such as hurricanes. Furthermore, in order to build rapport with every participant, the project's field guide - who had been thoroughly trained to undertake this exercise - showed every participant the way he would allocate the corn seeds among his own diverse occupational categories. Thus, the field guide listed all the occupational activities undertaken by himself and by his wife which altogether contributed to his household's income throughout a year. Once the field guide ended his income allocation, a person in each household did his/her own household income allocation and the resulting income categories were tagged with different names, accordingly.

During the first 9 interviews, the number of corn seeds was exactly 50 and participants were asked to allocate all of them among their sources of income. Nevertheless, in the 10th interview the participant showed concern because she believed 50 seeds were too many seeds to represent her household's annual

income. In view of the latter, and from there onwards, every interviewee was provided with 50 seeds but was asked to utilize as many corn seeds he/she needed to represent his/her household's annual income.

Data analysis

Data from the survey were systematized using a codebook and they were stored into a database (after Thiessen, 2001). The matrix of the survey was composed of cases represented by households and by variables representing a demographic component together with the income categories. The resulting general matrix could be also partitioned to analyze the data by *ejido*.

To estimate the households' income categories, all occupational categories were listed per household and per *ejido* and they were grouped into the following classes: "farm", "non-farm", "migratory work", "governmental grants", "ejidatario's income" (including both timber and non timber products, as appropriate per *ejido*), and "remittances" (see the full list in Appendix A). To every household, a first income diversity assessment was made taking into consideration the full list or the total number of occupational categories. The same procedure was made to assess income diversity at the *ejido* level.

In order to estimate the contribution of every source of income per household, the total number of corn seeds utilized by every participant was regarded as 100% of the household's annual income and the corresponding percentage for every occupational activity was estimated subsequently. Besides counting the list of all occupational activities, the number of households being engaged in every occupational category per *ejido* was ordered in a descending rank order (after Turkenik, 1976).

To assess diversity, richness and evenness using functional groups, the approach of Peterson et al. (1998) was used. In particular, these authors introduced a conceptual model wherein species richness, ecological resilience

and scale were related. In this respect, the full list of income categories was grouped using two criteria which were based upon a literature review and the author's own experience of four years (1999, 2001, 2004 and 2005) of fieldwork in these *ejidos*. The first one was the criterion used in conventional livelihood analysis which included both the location (a spatial scale) of the work (e.g., "farm", "non-farm") and the status (i.e., with or without property rights or being an *ejidatario* or a non-*ejidatario*) within an *ejido*. The second criterion was the purpose (or function) of the income including the following (devised) classes, "in-kind income and cultural identity" (encompassing agriculture, embroidery, sewing hammock, and backyard livestock which are used for rituals, ceremonies and festivals); "cash" (encompassing all activities targeted to get cash); "recreation" (e.g., other arts and crafts, fishing and game); "external support" (encompassing both "procampo" and "oportunidades" government grants); and "work out of the community" (strategies to get cash, for migratory work and remittances from outside the community). The two criteria utilized are shown in Table 2.1. Note that the criteria used to build functional income groups show a degree of functional redundancy among them. In particular, redundancy is observed for the criteria "in-kind income and cultural identity" (because as noted from Table 2.1, there were 2 types, one at "farm" and the other at "non-farm"), "cash" (there were 3 types, i.e., "farm", "non-farm" and "work out of the community"; Table 2.1), "recreation" (2 types, both "farm" and "non-farm"; Table 2.1) and "external support" (2 types, both "farm" and "non-farm"; Table 2,1).

Once the functional groups (FG) were built, the household income categories per *ejido* were examined to allocate every one of them into a function, F (i.e., from F1 to F10, Table 2.1), accordingly.

Table 2.1. Criteria used to build functional income groups (FG) based upon both their location and/or status (A) and purpose (B).

A	B	FG
Location and/or status	*Purpose*	*Functional Group*
Farm	In-kind income & Cultural identity	F1
Farm	Cash	F2
Farm	Recreation	F3
Farm	External support (Gov. grants)	F4
Ejidatario (& Non Timber Products)	Property rights	F5
Non-Farm	In-kind income & Cultural identity	F6
Non-Farm	Cash	F7
Non-Farm	Recreation	F8
Non-Farm	External support (Gov. grants)	F9
Work out of the community	Cash	F10

Afterwards, functional richness, diversity, and evenness were estimated for every household and averaged for every *ejido*. In an analogous form as it is done in ecology, (functional) richness was estimated simply by counting the number of functional groups per household (as would be number of species; after Peterson et al., 1998; Forys and Allen, 2002). Diversity was estimated through the Shannon index as follows (Omori and Ikeda, 1992, pp. 271-274):

$$H' = -\sum_{i=1}^{S} Pi \, Log_2 \, Pi$$

Where for every household, Pi = would in this case be the proportion of the number of income categories recorded in functional group *i* to the total number of

income categories recorded in all the functional groups; and S would be the total number of income categories (in this case, S = 10).

Evenness was estimated using Pielou's J' index (Omori and Ikeda, 1992):

$$J' = H'/\log_2 S$$

where H' is the Shannon index and S the total number of functional income categories (or S = 10).

Finally, all the aforementioned methods were complemented with both literature review and open interviews which tapped local knowledge of *ejidatarios* with over 20 years of experience in relying upon the rainforest for livelihood.

Qualitative data derived from observational records were cross-validated with several sources of information, either derived from the research or from literature review, and the results were integrated at every corresponding section (Bernard, 1995).

2.4. Results

The research comprised 6 communities (from a total of 8) located in three *ejidos* wherein 123 inhabitants were invited to take part in the study in the form of a structured interview concerning their livelihoods. From those invited people, 103 inhabitants (83.7 %) accepted the invitation; 63 of these were from *ejido* "Junp'éel" (61.2 %), 22 from "Óox p'éel" (21.4%), and 18 from "Ka'a p'éel" (17.5%). (The population coverage these figures represent in each of the communities is discussed below.) Refusals to participate were recorded only in *ejidos* "Junp'éel" (13.0 %) and "Óox p'éel" (3.3%).

At the *ejido* level, the language used during interviews was primarily Mayan. More specifically, in both *ejidos* "Ka'a p'éel" and "Óox p'éel" all interviews were

undertaken in Mayan whereas in "Junp'éel", 2 interviews were fully completed in Spanish; 21 were explained in both, firstly in Spanish and secondly in Mayan and, 40 were completed in Mayan only. Two native Mayan speakers were the Spanish-Mayan translators during the survey; a woman research assistant with a Bachelor degree in education, and the local field-guide, a man with third grade of elementary school but who had been working in research projects on natural resources for over the last 5 years. The latter person was also a user of the fishery resource in a regional *ejido* (Chapter 2).

In respect to the number of sampled households compared to the total number of households in each *ejido*, the results were as follows; a census (n= 18) in *ejido* "Ka'a p'éel"; 30 % of the households (n = 22) in "Óox p'éel" and 15% of the households (n = 63) in "Junp'éel". Moreover, corroboration of some field data was based on 4 open interviews with 4 *ejidatarios*; 1 from each of the studied *ejidos* (= 3) who were or had been local authorities in their communities plus one from a previously studied *ejido* (Chapters 3 and 5).

Age of interviewees from the survey ranged from 22 to 80 years old but varied among *ejidos* (Table 2.2). In regard to their place of birth; the majority of interviewees were from Quintana Roo, with over 94% being born locally – 75.7% and 18.4 % of them coming from their own *ejido's* communities and from neighboring *ejidos*, respectively (Table 2.2).

Generally speaking, and because of customs and traditions of the Mayan society, it was difficult to interview women (Table 2.2). For example, whenever the research team arrived at a household and both husband and wife were there, it was a local custom that men should welcome and talk with researchers.

Table 2.2. General demographic attributes of interviewees.

Variable	*Ejido* Junp'éel	Ka'a p'éel	Óox p'éel	Total 3
Age range (years):	22-65	25-75	23-80	22-80
Gender (%):				
Men	84.1	88.9	81.8	84.5
Women	15.9	11.1	18.2	15.5
Ejidatario's household?				
Yes	66.7	83.3	73.3	71.8
No	33.3	16.7	22.7	28.2
Place of birth (%):				
At the ejido	82.5	55.6	72.7	75.7
At neighboring ejidos	11.1	44.4	18.2	18.4
Yucatan state	4.8	0	9.1	4.9
Other state	1.6	0	0	1.0
num. of households =	63	18	22	103

Therefore, most agreed-upon visits for interviewing were arranged with men. Women only participated whenever their husbands were not around and in two occasions because they themselves were the head of the households.

From the 103 studied households, up to 96.1% belonged to *ejidatarios* and their relatives. More specifically, 71.8% belonged only to *ejidatarios* whereas 24.3% belonged to their relatives (e.g., parents, sons, daughters, etc.).

2.4.1. Conventional Household Income Analysis

In total, fifty-two occupational categories or sources of income were recorded in the studied *ejidos*; 49 of these occurred in "Junp'éel", 18 in "Ka'a p'éel" and 21 in "Óox p'éel". The full list of occupational categories, together with the number of households that recorded them and their average contribution to households per *ejido* are presented in Tables 2.3, 2.4, and 2.5 for "Junp'éel", "Ka'a p'éel", and "Óox p'éel", respectively. From the full list of occupational categories at each site,

a first assessment of income diversity was made with the following results: income diversity was higher in "Junp'éel" with 49 sources of income, followed by "Óox p'éel" and "Ka'a p'éel" with 22 and 18 sources of income respectively.

The results on income classes which were present at the three sites were as follows: the class "farm" with 8 single sources of income; "non-farm" with 34 sources; "ejidatario & non timber products" with 6; "governmental grants" with 2; and "work off the community" with 2 (see Appendix A).

Besides the above income classes, it was observed that in general terms, the rainforest provided many other products to people, some of which were harvested occasionally, perhaps once every 4 to 5 years, such as the raw materials to build traditional houses or huts (palm leaves and large woodsticks). Also, every year, the same materials used to build huts were used at the main festival of each *ejido*, to build rustic theaters and "rodeos" (a bull fighting site). Moreover, many households used firewood for cooking that were gathered every 3 to 4 days from secondary growth forested areas. Furthermore, other products like leaves from some trees were used to feed pigs and cattle, and several local fruits and medicinal herbs were gathered seasonally at the rainforest primarily by children, women and elders.

In respect to the income classes that were recorded at the households, the income category most frequently recorded in the three studied sites was slash-and-burn agriculture ("milpa") (Tables 2.3, 2.4 and 2.5). It ranked in first place in the number of households engaged in this activity (range = 83 % to 100 %) and, taking into account income categories which were present in at least 50% in the sample of surveyed households per *ejido*, its average household contribution was the highest (range = 18.3 % to 20.1 %; see Tables 2.3, 2.4 and 2.5).

Table 2.3. Average household income contribution of income categories recorded at Junp'éel (N =59; not ascertained= 4).

No.	Income category	Recorded at "n" households	Average income contribution (%)	Standard deviation
1	Milpa	51	18.3	6.4
2	'Oportunidades' grant	49	12.3	5.1
3	'Procampo' grant	45	15.2	6.1
4	Backyard livestock	36	12.1	6.8
5	*Ejido* 's income	33	8.5	3.8
6	Hunting	23	10.3	5.3
7	Freshwater fishing	16	7.4	2.7
8	Orchard	14	11.8	5.5
9	Honey bee production	14	18.8	10.1
10	'Chicle' (sap harvesting)	14	12.4	7.8
11	Convenience store	13	14.8	10.2
12	Hammock sewing	12	18.5	26.4
13	Vegetable growing	11	12.4	6.1
14	Migratory work	8	23.7	13.5
15	Cattle	7	20.7	11.0
16	Embroidery	7	8.3	4.4
17	Woodsticks ('palizada')	4	11.8	4.4
18	Firewood seller	3	11.9	7.3
19	Tailor	3	11.6	12.5
20	Knitting	3	10.0	5.5
21	Bricklayer (local)	3	17.0	12.5
22	Public transportation	3	32.4	14.6
23	Schoolteacher	3	58.9	35.1
24	Hair cutter	2	7.0	1.4
25	Baker	2	38.5	19.1
26	Hut (Palapa) builder	2	18.2	6.9
27	Bike repair	2	19.7	4.3
28	Sawmill	2	9.7	4.0
29	Tourism	2	16.5	0.9
30	Field guide (research)	2	10.3	5.2
31	Authority/comunidad	2	11.0	1.4
32	Rock & sand seller	1	10.0	0.0
33	Aesthetic plants	1	6.0	0.0
34	Carpenter	1	10.0	0.0
35	Librarian	1	31.3	0.0
36	Other arts & crafts	1	9.3	0.0
37	Food for sale	1	6.0	0.0
38	Lettering	1	50.0	0.0
39	Electricity repairing	1	16.0	0.0
40	Grass cutter	1	12.0	0.0
41	Chicken butcher	1	5.9	0.0
42	Corn meal machine	1	22.6	0.0
43	Aquaculture (fish)	1	18.0	0.0

No.	Income category	Recorded at "n" households	Average income contribution (%)	Standard deviation
44	Car repairing	1	74.0	0.0
45	Pickup	1	18.6	0.0
46	State's employee	1	29.0	0.0
47	Policeman	1	90.0	0.0
48	Bond paper, pencil and photocopies store	1	14.0	0.0
49	Remittances	1	4.7	0.0

Table 2.4. Average household income contribution of income categories recorded at Ka'a p'éel (N = 18).

No.	Income category	Recorded at "n" households	Average income contribution (%)	Standard deviation
1	Milpa	18	19.2	7.3
2	Backyard livestock	15	17.5	6.9
3	'Procampo' grant	14	18.9	7.6
4	'Oportunidades' grant	14	15.5	3.8
5	Vegetable growing	11	15.9	6.0
6	Orchard	9	14.9	6.3
7	Freshwater fishing	8	11.4	4.2
8	Palm leaves gatherer	6	12.0	4.1
9	Grass cutter	4	11.6	6.8
10	Hunting	3	12.0	4.7
11	Cattle	2	20.3	8.3
12	Bricklayer	2	11.0	3.0
13	Migratory work	2	18.3	4.0
14	Woodsticks ('palizada')	1	17.4	0.0
15	Other Arts & crafts	1	10.0	0.0
16	Convenience store	1	10.9	0.0
17	Nurse assistant	1	9.5	0.0
18	Authority/community	1	8.7	0.0

Table 2.5. Average household income contribution of income categories recorded at Óox p'éel (N= 22).

No.	Income category	Recorded at "n" households	Average income contribution (%)	Standard deviation
1	Milpa	19	20.1	7.1
2	'Oportunidades' grant	19	15.3	6.3
3	Backyard livestock	18	14.4	6.6
4	'Procampo' grant	16	18.7	6.6
5	Palm leaves gatherer	10	12.6	4.2
6	Vegetable growing	9	21.8	11.1
7	Orchard	7	15.6	11.9
8	Migratory work	6	19.7	10.8
9	Cattle	5	19.3	5.8
10	Hunting	4	8.0	1.7
11	Convenience store	4	14.1	6.8
12	Honey bee production	2	11.1	0.3
13	Freshwater fishing	2	15.2	5.7
14	Woodsticks ('palizada')	2	9.0	0.5
15	Other Arts & crafts	2	19.8	15.5
16	Hut (Palapa) builder	2	15.8	7.3
17	Grass cutter	2	10.5	4.8
18	Sisal's fiber seller	1	19.0	0.0
19	Carpenter	1	31.3	0.0
20	Public transportation	1	18.0	0.0
21	Authority/community	1	4.3	0.0

The occupational category which ranked in second place relevant to the number of households engaged in it (range = 61% to 83%) was backyard livestock. Its average income contribution ranged from 12.1 to 17.5 % in at least 50% of the surveyed households in the three *ejidos* (see Tables 2.3, 2.4 and 2.5).

In regard to external support to Mayan households, specifically governmental grants, except in *ejido* "Junp'éel" in which the "oportunidades" grant contributed with 12.1% to at least 50% of surveyed households, the remaining 5 governmental grants (2 in each *ejidos* "Ka'a p'éel" and "Óox p'éel", and 1 in "Junp'éel") contributed each with over 15% annual average household income to at least 50% of the sampled households (Tables 2.3, 2.4 and 2.5).

Finally, only the largest of the three studied *ejidos*, "Junp'éel", a site with governmental authorization for logging, did have the income category called as "*ejidos*' income", an exclusive income to entitled persons as *ejidatarios* (see

Appendix A). The latter was present in 56.0 % of its surveyed households and contributed with 8.5% in annual average household income (Table 2.3).

2.4.2. Functional Income Richness and Resilience

The resulting matrix of households' income by functional groups which included the values for functional richness, evenness and income diversity is shown in Table 2.6.

Table 2.6. Matrix of functional richness, evenness and diversity with 10 functional groups showing a sample of households per *ejido* only.

Ejido and Households	Functional Groups (*F*'s) for income										Richness	Evenness	Diversity
	F1	*F2*	*F3*	*F4*	*F5*	*F6*	*F7*	*F8*	*F9*	*F10*	S	J'	H'
Junp'éel													
1	1	1	0	1	2	0	1	0	1	1	7	0.83	2.75
2	1	1	1	1	1	0	0	0	0	0	5	0.70	2.32
3	1	0	0	1	1	0	1	0	1	1	6	0.78	2.58
58	1	2	2	1	1	1	0	0	1	0	7	0.88	2.92
59	1	2	2	1	0	1	0	0	1	0	6	0.75	2.50
Ka'ap'éel													
1	1	1	0	1	0	1	0	0	1	0	5	0.70	2.32
2	1	0	1	1	0	1	1	0	1	0	6	0.78	2.58
3	1	0	0	0	0	1	1	0	1	0	4	0.60	2.00
17	1	1	0	1	1	0	0	0	1	0	5	0.70	2.32
18	1	1	1	1	0	1	0	0	1	0	6	0.78	2.58
Óox p'éel													
1	1	1	0	1	0	1	1	1	1	0	7	0.85	2.81
2	1	0	0	1	0	1	0	0	1	1	5	0.70	2.32
3	1	0	0	1	0	1	0	0	1	0	4	0.60	2.00
21	1	0	0	1	1	0	1	0	1	0	5	0.70	2.32
22	1	1	0	1	0	1	0	0	1	0	5	0.70	2.32

The summary or averaged calculation of these three variables is shown in Table 2.7. In contrast to the first assessment of income diversity as presented in section 4.1, an examination of the results of Table 2.6, which in this case are based upon functional groups of income, indicates very similar values in richness, evenness

and diversity among the three studied *ejidos*. Therefore, they all three seem both similarly diverse and resilient.

Nevertheless, a close examination of richness indicates that "Ka'a p'éel" showed slightly higher values, followed by "Junp'éel" and "Óox p'éel". Given this outcome it is suggested that the relative resilience of livelihoods as estimated from functional richness, is slightly higher in "Ka'a p'éel" followed by "Junp'éel" and "Óox p'éel".

Table 2.7. Summary of metrics for averaged values of richness, evenness and diversity per *ejido*.

Ejido	Average richness	Average evenness	Average diversity
Junp'éel	5.66	0.71	2.35
Ka'ap'éel	5.72	0.74	2.46
Óox p'éel	5.45	0.71	2.35

2.5. Discussion

Studying livelihoods wherein people rely on natural resources as their primary source of sustenance, like the Mayan people of Quintana Roo, provides insights into interactions between socioeconomic and natural systems (sensu Berkes and Folke 1998; Holling et al., 1998). In this case, the interaction was Mayan people pursuing livelihoods in the rainforest landscape.

It was found that Mayan communities in the common property lands of Quintana Roo rely on multiple livelihoods with seasonal variation. From an analysis of the income classes, a method that is most often undertaken in development studies, the livelihoods consisted of 6 classes of income, whereas in the ecological resilience approach, they were composed of 10 functional groups. Livelihoods are currently supported by property rights derived from the Mexican Constitution and *ejidatarios*, once a sanction from the *ejido*'s authority is obtained, very often extend their property rights to their descendants as well as to other relatives,

either by allowing them to pursue a livelihood in common lands or through inheriting the holder's property rights (Estrada-Lugo, 2005).

In general terms, the rainforest of the study area to a great extent sustained the livelihoods of the *ejidos* studied. Overall, two types of livelihoods were recorded, one which could be readily listed and accounted for –represented in this case by a number of corn seeds- by the head of households and another that was recorded qualitatively by the research team during fieldwork. The former will be explained in the following paragraphs and the latter included products from which local people benefited (in-kind income) and included palm leaves, large woodsticks, firewood, leaves of trees, fruits and medicinal herbs.

From a development studies perspective, and taking into consideration the people's occupational categories, "milpa" was the top-ranked source of income for the three *ejidos* – whether assessed from the average of household income contributions of 50 % and over the surveyed households, or from the percentage of households engaged in that activity (83 % to 100 %).

Setting aside external support from governmental grants, the second-ranked single source of income relevant to both the number of households engaged in it (range = 61 % - 83 %) and the average of household income contributions of 50% and over the surveyed households, was backyard livestock.

In this paper, slash-and-burn agriculture ("milpa") together with backyard livestock and handcrafts were regarded as sources of income which provided cultural identity to the Mayan people for several reasons. Several studies had widely reported the cultural, social and economic importance of corn to indigenous Mesoamerican cultures, including the Maya from their ancient origins to the present (Odile, 1994; Velazco-Te, 1999; Estrada-Lugo, 2005). In respect to Mayan people from Quintana Roo, wherein traditions are linked to the Mayan Church, "milpa" – as the only source of corn – has associated with it the most

important rituals and ceremonies, related to prayers for a good harvest throughout a year. For example, in one of those *ejidos*, Velazco-Te (1999) recorded 22 ceremonies and rituals which were tightly linked to 19 "milpa" activities. Both ceremonies and rituals, and agricultural activities, are undertaken, with varying intensity throughout a year. Furthermore, as it was recorded during our fieldwork, during those ceremonial activities, beverages and food are primarily made of corn meal, and backyard livestock is the primary source of meat (Velazco-Te, 1999). Given the above importance of "milpa" and backyard livestock to local people, policies and development projects might well be targeted either (a) to provide capacity building in improving livestock production or (b) to address the stress that people are currently coping with, related to the diminishing yields of agriculture (Bello-Baltazar et al., 2002), but also related to extended droughts.

Although currently there might be some institutional budgets targeted on the Mayan people, appropriate development policies have not arrived fully to this area. For example, in one of the studied *ejidos*, Mexican governmental officials arrived in 2004 to tell local people that, in order to spend their 2004 budget targeted at Quintana Roo's rural people, they were devising a development project to raise livestock. However, the offered livestock species were exotic species, which, in the opinion of local people, were not as resistant to drought as their own. In view of this, people refused to waste their time in starting what they regarded as an inappropriate project (M.J.S., 2005, personal communication).

In respect to external support to Mayan livelihoods, the governmental grants known as "procampo" and "oportunidades" were amongst the 4 top-ranked source of income. A fair acknowledgement to the Mexican government would be that from a functional point of view of a livelihood system, these two grants are utilized because they complement each other; i.e., from ecological theory they both show "redundancy". More specifically, following the conceptual model of Peterson et al. (1998) and Allen et al. (2005), a degree of redundancy is

necessary for (livelihood) systems to persist in the face of disruptions. In this case, where "procampo" grant provides cash to support "milpa" activities (farm), "oportunidades" grant supports the nourishment of women and children in the household (non-farm). In other words, livelihoods are backed up with cash at two different spatial scales (farm and non-farm) and thus its redundancy.

Nevertheless, three shortcomings of the governmental support would be highlighted here. First, not all households engaged in "milpa" work received the "procampo" grant. Those people not receiving the grant were those *campesinos* who were out of their community whenever "procampo" officials arrived to fill out the corresponding applications. For example, in *ejido* "Ka'a p'éel" wherein this study undertook a census, 22 % of households got no "procampo" grant. In order to solve this problem, local authorities from this and many other *ejidos* have contacted the corresponding governmental offices to insist on a solution so that such people can receive "procampo" grants. Unfortunately, it seems that no solution to this problem would be possible in the short term so those without this support would remain that way for an uncertain time (A.C.C., local authority, 2004, 2005, personal communication). Second, delivering money to people might well be complemented with a program on capacity building for improving both their farming and non-farming work. For example, during fieldwork, it was observed that currently, while there are several governmental and non-governmental agencies in the municipality of Felipe Carrillo Puerto which have budgets to support the Mayan livelihoods, the illiterate or the Mayan monolingual people do not receive the information about these programs, especially because of the remoteness of many communities [A remote community was one in which in order for its people to reach a larger, 3,000 inhabitants town, they walked 8 kilometers one way.] Moreover, even if they get the information (as happened when the author of this study provided some information to people on one such project), they had not the literacy to follow through the entire submission process.

A program on education and capacity building might also overcome a big concern to both local families (J.P., *ejidatario*, 2006, personal communication) and to governmental agencies (M. L. Arzacoya-Gómez, C.D.I. Director, Radio XENKA, 2006, personal communication) about the problem of alcohol. Unfortunately, an addiction to alcohol on the part of some people, it was recorded, pushes them to spend the "procampo" grant on the very same day they receive it. In one of the studied communities, with approximately 1,000 inhabitants, there were 5 bars servicing this practice.

Furthermore, although according to the Mexican government, the Mexican economy has been relatively stable over the last 6 years, that government should foresee that providing capacity building to farming people would be a precautionary approach in the face of any potential and unexpected crash of the economy.

And third, Mexican governmental officials in charge of both administering and delivering "procampo" grants should receive better training in understanding indigenous non-Western cultures as well as about the complexity of running uncertain rain-fed agro-systems for livelihood which lately have been impacted by extended droughts. It is both unfortunate and unfair that while delivering the "procampo" grant to *campesinos*, some of them did not show due respect to local people.

Returning to the issue of income diversity and resilience, an assessment of income diversity solely based upon a development studies perspective, which considered a full list of income categories per *ejido*, pointed toward a higher diversity for "Jun p'éel", followed by "Oox p'éel" and "Ka'apéel". Thus, from this analysis, one may think that the livelihood with the greatest relative resilience is that which is highest in diversity (i.e., "Jun p'éel"), followed by "Oox p'éel" and "Ka'apéel". But under the functional richness approach, it was surprising that "Ka'apéel", a tiny settlement of approximately 250 inhabitants with the lowest

total number of income categories of the three *ejidos*, in fact had a slightly higher richness and diversity and hence, a slightly higher relative resilience. Nevertheless, a close examination of income data (i.e., the database) showed that in respect to richness, households from "Ka'apéel" had more income categories distributed among the 10 functional groups than the remaining two *ejidos*. In other words, the income categories for this site encompassed more functional groups than the other two. This explains why this site as a whole was more resilient than the other two *ejidos*.

In respect to the remaining variables, evenness and diversity, a close examination of data showed that whereas evenness ranged from 0.0 (zero) to 0.887 in "Jun p'éel" and 0.477 to 0.887 in "Oox p'éel", it ranged from 0.602 to 0.845 in "Ka'apéel". According to ecological theory on diversity, higher values of evenness, such as the latter, would result in a higher diversity (Omori and Ikeda, 1992). Generally speaking, lower values of evenness were found in those households that, for example, registered only two income categories, as well as in cases where several income categories were present but belonged to only one or two functional groups. An example of such a household was a schoolteacher from "Jun p'éel".

Finally, a more general but no less important concern is in relating resilience with sustainability in the Mayan livelihoods. It is suggested in the literature that, all things being equal, more resilient systems are likely to be more sustainable (Ludwig et al., 1997; Charles, 2001, Germestani et al., in press). Thus, results from this study suggested that should the sampled households in each *ejido* be considered statistically representative of the studied sites, "Ka'apéel" livelihoods would be more sustainable than those of "Jun p'éel" and "Oox p'éel". Of course, in this study, there were limitations in sampling, and the latter statement on resilience and sustainability will be only applicable to the sample of households used. Nevertheless, the latter results illustrate on the type of finding this approach could yield.

At a more general level, there is no doubt that Mayan livelihoods are resilient and that they show signs of sustainability because the Maya have pursued livelihoods, roughly within the same landscape, over the last 3 millennia (see Colunga-GarcíaMarín and Larqué Saavedra, 2003). Nonetheless, sustainability as it was first referred to in the Brundtland Report implies generational equity, and given the current social justice issues in the study area, this attribute seems to be lacking (see WCED, 1987). Moreover, during the fieldwork, it was clear and noticeable that currently, the Mayan people in Mexico suffer from a degree of deprivation and, as has been stated by Anan and Sen (2000, p. 2030) under this type of circumstances, "sustaining deprivation" should not be the goal. Thus, to the extent that the current Mayan reality involves sustaining a deprived livelihood, there is a lack of social justice. In the latter respect, present and future development policies in the Mayan area should consider improving the factors which make this a highly marginalized area. This should include programs on community-based production and community-based natural resource management. Once those programs are in progress in the area, together with social justice, they would set the path toward calling the indigenous Mayan livelihoods truly sustainable.

Chapter 3

Data-sparse Fisheries from Inland Waters of Quintana Roo, Mexico

3.1. Introduction

Small-scale freshwater fisheries form part of the livelihood portfolio of many rural communities scattered throughout Southern Mexico and Central America. In those areas, a conservation program funded by the World Bank and the Global Environmental Facility, among others – the "Meso-American Biological Corridor" (MABC) – is currently in place. The MABC is primarily focused on biodiversity conservation in several parts of Southern Mexico and in all the countries of Central America, because these areas have been acknowledged as one of the world's richest areas in terms of both linguistic and biological diversity (WRI, 2002). In respect to the former aspect, it has been reported that in this area, approximately 100 ethnic groups are currently settled in rural areas and that they are coping with several problems notably, environmental degradation, social inequality, and poverty (DFID, 1999; Toledo et al., 2001; WRI, 2002). In particular, this area is the homeland of the Mayan people who has been living in this area for the last three millennia (Colunga-GarcíaMarín, and Larqué Saavedra, 2003).

In the case of the Mayan communities from Belize, Mexico and Guatemala, many of them are located close to forested areas wherein they pursue slash-and-burn agriculture, livestock rearing, honey bee production, hunting, and small-scale fishing (Schwartz, 1990; Wilk, 1991; Villanueva and Collí-Ucan, 1996; Rojas-García, 1999; Velazco-Te, 1999; Morales-Garzón, 2000; Armijo and Llorens, 2004; but see also Chapter 2).

In Southern Mexico, and particularly in the Yucatan peninsula, inland waters are the only sources of water allowing for both commercial and subsistence activities. In this area, recent scholarly literature on limnology reported that several of the

water bodies were relatively shallow (approximately 15 m on average), and included lakes, ponds and the nearly-circular shaped aquatic ecosystems locally known as cenotes (Cervantes-Martínez, 2001). Additionally, Cervantes-Martínez (2001) reported that some of the studied water bodies were used for fishing by local people.

Nevertheless, to date, freshwater fisheries of the Yucatan Peninsula have been little studied. Although it is acknowledged that freshwater fisheries do not contribute very much to world fish production, their importance stems from providing essential food resources to local communities (WCMC, 1996).

In Quintana Roo (one of three states in the Yucatan peninsula of Mexico), inland fisheries are not being recognized within government statistics and hence there are no data regarding their annual catch, the species caught and the number of people involved in this activity. However, in this state, surveys undertaken by local research institutes during 1999-2001 (e.g., Rojas-García, 1999; Arce-Ibarra and Estrada-Lugo, 2000), showed evidence that this activity was seasonal for communities located within several common property holdings locally known as *ejidos*. Therefore, there is a gap in knowledge regarding many issues, notably the attributes of inland fisheries, including social, biological and management aspects. Addressing these topics would not only benefit science but also governmental agencies dealing with the management of resources at a regional level, and communities as well, because local people are often little aware of the cultural and traditional aspects of regional freshwater fishing.

In this study, and according to articles 9th and 12th of the Mexican Agrarian Law (Ley Agraria), 'common property' refers to a situation in which a group of people (locally called *ejidatarios*) own a piece of land in common, with the right to exclude others from using it (Ley Agraria, artículos 9 and 12, see DOF, 1992; DOF, 1993). Note that common property (res communis) differs from open

access (res nullius) in that the latter refers to a lack of property rights (Seijo et al., 1998; Charles, 2002).

This paper aims to assess the freshwater fisheries located in both Mayan and non-Mayan rural *ejidos* of Quintana Roo. In particular, the assessment included: (a) a description of the group of users, including gender aspects; (b) determining the underlying motivations in pursuing fishing; (c) identifying the natural resource base used for fishing; (d) recording the fishing methods and seasonality of fishing; and (e) determining whether there was any form of local management of the fisheries (after Mahon, 1997). The paper is organized into 5 sections: section 3.2 describes the material and methods used; section 3.3 presents the results obtained based upon the objectives of the research; and section 3.4 presents a discussion of the results.

3.2. Material and Methods

3.2.1. Study Area

This study was undertaken in Quintana Roo state, located on the Mexican Caribbean. This study was undertaken at common holding called *ejidos* located at the municipality of Felipe Carrillo Puerto. The geographical setting of the study was the rainforest of wherein there are several interspersed many water bodies (see Chapter 2).

The research was undertaken at three types of settlements, indigenous, non-indigenous and mixed, indigenous and non-indigenous. The indigenous people are Yucatec Mayan speakers who most often acknowledged themselves as descendants of the Mayan immigrants who came from the Yucatan area once a rebellion, called the "The Caste War", had started. The last war was started by the indigenous Mayan people who since 1847 fought against Spaniards, firstly for land and later on for autonomy (Villa -Rojas, 1992). These Mayan people currently inhabit an area of Quintana Roo locally known as The Mayan Zone ("La Zona Maya"). In this area, indigenous Mayan people from one community often

have relatives in neighboring communities, either from the same or from other *ejidos*. In The Mayan Zone there are also some Mayan people who came from the Yucatan state after "The Caste War" had ended, and therefore they themselves consider themselves different from Mayan people from Quintana Roo. Some of these people were living in the mixed *ejidos* together with non-*indigenous* people (see below).

The non-indigenous people were primarily immigrants, coming from several states of Southern Mexico, who in this case settled either at the border of The Mayan Zone, between two Mayan *ejidos*, or forming ejidos with indigenous people. Over several decades from 1935 to 1985, indigenous and non-indigenous peoples organized themselves and, after the requirements of the Agrarian Law had been fulfilled, they formed several *ejidos*. In 1935, *ejidos* were originally devised for "chicle" or sap harvesting. Nevertheless, later on new *ejidos* were formed with farming in mind (Armijo and Llorens, 2004).

To some extent, all three indigenous, non indigenous and mixed settlements are dynamic entities (sensu Alcorn and Toledo, 2000) because, among other changes, during some months of the year some people engage in migratory work in the tourism sector of Quintana Roo (Estrada-Lugo, 2005; but see also Chapter 2).

Some of the indigenous *ejidos* under study were engaged in community-based logging in which case the government allocated an annual harvest quota. In contrast, the non-indigenous and mixed *ejidos* under study were not engaged in logging.

In respect to spoken languages in the communities within the studied *ejidos*, generally the Mayan people primarily use the Mayan language to communicate amongst themselves. Nevertheless, during the study there were some Mayan communities with mixed characteristics – i.e., in most communities, Mayan was

the preferred language over Spanish and there were many monolinguals (i.e., only Mayan speakers). But also a few other communities were fully bilingual (Spanish-Mayan) with only a few monolinguals (Mayan speaking) people. Within a Mayan *ejido*, monolingual people were primarily both, elders and women, living in the most remote communities with little contact with urban communities.

3.2.2. Approach

The author of this study had been undertaking collaborative research with scholars from other disciplines such as anthropology, engineering forestry, and ethno-botany in Mayan settings of Quintana Roo, from 1998 to 2001. From those experiences, from interactions with local people, as well as from looking at the many remote fishing sites, she realized that working in these settings would impose several methodological restrictions when addressing fishery research. In particular, she realized that undertaking research on common lands would not only imply asking for consent from both traditional and provincial authorities but also a requirement to abide by local customs and traditions. The latter also apply to both non-indigenous and mixed *ejidos* because their inhabitants are rural, low literacy people for whom religious activities had priority over other issues. Therefore, some methods used in fishery science to assess a local fishery, including tag-and-recapture methods, would not apply in these settings. Hence, the methods selected for the present study, which will be explained in the following paragraphs, were ones that considered the local dynamics of fishing within the context of the local customs and traditions.

The selected methods were ones that have proved useful in both rural settings and non-Western societies (see Bernard, 1995; Chambers, 1997; Silvano and Begossi, 2005). One of the methods was a social survey (Thiessen, 2001). In respect to the sampling design to undertake the survey and because previous authors had demonstrated that not all local people linked to fishing would be willing to participate in this type of study (e.g., Rojas- García, 1999; Velazco-Te, 1999), a purposive (or qualitative) rather than a probabilistic (or quantitative)

design was selected (de Vaus, 1996). Thus, during the literature review it was found that the "snow ball" technique would be the appropriate to use in this case. The latter technique encompassed the following procedure: during the survey, local authorities were first contacted and, once they had granted consent to undertake the research, they provided the first names of people who were locally acknowledged as "very good at fishing" ("muy buenos para la pesca").

Afterwards, those first people provided new names of both "very good at fishing people" and some other less-skilled-at-fishing people who practiced this activity. In every visited community, the social survey stopped once either of the two following conditions happened; a) whenever, after the sixth interviewed person, new people provided virtually no new information on fishing, compared to former interviewees, or b) whenever 10 days of field work had elapsed in the same *ejido*.

During the survey, information was collected using a questionnaire with both closed and open questions which was completed using face-to-face interviews (de Vaus, 1996). The questionnaire consisted of 30 questions organized under the topics covering the objectives of the study. In addition, and as internal conflicts arose in some *ejidos*, several open interviews were undertaken whenever people wanted to have a chat on fishing but not to respond to the printed questionnaire. Besides interviews, the research team undertook participatory research and accompanied people in several fishing events (Chambers, 1997; Campbell, 2001). Moreover, in order to build rapport, they also participated in diverse festivals and rituals in 3 indigenous *ejidos*.

During the fishing trips, the research team performed fishing together with local people, recorded the type of water body being used, and determined the captured fish species following the scientific guides of Schmitter-Soto (1998b). Observation was also utilized to record the methods and techniques used for fishing, as well as other daily aspects of community organization to pursue an

array of local productive activities and festivals. All observational records were systematically written down at night time, in a journal (after Cohen, 2001).

Given that in the study area, there were no current formal or centralized fisheries management regulations in place (see Álvarez-Torres et al., 2002) and in accordance with Dalhousie University's Research Ethics Board guidelines, notably in order to preserve the confidentiality and privacy of the people who granted consent to be interviewed, the present research report will only use pseudonyms for the lands or *ejidos*, communities and fishing sites studied.

Data Analysis

Collected information from the survey was systematized using a codebook and all data were stored in a database (Thiessen, 2001). The matrix of the survey was composed of cases (interviewees) and variables representing the topics covered by the research objectives. Given the qualitative sampling design of the survey, responses to questions were counted and converted into percentages and were reported only as a percentage of responses out of "n" interviewees, either in general form or per group of users whenever appropriate. In addition, some data were represented graphically to show the trends of independent variables and their general patterns.

Qualitative data derived from observational records were cross-validated with as many sources of information as possible, derived from the same research and/or from literature reviews, and the results were integrated in every corresponding section (Bernard, 1995).

For the analysis of the number of fishery participants, and given that there was no previous data on this topic, interviewees were asked about the number of fishery users in their community. These results were pooled per *ejido* and presented only as a range, with the minimum and maximum values of users per *ejido*, as estimated by interviewees.

3.3. Results

Twelve *ejidos* were visited from January 14 to September 14, 2004, but at only 9 of them authorities granted consent to undertake the study on their lands (Table 3.1). The settlements of these *ejidos* were primarily composed of indigenous (5), non-indigenous (3) and mixed people (1; indigenous and non-indigenous). The research encompassed 15 communities (from a total of 19) in which 107 inhabitants were invited to take part in the study in the form of an interview on local fishery issues and/or as participants in fishing trips at their traditional fishing sites. Except in one case in which the community was the head of a municipality –with 17,500 inhabitants, settlements ranged from about 27 to 3,000 inhabitants. For example, 4 out of 16 communities were inhabited by less than 100 inhabitants, and another 3 communities out of 16 had less than 250 inhabitants.

From the 107 people who were invited to participate, 79 inhabitants (75.2%) accepted the invitation; 12 of them participated exclusively on fishing trips and 67 participated either in interviews or both, in fishing trips and interviews. The reluctance of some to participate may be explained by the experience, during the fieldwork, in which local people expressed concern regarding whether, once the research had been completed, it would result in their fishing activities being somehow restricted. Moreover, some local people asked whether there was any Government Fishery Officer ("inspector de pesca") as part of the research team.

Interviews were completed using both structured (n= 58) and open (n= 9) formats; with 52 structured ones being completed in Spanish and the remaining 15 (6 structured and 9 open) in Mayan. Two native Mayan speakers were the translators from Spanish to Maya during the survey; an anthropologist who participated in devising the questionnaires and a local 23-year-old *campesino* whose father was an *ejidatario* and who had been trained as a field guide, during 5 years in regional research projects.

Table 3.1. Types of studied *ejidos* and an estimate of minimum and maximum number of users per site (from survey responses).

Ejido ID	Type of *ejido*	No. of users per *ejido* (min – max)	Interviews		*No. of refusals
			Structured	Open	
1	Non-indigenous	10 - 40	8	0	3
2	Mixed	5 -16	5	1	1
3	Indigenous	35 - 202	16	0	14
4	Indigenous	10 - 50	6	0	2
5	Indigenous	44 - 124	6	2	2
6	Indigenous	10 - 25	7	0	0
7	Indigenous	145 - 240	10	1	3
8 **	Non-indigenous	?	0	3	2
9***	Non-indigenous	?	0	2	-
		259 - 697	*58*	*9*	*27*

* People who did not accept to take part in the study.
** No structured interviews were completed because of internal conflicts in the *ejido*.
*** The President of the General Assembly did not grant consent to undertake structured interviews.

3.3.1. The Resource Users

Taking into account both structured and open interviews (n= 67), 61.2 % of interviewees were from any of the communities located in the *ejidos* where they were currently living, whereas 34.3% were immigrants to the region, coming from several other states of Southern Mexico. The former group of people was primarily Mayan whereas the latter were composed of both non-indigenous and mixed people (immigrants and Mayan people coming from the state of Yucatan.)

The age of interviewees ranged from 14 to 66 years old and their fishing experience ranged from 1 to 54 years. As was expected, the level of experience showed a tendency to increase with the individual's age (Figure 3.1).

In respect to the number of users per *ejido*, a range, or minimum and maximum values, was computed and is shown in Table 3.1.

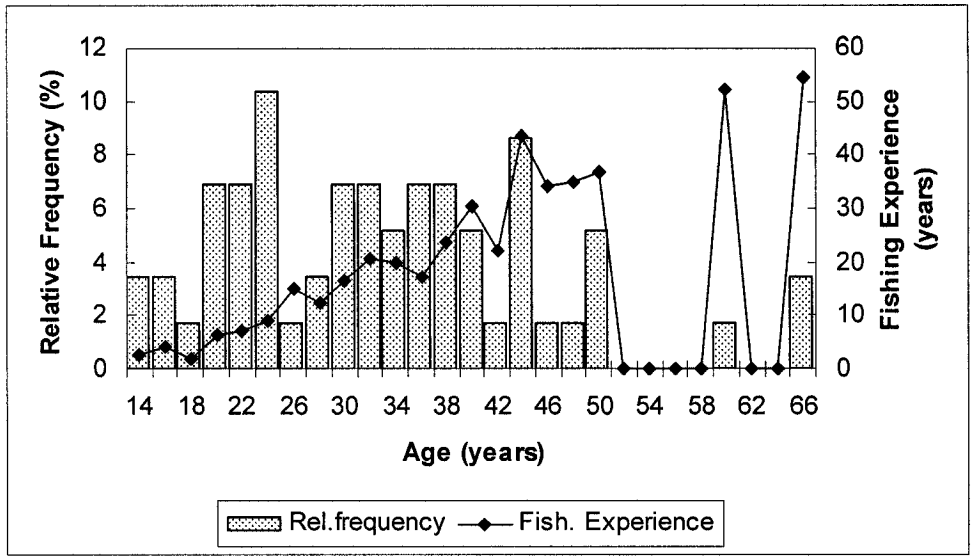

Figure 3.1. Frequency of age (years) and fishing experience of fishery users from 7 *ejidos* of Quintana Roo.

In respect to major sources of livelihoods, 84.5 % out of 58 interviewees responded that their major source of livelihood was slash-and-burn agriculture (locally known as 'kool' and 'milpa' in Mayan and Nahuatl languages, respectively). Some other major sources of livelihoods, such as seasonal migratory work, logging and small-scale business, were also recorded. It was observed that in several cases, interviewees pursued multiple livelihoods including hunting, honey bee production, edible gum harvesting and gathering. Thus, in spite of being practitioners of fishing, interviewees did not acknowledge themselves as "fishers" but only as "campesinos" and as "rural people". [Note that there were 6 students from Junior High and High School levels among the interviewees; three of these were agriculturists, while for the three others, the only occupation was being a student.]

What would be the underlying motivations of these rural people for pursuing fishing? From a multiple response question, it was ascertained that motivations included providing food to the household (subsistence), recreational purposes, and a combination of motivations which included the former two with or without a motivation to sell fish (Table 3.2).

Table 3.2. Motivations underlying the pursuit of fishing in 7 *ejidos* of Quintana Roo.

Motivations	%	Motivations	%
Only Subsistence	43.86	All responses Subsistence	89.47
Only Recreational	10.53		
Only For sale	0	All responses Recreational	49.12
Subsistence + recreational	29.82		
Subsistence + for sale	7.02	Al responses For sale	15.79
Subsistence + recreational + for sale	8.77		
(n= 57)*	100		

*Not ascertained n= 1.

Information collected from interviews plus observational records during fishing trips provided indications that, generally speaking, there were two broad categories of users of the fishery resource, namely a) a regular user and b) an occasional user. The former encompassed the most skilled-at-fishing people but also some others who, although not locally acknowledged as "very good at fishing", nonetheless provided a regular amount of fish to the household every fishing season. The occasional user included other less skilled-at-fishing people; elders and those "retired" from regular fishing; children and youth with interest in fishing, as well as whole families that, while spending a holiday at the water body, would have some of its members fishing (see also section on seasonality of fishing.)

Gender Issues

At the 9 studied *ejidos*, fishing was clearly a male-oriented activity. Except in one case, names of women pursuing fishing were not provided either by authorities or by any other local people. As a result, only 2 out of the 67 interviews were completed with women as users; one utilizing a structured (*ejido* 3) and the other using an open interview format (*ejido* 9). These two women belonged to the category of "regular user" explained in preceding paragraphs. The first-noted woman interviewee was specifically recognized as a person who pursued fishing by two *campesinos* from two neighboring *ejidos*. Moreover, two other teenaged

women who had stated they pursued fishing in *ejido* 5 were met by the research team during June, 2004, but as at that very time their parents were not home, they decided not to grant consent to be interviewed.

During structured interviews (n= 58), 82.8 % participants acknowledged that fishing was a male-oriented activity while the remaining people considered it to be an activity in which women might or currently do participate. Overall, it was recorded that women from 5 out of the 9 *ejidos* were users of the fishery resource; they were from the indigenous *ejidos* 3, 5, and 7; from the non-indigenous *ejido* 8, and from the mixed *ejido* 2.

Generally speaking, fishing sites used by women were not as muddy and deep compared with the ones used by men. For example, it was observed that their fishing sites were relatively close (from a few meters to 1 km) to their households. Ages of women involved in fishing ranged from approximately 14 to 49 years old.

From a multiple response question, the same sample (n= 58) of structured interviewees acknowledged women pursued some other fishing-related activities including cooking fish (99.55%), cleaning-eviscerating (63.79%), gifting fish to relatives (41.37%), and selling the captured fish (13.79%).

Three fishing trips were undertaken with two interviewed women; one in the indigenous *ejido* 3 and two in the non-indigenous *ejido* 8. (A further discussion of gender aspects is included in section 3.3.)

3.3.2. The Natural Resource Base Used for Fishing

In respect to fish species supporting local fisheries, it was recorded that 16 bony fish species belonging to 6 families and 5 orders were used as the biological resource base. The list of 16 species included target, by-catch as well as species used as bait (Table 3.3). Other incidental fauna included turtles and occasionally, crustaceans.

Table 3.3. List of bony fish species used as resource base in local fisheries.

Local name	Scientific name	Target	By-catch	Bait
"Bocona"	*Petenia splendida*	X		
"Mojarra"	*Cichlasona urophthalmus*	X	X	
"Mojarra"	*Cichlasoma synspillum*	X	X	
"Mojarra"	*Cichlasoma salvini*	X	X	
"Mojarra"	*Cichlasoma robertsoni*		X	
"Mojarra"	*Cichlasoma friedrichsthali*	X	X	
"Mojarra"	*Archocentrus octofasciatus*		X	X
"Mojarrita"	*Thorichthys* spp.			X
"Dormilona"	*Gobiomorus dormitor*	X	X	
"Sábalo"	*Megalops atlanticus*	X		
"Bagre"	*Rhamdia guatemalensis*		X	X
"Agujeta"	*Belonesox belizanus*		X	X
"Sardina"	*Astyanax aeneus*			X
"Sardinita"	*Poecilia mexicana*			X
"Sardinita"	*Gambusia yucatana*			X
"Sardinita"	*Gambusia sexradiata*			X

Source: fieldwork from this study; Arce-Ibarra (2000) and Arce-Ibarra and Estrada-Lugo (2000).

In respect to the aquatic ecosystems recorded as being used for fishing, there were 48 recorded sites within 9 *ejidos*. These were of several types including 2 lagoons with a slight marine influence, 16 lakes, 14 cenotes (round-shaped limestone holes filled with water), 11 ponds, 2 channeled wetlands and 1 flooded savanna.

Of course, the use of the water bodies by the three types of settlements was dependent upon their location. In other words, whenever a water body was closer to a Mayan community or *ejido* it was primarily used by them. Thus, this study found that lagoons with a slight marine influence were used primarily by non-indigenous *ejidos* whereas channeled wetlands and the flooded savanna were used only by indigenous *ejidos*.

Except in five water bodies in which fishing was based upon a single species (i.e., there was only one local fish species which could be captured with hook and

line) fisheries were multi-specific in nature. In respect to a preferred fish to capture, and considering 47 users of multi-specific fisheries, 91.5 % responded they had a preferred fish to target, whereas the remaining people responded they had not. From this sub-sample (n= 43), 76.7 % commented their preferred fish was the cichlid P. splendida followed by 11.6 % of people who preferred both P. splendida and another cichlid fish locally known as "mojarra" (Cichlasoma spp.). The remaining people (4.7 %) commented they preferred to capture "fish of big size"; some others (2.3 %) preferred the cichlid C. friedrichsthali whereas still others (2.3 %) preferred both P. splendida and C. friedrichsthali.

Because of differences in fish distribution per water body, catch species composition varied widely per water body with the most common species being the cichlid C. urophthalmus, followed by two other cichlids, P. splendida and C. synspillum. Nonetheless, capturing P. splendida seemed to be far more difficult than capturing the remaining two species because in order to succeed in capturing it, one needed certain fishing skills as well as live bait (generally the characid fish A. aeneus).

The perception or the meaning of a "good" and a "poor" (or "bad") catch per fishing event varied among people from different *ejidos*. The range of a "good catch" ("una buena pesca") varied from 5 to 20 kg per event of fishing. Taking into account 57 interviewees from 7 ejidos (5 indigenous sites; one mixed and one non-indigenous), the percentage of users that commented on the meaning of a "good catch" per fishing event is shown in Figure 3.2.

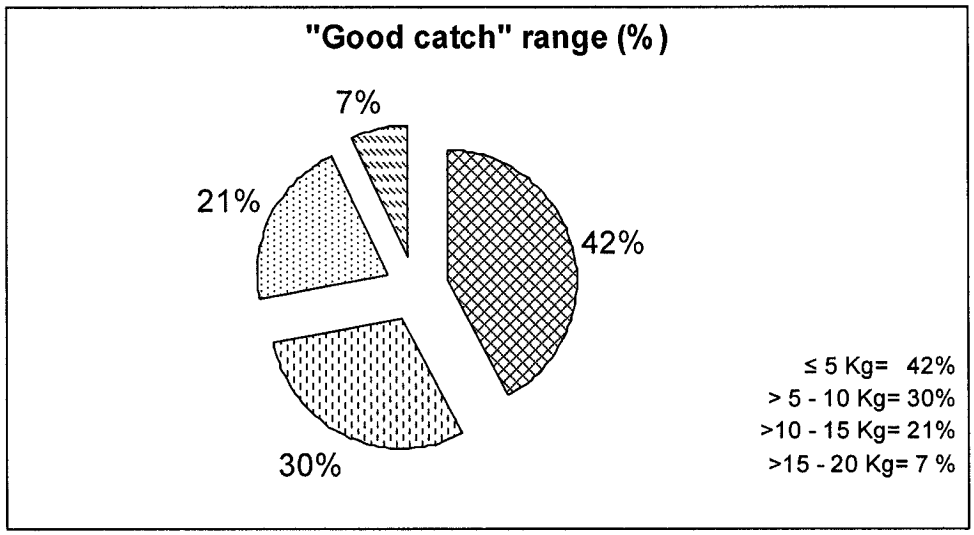

Figure 3.2. Opinions on the meaning of a "good catch" from users of 7 *ejidos* of Quintana Roo.

Moreover, the frequency of opinion on the meaning of a "good catch" per *ejido* is shown in Figure 3.3.

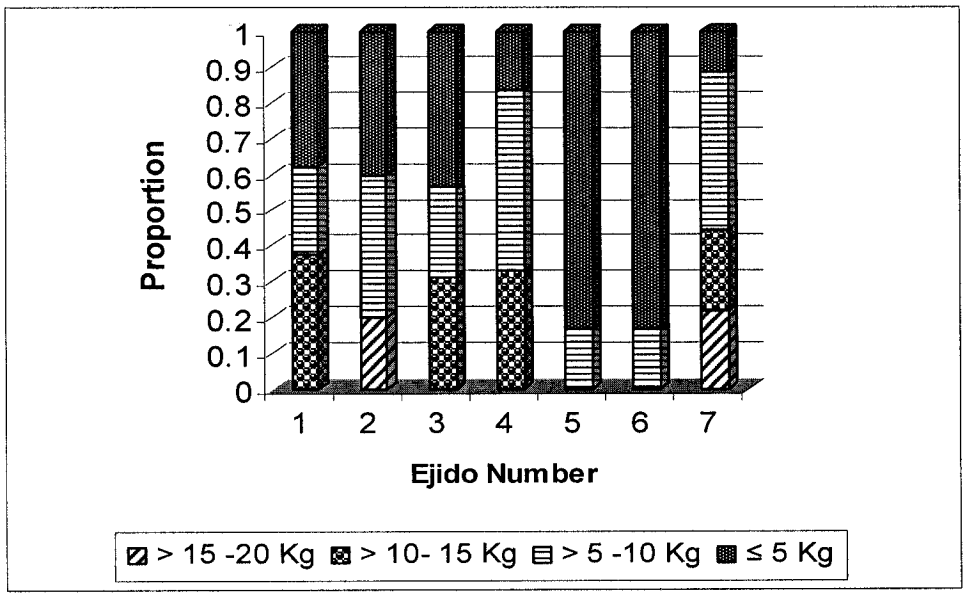

Figure 3.3. Frequency of opinion on the meaning of a "good catch" of users from *ejidos* 1 to 7. Opinion is based upon 4 range values (see legend).

It was striking that only at two *ejidos*, the mixed number 2 and the indigenous number 7, recorded values of >15 to 20 kg which were regarded as to represent a "good catch".

In respect to the meaning of a "poor or bad catch" ("una mala pesca"), this ranged from 0 to 6 kg per fishing event per user.Taking into account 55 interviewees from 7 *ejidos* (5 indigenous sites; one mixed and one non-indigenous), the percentage of users that commented on the meaning of a "poor or bad catch" per fishing event is shown in Figure 3.4.

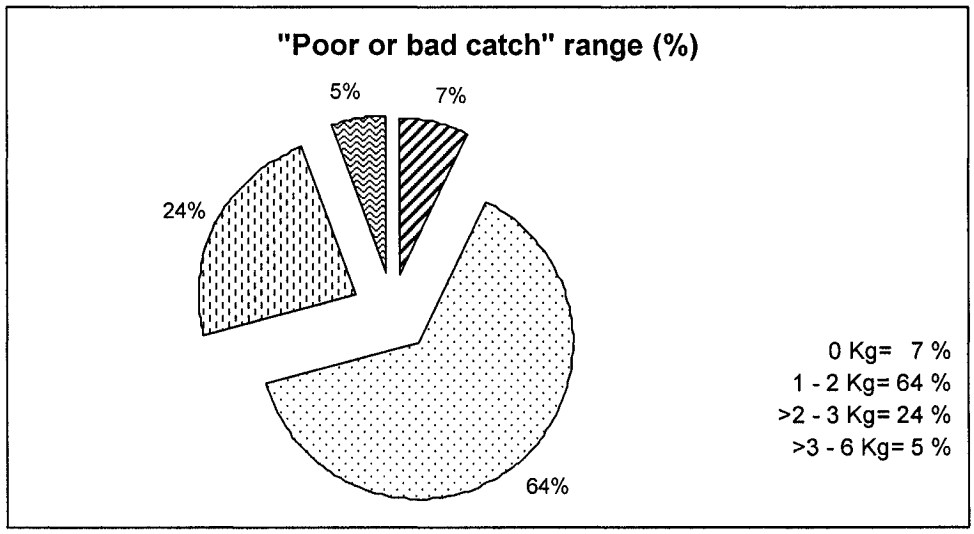

Figure 3.4. Opinions on the meaning of a "poor or bad catch" from users of 7 *ejidos* of Quintana Roo.

3.3.3. Fishing Methods and Seasonality of Fishing

Fishing methods used in local fisheries belonged to both the passive and active categories (Bjordal, 2002). The former included hand-lines which were recorded as being the main fishing gear for 58 people from 7 *ejidos* (5 indigenous sites; one mixed and one non-indigenous). In all cases, hand lines were composed of steel-made hook and nylon monofilament. Also, some people from indigenous *ejidos* reported an active method which included the use of both rustic wood-made and steel-made harpoons and one net which were recorded, respectively, in 6.9 % (*ejidos* 3 and 7) and 1.7 % (*ejido* 7) out of 58 cases.

Observational data plus 5 open interviews completed in non-indigenous *ejidos* 8 and 9 provided additional information on fishing gears. In *ejido* 8, fishing gears

were hand-lines as previously described, whereas in *ejido* 9, hand-lines, harpoon, circular cast nets and trammel nets were recorded.

Except in the mixed *ejido* 2, fishing was primarily performed with hand-lines, walking barefoot on the shores of the water bodies while the level of water reached the first half of the users' body (Figure 3.5). Most often, people moved from one fishing spot to another during a fishing event.

In contrast, and because their fishing area was acknowledged a "deep lagoon", fishing in *ejido* 2 was performed from both wood-made and steel-made canoes (from approximately 1.5 to 2.5 m in length). In addition, in the flooded areas of the latter site, fishing was also performed walking barefoot without the use of any fishing gear. The latter, a very unusual technique, was described during four structured interviews and the (Western science) rationale behind it was completed by the author of this study as follows (in italics, below): people walked barefoot along the shore of lakes which have several other small pools or natural fish enclosures; while walking, people remove purposively the muddy bottom for several minutes. *Mud removal depleted the dissolved oxygen of the column of water and, enclosed fish died by anoxia*. Once the fish appeared at the water surface –either dead or about to die- they were collected by hand. Local people called this fishing technique as "fishing by hand" ("pesca a mano").

It was observed that in some sites of indigenous *ejido* 7, fishing was performed with the level of water as previously described even though some medium size (approximately 1.5 to 2 m total length) crocodiles (Crocodrilus moreletti) were near the users (approximately 5 to 20 m away). Strikingly, people seemed to co-exist with crocodiles during their fishing time (over approximately 2 to 6 hours) because no one recalled there ever being any attack of crocodiles upon any person. The research team could be similarly exposed to crocodiles while fishing without any problem either.

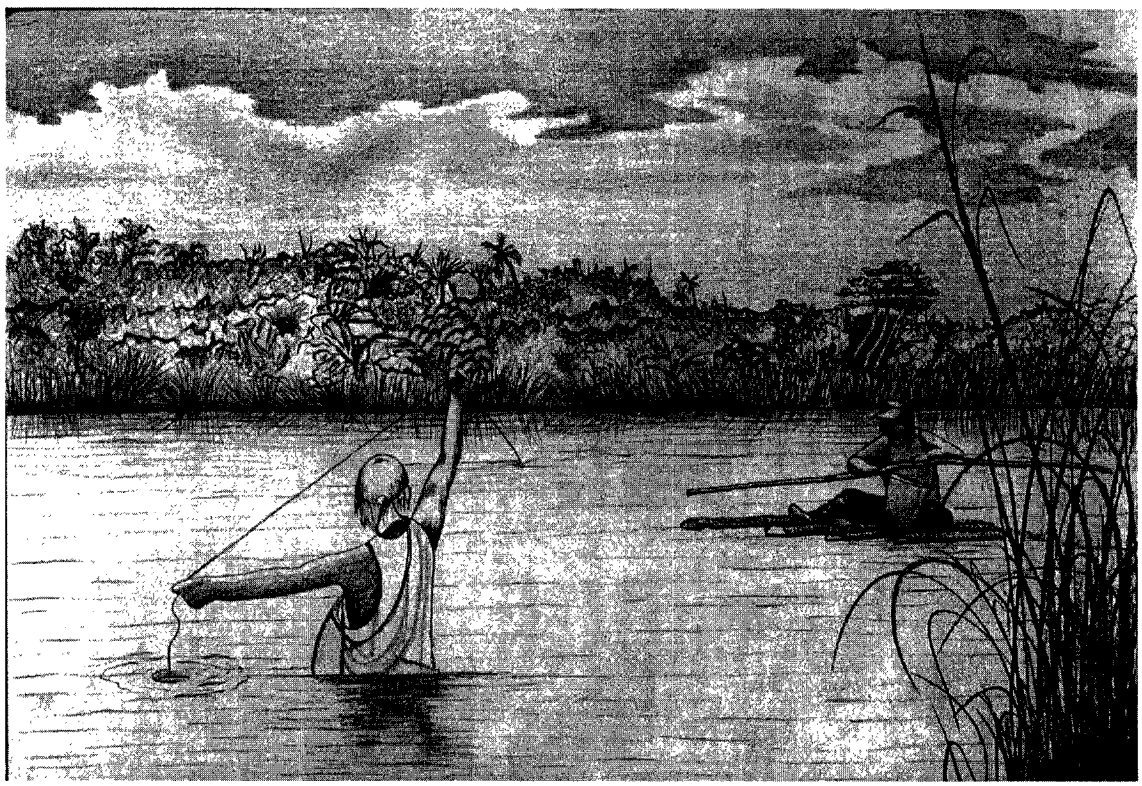

Figure 3.5. Two Mayan people performing fishing in a local water body in Quintana Roo, Mexico (drawing by María Magdalena Noriega Guevara, 2006).

In other sites (indigenous *ejidos* 3, 6 and 7) , it was recorded that in some ponds and lakes located in the rainforest wherein there were specific species of trees, some people had the custom of building rafts (from 1.5 to 2.5 m length) made of dry trunks (Figure 3.5). Thus, overall 41.4 % out of 57 persons did at some time use rafts or canoes for fishing. Except in one case in which the steel-made canoe of *ejido* 5 used an outboard engine, movement of canoes and rafts were made by paddling and by using large wood sticks, respectively.

Additionally, at some water bodies in which walking on the muddy shore seemed difficult and risky, people had built some structures resembling little bridges made of large woodsticks onto which they climbed to fish from them. These wood-made structures were visually recorded at 4 water bodies located in indigenous *ejidos* 3 and 5 (two each). Furthermore, at cenotes, lakes, and lagoons surrounded by mangroves, people pursued fishing from on top of their roots.

In respect to the use of bait, information derived from both interviews and observations during fishing trips showed that it differed among *ejidos*. The difference was due to several factors, notably because of the geographical distribution of fish species in the study area. For example, whenever the small-sized fish of the Characidae family (A. aeneus) were present in some fishing areas used by indigenous *ejidos*, it was used as bait to capture either P. splendida or other fish species. Nevertheless, whenever the characid species was absent, other species from the Poeciliidae family, which were smaller than the former, were used instead.

Among indigenous *ejidos*, people differed in the ways of capturing the characid fish (A. aeneus). For example, in indigenous *ejidos* 4 and 7, a glass or plastic bottle, baited with corn meal, was used whereas in indigenous *ejidos* 3, 5 and 6, fish were captured with the smallest hook, using wet corn meal as bait.

Furthermore, it was observed that whenever people had brought their rifle on the fishing trip, the latter was used to shoot birds the meat of which was used as bait too. Other recorded baits were earthworm, chicken gut, the first captured fish and, to a lesser extent, a freshwater snail species. But bait used in the non-indigenous *ejidos* 1 and 9 were a bit different than that recorded in the remaining *ejidos*. In *ejido* 1, bait was composed of at least 8 juvenile bonyfish species belonging to the families Cichlidae, Characidae and Poecilidae. These species were captured with hand nets at smaller pools located on the way to the fishing areas. No other bait was recorded at this site. In *ejido* 9, only two types of bait were recorded – earthworms and the first captured fish.

In respect to the seasonality of fishing, 74.7 % out of 57 interviewees responded it was performed during one or more months of the dry season – usually from February to early June. Nonetheless, depending on several factors, 24.6 % of interviewees performed fishing in months of both the dry and the rainy (late June to October) seasons. It was observed that at fishing sites fully located in wetlands

where seasonal flooding was marked, the fishing season halted once the rainy season had started. Nevertheless, some other water bodies remained fished throughout the year, although with less frequency and intensity than during the dry season.

The frequency of fishing varied widely. For the regular users, it ranged from once a week to once a month during the dry season. Except in remote fishing sites, in which people stayed for 2 or 3 days, no records of daily fishing were found.

From observational data, it was ascertained that most often people performed fishing with a higher frequency at the beginning of the dry season (February) and, as the fish biomass was being depleted at the fishing sites, the initial frequency decreased and ended at once per month by the end of the season (late May and early June). This fact was noted only by one interviewee (a native Mayan speaker) from the mixed *ejido* 2 who, when asked his frequency of fishing, commented that local people pursued fishing more often whenever fish abundance was high. In addition, other people commented that the frequency of fishing may vary because of several factors including whether they had "time to go fishing"; the arrival of the Holy Week and whether friends and relatives had invited them to pursue fishing. The expression "time to go fishing", which was common in several interviews, meant if they had no work to do in activities recognized as their major livelihood.

Moreover, 57 people were asked the reasons for pursuing fishing during their selected time period and, their responses are shown in Table 3.4.

In respect to the day preferred to pursue fishing, 87.9 % out of 58 interviewees responded they did have a preferred day for fishing whereas the remaining people responded they did not. In general, the preferred days to pursue fishing were the weekends. In particular, from the people who did have a preferred day to pursue fishing (n= 51), 84.3 % of people responded their preferred day was

Saturday and/or Sunday whereas another 13.7 % preferred Fridays, either apart from (5. 9 %) or together with (7.8 %) Saturdays and Sundays.

The duration of fishing trips varied widely. Generally speaking, at water bodies located near a community (from 0 to 4 km), a fishing trip may last from 1.5 to 4 hours, at places located approximately 5 to 14 km from the community, trips may last between 6 to 12 hours, and at places further than 14 km, people left the community in the morning, stayed overnight and returned the next afternoon. In some cases, the latter also included a staying period from 2 to 3 days.

In general terms, the way to get to the *nearby* water bodies was either by walking or by bicycle. For the *middle distance* sites, people either used bicycles or – whenever roads were in good condition – they traveled by car (after an amount of money had been previously collected, among participants in the fishing trip, to cover the cost of the gas of a friend's car). To reach distant places, for which roads are mostly unsuitable for cars, people usually used bicycles the first half the way and walked the other half, as appropriate.

Fishing trips were mostly undertaken with one or more friends or relatives. The research team participated in 9 fishing trips in which groups of local users ranged from 3 to 8. Nevertheless, on a few occasions (1.8 % out of 58 interviewees), people responded that they pursued fishing alone.

It was both observed and recorded that often, people who were close friends or relatives pooled their captured fish, and the pooled catch was divided among the individuals pooling their catch. From structured interviews it was ascertained that 78.2 % out of 55 people who performed fishing in groups of friends and/or relatives shared their catch, to some extent, whenever any of the friends or relatives did not capture any fish. Another 14.6 % of people responded they did not share their catch with their buddies and, the remaining 7.3 % responded they

did not need to share their catch because their buddies always captured some fish.

Table 3.4. Reasons for fishing during the chosen fishing period (from a multiple response question with n= 57.)

Category (Reason)	%	Category (Reason)	%
Water level of the site is low and access is good	38.60	All responses Water level is low and access is good	66.67
Fish abundance is high	5.26		
Holy Week	3.51	All responses Holy Week	22.81
There is little or no work to do	10.53		
Enjoy performing fishing	7.02	All responses Fish abundance is high	21.05
Water level is low and access good + Fish abundance is high	12.28		
Water level is low + Holy Week	10.53	All responses Enjoy performing fishing	14.04
Water level is low and access good + Holy Week + Enjoy performing fishing	1.75		
Water level is low and access good+ Enjoy performing fishing	3.51	All responses There is little or no work to do	12.28
Fish abundance is high + Holy Week	3.51		
Holy week + There is little or no work to do	1.75		
Holy Week + Enjoy performing fishing	1.75		
Total	*100*		

Once people have returned from a fishing event, the captured fish may have several fates. If people had captured fish in excess of a quantity for a family meal (approximately from 1 to 4 kg) and, provided there was a refrigerator in the household or in the household of any relative, people refrigerated the remaining fish. Alternatively, some people may either give these fish as gifts to relatives or sell them in the community at a cost ranging from $2.00 to 3.20 U.S. dollars per kilogram.

3.3.4. Fisheries Management

This section includes results on issues related to management of both the water bodies and the fishery, including rights to access the fishing resource. Survey questions for which responses are provided in this section included a) describing any type of care (conservation activities) that users undertake on water bodies; b) describing whether there were any people in the *ejido* who played the role of local caretaker of the fishing sites; c) determining whether interviewees could pursue fishing anywhere inside the *ejido* limits and d) as in the previous question but outside of the *ejido*; and e) who were the people without a right to access the fishery at the *ejido*'s water bodies utilized for fishing. Some of the questions, particularly c), d) and e), were not appropriate for the non-indigenous *ejido* 1 because its fishing areas were located fully outside their land limits.

From the responses obtained (n= 52), 40.4 % of people (from 5 indigenous and 1 mixed *ejidos*) responded there were no types of care undertaken on water bodies whereas the other 59.6 % responded there were one or more forms of care undertaken on those sites. Among the latter, there were three main forms of care plus a few combinations, as shown in Table 3.5.

In respect to a water body's caretaker, 64.3 % out of a sample of 56 interviewees (from 5 indigenous, 1 mixed and 1 non-indigenous *ejidos*) responded there was no caretaker for those sites; 33.9 % responded there were one or more caretakers and 1.8 % responded "don´t know". According to interviewees who responded there was a caretaker (n= 19), 36.8 % pointed out that such a role was performed by the representatives of the General Assembly of *ejidatarios*; 10.5 % responded it was performed by the representative of the state authority ("Delegado" or "Subdelegado"), 31.6 % pointed simultaneously toward both types of authorities, and 21.1 % believed that role was performed by the *ejidatarios* themselves, their sons plus any other inhabitants.

Table 3.5. Forms of 'care' for water bodies (based on responses of interviewees).

Type of care	%	Type of care	%
Not leaving trash at the site	58.06	All responses Not leaving trash	70.97
Not burning the surrounding vegetation	12.90		
Not using dynamite for fishing	3.23	All responses Not using dynamite	6.45
No trash+ no oil or gas into water	9.68		
No trash+ no dynamite	3.23		
Other*	12.90		
Total	*100*		

* Includes: not using harpoon, no chemical pollutants into water, no poison into water, and releasing small size fish back into water.

Analyzing the responses of whether users were able to fish anywhere inside the *ejido* limits, 96 % of 50 people (from 5 indigenous and 1 mixed *ejidos*) responded affirmatively whereas the remaining people responded as "do not know". Moreover, in *ejidos* having more than one community and several fishing sites, no user specifically claimed any fishing site belonged to a specific community. Nevertheless, in the indigenous *ejido* 7, the research team had on two occasions invited 2 people from different communities to become a "field guide" at water bodies other than the ones located close to their communities but still within their *ejido*'s limits. As a result, both people had commented they were accustomed to pursue fishing at water bodies located close to their communities and they suggested the research team should contact people whose community was close to the water bodies at which the research team wanted to work.

In respect to whether users were able to fish anywhere *outside* the *ejido*'s limits, 52 % of the same 50 interviewees responded affirmatively; 26 % responded negatively; 4 % responded "only if I am invited to do so" and 18 % responded "do not know".

Given that an *ejido* is a land owned in common by entitled persons, who would be the people without a right to access the fishery (i.e., without a use right; see

Charles, 2002) at the local water bodies?. Overall, 42.0 % out of 50 people (from 5 indigenous and 1 mixed *ejidos*) responded that there were no such people without a right to access the fishery (in other words, they thought everyone had a use right or a right to go fishing). The remaining 58.0 % of interviewees considered that there were several people who had no right to go fishing at the water bodies located in their lands (Table 3.6).

Table 3.6. Opinions on whether or not granting use rights to outsiders at indigenous (3,4,5,6 and 7) and mixed (2) *ejidos*.

Type of Response	Total numbers	Ejido2 (%)	Ejido3 (%)	Ejido4 (%)	Ejido5 (%)	Ejido6 (%)	Ejido7 (%)
Unrestricted fishing	21	80	25	66.7	50	85.7	0
Restricted fishing	29	20	75	33.3	50	14.3	100
Total of cases	*50*	n= 5	n= 16	n= 6	n= 6	n= 7	n= 10

From additional comments to this question, two users from different *ejidos* acknowledged the water of lagoons, lakes and cenotes to be a federal (state) property. Therefore, they argued, they belonged to all Mexicans. For this reason, they commented, fishing at those sites could not be banned.

Among the factors influencing restrictions on who has fishing use rights in an *ejido*, the two most important factors for exclusion were a) people causing any damage to fish and water bodies and b) people coming from alien communities (Table 3.7).

In respect to non-indigenous *ejidos*, data collected from observation as well as from an open interview with a person who was both the representative of the state authority and the representative of the General Assembly of *ejidatarios*, at the non-indigenous *ejido* 9, provided understandings that the local lagoon in their *ejido* usually had many visitors from abroad who enjoyed both swimming and

fishing but who often left large amounts of litter, and, for the latter reason, ejidatarios had been considering that they should somehow restrict entrance to that lagoon.

Table 3.7. Causes for restricting fishing rights in indigenous and mixed *ejidos*.

Category	%	Category	%
People causing damage	31.03	All responses People causing damage	44.83
Alien (outside) communities	20.69		
People without consent	13.79	All responses Alien communities	37.93
People without a local friend and/or relative	10.34		
Alien communities + People causing damage	10.34	All responses People without consent	27.59
Alien communities + People without consent	6.90		
People without friend and/or relative + People without consent	3.45	All responses People without friend and/or relative	13.79
People causing damage + People without consent	3.45		
Total	*100*		

3.4. Discussion

3.4.1. Attributes of Local Fisheries

In spite of local freshwater fisheries being clearly artisanal and subsistence in nature, this activity needs to be either recorded or acknowledged in both regional and national catalogs on fishing, such as for example, the National Fisheries Charter (see DOF, 2004). Once the latter is done, it would be easier for researchers to locate them and if interested, undertake studies from several scholarly angles including biodiversity conservation, ecology and community-based natural resource management, among others.

Most fishery resource users were primarily agriculturists ranging in age from teenagers to senior adults. Although some women were recorded as users of the

fishery resource, fishing was primarily a male-oriented activity. As far as the author could ascertain, previous studies on fishing from the studied area had not reported women either as "occasional" or as "regular" participants in freshwater fishing (see Rojas-García, 1999; Bello-Baltazar, et al., 2001 Jorgenson, 1993; Estrada-Lugo, 2005). In contrast, a review on freshwater fishing from Amazonia, South America, undertaken by Gragson (1992a) portrayed fishing as an activity that was performed regardless of gender. Nonetheless, Gragson (1992b) also reported that in some native cultures such as the Ciri Khonome Pumé which inhabits seasonal lacustrine land conditions from Venezuela, women did engage in only some type of fishing but not in others. For example, Gragson (1992b) reported that women did engage in poison fishing but not in fishing in which the use of hook and line, bows and arrows or spears were recorded. According to Gragson (1992b), women fished at the shallowest and hence safest places compared to that fished by men. In a similar way, Arce-Ibarra and Estrada-Lugo (2000), had asked 8 male practitioners of fishing from a Mayan indigenous *ejido* about the reasons women from their communities did not pursue fishing. Generally speaking, people responded that (a) fishing sites were interspersed in the rainforest wherein one could find snakes during a journey, and (b) many of the fishing areas were relatively far apart from the community and they were generally very muddy in nature. Therefore, interviewees considered that their fishing sites were not appropriate places for women to go.

The estimation of the number of users per *ejido*, derived from interviewees, varied widely. This fact was more striking in indigenous *ejidos* 3 and 4 because the maximum value of the range given was five times the minimum. This could be partially attributable to some people's hesitancy and concern in showing details of their fishing activity to outsiders. Nonetheless, results obtained on this topic as well as observational records provided an understanding that in any community, fishing was not practiced by all men.

Fishing was not recorded as a major source of livelihood of any user and therefore, it is suggested to be of secondary importance to local livelihoods. This is explored in more detail in Chapter 5 wherein multiple livelihoods are assessed and fishing explicitly compared among them. The latter type of studies has not previously been done in Mayan communities, for most studies have addressed agricultural and forest issues, and resources of secondary relevance to livelihoods have been only listed or briefly explained as they have been found for example, in the studies of Atran (1993) in Guatemala and, Jorgenson (1993), Hostettler (1996) and Bello-Baltazar et al. (2001) in Mexico.

Still fewer studies have addressed the motivations or rationale behind pursuing fishing in indigenous and rural settings. From a multiple response question, results of this study show that subsistence followed by recreational purposes were the key motivations in fishing. The former motivation is understandable in terms of previous studies reporting the Mayan people as reliant on local resources for livelihoods. Nevertheless, the second motivation – recreation – has received little or no attention as an attribute of artisanal fisheries, having been discussed only in the context of so-called sport/recreational marine fishing. Nonetheless, once local conditions of the studied *ejidos* were known, it was understandable that fishing is a recreational activity too, because options for leisure and recreational activity in the studied area were very scarce. For example, the only recreational activity that was seasonally observed in the study area was baseball (yet this activity was exclusively for male adults) and records also indicated that the youth played volleyball and football (soccer), although with no league formally in place.

In respect to additional observation on indigenous community dynamics, it was found that during the dry season, in which local air temperatures reached 37–39 C°, the lakes, lagoons and cenotes located close to communities were often used for family holiday purposes, particularly during weekends. Thus, fishing and overall aquatic resources are suggested to be relevant to both subsistence and

recreational purposes in all three, indigenous, mixed and non-indigenous *ejidos* of Quintana Roo.

Fisheries were mostly multi-specific in nature. The resource base of fishing was composed of 16 species in which the cichlids P. splendida, C. urophthalmus and C. synspillum were the most caught. Other multi-specific fisheries with a similar list of fish species have been reported as the resource base in other indigenous and rural communities from Mexico and Guatemala. In the case of Mexico, Maimone-Celorio et al. (2005) showed that 4 of the same fish families reported in this study, including the cichlids P. splendida, C. urophthalmus and C. synspillum, were among the resource base of fisheries of the indigenous Mayan-Chontal and of non-indigenous communities from "Pantanos de Centla" (Wetlands of Centla), Tabasco. In Guatemala, cichlids have been reported as inhabiting the Lago Peten Itzá (Schmitter-Soto, 1998b), on the shores of which the last Mayan Itzá people and their descendants are currently settled (Atran, 1993). People from those communities are known to pursue fishing (M. Valdéz, 2004, personal communication). Based on the above studies and looking at the geographical distribution of both Central American cichlids and Mayan people, this study suggests that most Mayan people that pursue fishing across the whole Mayan area would have a similar cichlid resource base as the one described in this study, because geographical distributions, people and fish, were to a large extent coincident. Unfortunately, detailed fishing studies from other Mayan groups are scarce in the area and therefore, a more detailed comparison and review on this topic was not feasible.

In respect to the amount of catches (kg) obtained during a fishing trip, opinions on the meaning of a "good catch" varied among *ejidos*. The latter difference in fish production might be explained in terms of both the inherent productivity of a water body and the fishing skills of people. Alternatively, this difference might be understood on the basis of the current status of the local fisheries because they might be subexploited, overexploited or depleted. As far as the author could

ascertain, there have been no previous studies explicitly addressing the latter considerations but this dissertation addresses this topic in Chapter 5.

Local water bodies used for fishing were relatively small in size. In this respect, Cervantes-Martínez (2001) studied the morphometry of eight local water bodies used for fishing in Quintana Roo and found areas ranging from 264 to 28,895 m^2. For the latter reason, fish biomass might be relatively depleted at the end of the fishing season. A similar process of depletion of fish biomass was reported for small size lakes (50 – 2000 m^2) in indigenous fisheries from Venezuela's tropical savanna by Gragson (1992b). This author also explained that the success of subsequent fishing trips at depleted ponds was affected by those preceding it.

In general terms, the local fisheries studied here could be classified as artisanal, with use of very low technology, including the use of hook and line gear in which the activity is performed both barefoot on the shore of water bodies and often with the aid of rafts and canoes. (Notably, the fishing methods in some water bodies often involved many indigenous fishers coexisting with medium size crocodiles, a characteristic not found previously reported in any other freshwater fishery.) Furthermore, in a mixed *ejido* an unusual fishing technique such as "fishing by hand" was recorded. The latter type of fishing was first reported by Rojas-García (1999) in The Mayan Zone's channeled wetlands, particularly, at an indigenous *ejido*. The latter technique seemed to be very efficient (i.e., virtually all enclosed fish would die during a fishing event), and it resembled the one reported by Gragson (1992a) which included the use of poison by the Ciri Khonome Pumé from South America. Moreover, at both fishing sites, fish biomass would be replenished after the rainy season had arrived because flooding would cause fish to move and spread over most habitats.

The seasonality of fishing primarily included the dry season (February-May) because (a) once the water level receded, from December to January, access to the fishing sites was in good condition, and (b) fish abundance was high.

Likewise, as in many other freshwater fisheries in the world, the "dry" season has been noted as the preferred time to pursue fishing. More specific examples included the "cablocos" from the Brazilian Amazonia (Begossi, 2000), as well as several communities relying on the "varzea" ecosystem (called "varzeiros") from the lower Amazon (McGrath, et al., 1993). Nevertheless, depending on several factors, it was also found that users of the fishery resource in Quintana Roo might decide to pursue fishing during the wet and/or rainy season although with less intensity than during the dry season. Some examples of fishing during both rainy and dry seasons have been recorded in the Amazonia by McDaniel, (1997) and by Gragson (1992a).

3.4.2. Local Fisheries Management

Property rights of natural resources within the Mexican territory were addressed under the article 27th of the Mexican Constitution of 1917 (Constitución Mexicana de 1917, see DOF, 1917; DOF, 2005). In respect to waters, it specified that lakes and lagoons located within Mexican borders are federal (state) property. Nevertheless, articles 52th and 55th of the Agrarian Law (Ley Agraria) specified that, provided that water bodies located within the limits of *ejidos* have not been specifically allocated to any individual, they are considered of common use and should be used in accordance with the *ejidos'* internal rules. Nevertheless, under certain conditions such as for example, a deterioration of ecosystems and/or a risk of endangered species, the Mexican state would retain the rights, on behalf of all citizens, of managing and/or conserving the natural resources.

Similarly, property rights in Mexican *ejidos* were clearly defined by the Agrarian Law but its origins depicted it as a land to pursue primarily agriculture and household farming. In a study on *ejidos* and "comunidades" located in the centre and Eastern parts of Mexico, Alcorn and Toledo (2000) argued that the community through its institutions allocated local resources to members of the community, which in turn, utilized and managed them on an individual basis. Nevertheless, based on both a literature review and personal observation on user

rights in Mayan *ejidos* of Quintana Roo, the current study found that the above statement of Alcorn and Toledo on the community's allocation of resources to individuals did not hold.

In exploring this, consider first the situation with land-based activities. For example, Estrada-Lugo (2002, 2005) found that in the case of land used for farming purposes and/or for production of precious wood (the resource base of logging), both use and management rights were well defined at the community level and were exclusive rights to entitled persons (*ejidatarios*). Moreover, at least in the Mayan *ejidos*, access to land and logging resources were fully regulated by kinship, through patrilineal (from father to his descendants, including sons-in-law) organization (Bello-Baltazar, 2001; Estrada-Lugo, 2002, 2005). Besides, land allocation (to undertake agriculture) was regulated by the General Assembly, taking into consideration the location of traditional lands (locally known as "rumbos"), because each differentiated land (or "rumbo) has been traditionally utilized by a set of families tied to an elder who is usually an *ejidatario* (Hostetler, 1996; Estrada-Lugo, 2002, 2005).
Further, in *ejidos* with an authorization for logging, it was the General Assembly who allocated the granted quota, dividing it only among the total number of *ejidatarios*. In turn, every *ejidatario* is organized into a working kinship group to log his quota share (Bello-Baltazar, 2001). For example, during 2005, this type of division yielded only 1 m^3 to every *ejidatario* in a local indigenous *ejido* (F. K., *ejidatario*'s son, 2005, personal communication).

In contrast to the above-noted well-defined user rights for land and precious wood, fishing resources seemed to have more "permeable" or less defined user rights in Mayan *ejidos*. This aspect was first noticed when several of the users acknowledged they pursued fishing outside the limits of their *ejido*. In addition, several interviewees from 5 indigenous *ejidos* were willing to allow outsiders to fish in water bodies located on their lands. Nevertheless, the remaining people of the same *ejidos*, being concerned about the state of the local aquatic resources,

wanted to restrict access to the fishery to people who, among other things, caused damage to water bodies or were from communities located out of their *ejido*.

In respect to management rights for water bodies in indigenous *ejidos*, although they were not as clearly defined as in land for agricultural purposes or precious woods, several interviewees acknowledged local authorities to be the "caretakers" ("managers") of those sites. In contrast to fishing use rights, for which some local people could envision allowing some outsiders to pursue fishing in their water bodies, no user felt that care (management) of local water bodies is a right of outsiders.

Unfortunately, the results of this study indicate that, except for water bodies located close to communities, it would be hard for local people to enforce restrictions on fishing at many of their fishing sites, due to their remoteness. Thus, it seems that fishing use rights will likely keep being flexible or "permeable" to outsiders in several of the *ejidos*. Perhaps the exception to this would be if people recognize that there is a degree of overexploitation or damage to their aquatic resources. This is because, comparing results of this study with other studies on local common-pool resource management, it was found that situations of resource damage or loss in communities that relied on common pool resources can lead to better resource stewardship, if experience has been gained about the depletability of resources (i.e. the potential for overexploitation) and the capability to control or limit such problems (Berkes, 1999; Alcorn and Toledo, 2000).

Finally, on a more general level of local resource management, this study also found a great concern among scholars from several disciplines about both the natural resource base of *ejidos* and the state of the communities themselves. Unfortunately, it is known that the *ejido* system in Mexico has been in decay over the last 30 years (M. Molina, social scholar, personal communication, 2004).

Among other things, the latter meant that – except for localized efforts in which small grants are provided for people to undertake environmental friendly productive projects by some international initiatives (e.g., UNDP) – the *ejidatarios* and the rest of the community received little if any organized and systematic support, such as capacity building, from the government to sustain their resources and livelihoods. Thus, it was observed that most often, local people worked under a weak organization of groups wherein local conflicts and corruption were pervasive. Regrettably, since it was created, the support or neglect of the *ejido* system has suffered from the changing ideologies and philosophies of every Mexican government in turn (Yetman, 2000). Nonetheless, with the international initiative of the Meso-American Biological Corridor (MABC) now in place in Southern Mexico and Central America, this would be a great opportunity to use funding available to endorse both basic and applied research in the area, in order to ensure local conservation of biodiversity, generational equity in the use of resources, and a lessening of internal conflicts in rural communities of the area. The latter efforts should also encompass local capacity building, in the form of community-based natural resource management.

Chapter 4

Assessing Non-monetary Values of Natural Resources in the Lowland Maya Area Through Damage Schedules

4.1. Introduction

Natural resources provide value to humans in many different ways. In addition to the direct value of natural resources as key inputs to many economic systems, there are several other reasons to focus on a valuation of those resources, including (i) in assessing loss or damages due to resource changes, whenever necessary to provide corrective justice for those injured; (ii) in resource allocation, taking into consideration either individual or community values; and (iii) in promoting appropriate incentives, either to use or to conserve resources (Rutherford et al., 1998). There are also many different economic realities in which the need for valuation of natural resources arises. Consider, for example, the difference between industrial and rural indigenous settings. Each of these would require different valuation methods, particularly because, most likely, market prices would be easier to find to the former than to the latter. This study addresses natural resources within indigenous Mayan settings (of Quintana Roo, Mexico) and thus finding valuation methods suitable for non-pecuniary assets is a fundamental goal in this case.

According to Vatn and Bromley (1994), the majority of available methods to value environmental assets and natural resource losses focus on estimating their monetary value, because most methods regard environmental assets as commodities. However, critiques of these environmental valuation methods, and their focus on the market model, are widespread, because it is argued that very often they do not provide reliable and/or consistent valuations (Knetsch, 1994, Rutherford et al., 1998). In order to overcome the latter problem, researchers working on natural resource valuation have developed a few other alternatives (e.g., Peterson and Brown, 1998; Rosenberger et al., 2002).

Notably, in order to partially overcome the biases and errors of mainstream valuation methods, particularly those found through hypothetical or contingent valuations, Knetsch (1994) suggested the use of damage schedules and resource loss schedules. This approach, referred to in the literature as the damage schedule approach, could utilize predetermined relative scales of importance based upon people's judgments of the importance of resource damages or losses (Rutherford et al., 1998). Hence, a damage schedule approach could also be referred to as a non-monetary valuation (Rutherford et al., 1998).

In the last decade, damage schedules have been tested in Thailand, Mexico, and Belize by Chuenpagdee (1998) and Chuenpagdee et al. (2001, 2002). Their results produced useful insights for resource managers, development agencies, and communities, concerning the relative importance of both natural resource losses and damage to local people and communities.

This paper undertakes a damage schedule approach to natural resource valuation in Mexico's lowland Maya area. Besides the importance of assessing non-monetary values of local resources, it is stressed that results derived from this type of valuation should be useful for centralized, regional and local development programs which should be devised to support and respect the culture and traditions of rural and indigenous people, including the Maya.

This study was aimed at assessing the relative non-monetary values that different group of users from Mayan communities place upon their natural resources. The study's research hypothesis was that the relative common values of several groups of users from a common property land or *ejido* were consistent across groups.

Compared to previous damage schedule studies, two things were novel in this study. Firstly, the current approach had not been used before in indigenous non-

Western literate communities. Secondly, unlike previous studies in which damage schedules were undertaken using printed questionnaires – wherein the issues addressed were either written (described) for a participant to respond, or verbally described with responses written down by an interviewer – this research used a set of color pictures to represent each of the assessed resources (see section on methods). This approach was designed to reflect the reality of the study being undertaken in Mayan settings where people were mostly non- Western literate and/or not fluent in Spanish language. It avoided the process used in previous studies that required a certain level of abstraction among interviewees in understanding and responding to questions.

4.2. Methods

4.2.1. Study Area

Research was undertaken in Quintana Roo state in which one of the most well preserved rainforest areas of Mexico is located. In particular, the study was undertaken at common holdings (*ejidos*) located in a region called as The Mayan Zone (La Zona Maya), a place wherein the Mayan culture prevails over the Western culture.

As this dissertation has shown in Chapter 2, the majority of local Mayan people pursued multiple livelihoods including traditional agriculture, honey bee production, arts and crafts, rural tourism, rural public transportation, rural schoolteacher, convenience store owners, hunting, and fishing.

4.2.2. Approach

After the first research stage of a larger project, of which this study was part, had been completed (see Chapters 2 and 3), one *ejido* called X-Maben[1] was selected in which to undertake the present study. The study encompassed 5 communities in the *ejido* (from a total of 6) in which the Mayan language was primarily spoken

[1] X-Maben is a real name (not a pseudonym).

in everyday life. All 5 communities had relatively small populations, ranging from approximately 27 (twenty-seven) to 3,000 inhabitants.

Fieldwork

The process of selecting the several local resources to be included in the damage schedule exercise, called a "pre-survey" (Chuenpagdee, 1998), was undertaken during a concurrent study of multiple livelihoods. During the pre-survey, resources used for both subsistence and market-oriented activities were identified and several of the local livelihood strategies were determined. The pre-survey was complemented with archival material from previous research undertaken in The Mayan Zone by national and international researchers (e.g., Hostetler, 1996; Ramírez-Barajas, 2004), as well as from open interviews with people who participated in the livelihoods study (Chapter 2). The pre-survey lasted from February 22, 2004 to January 14, 2005, a date when the final questionnaire format for the survey was printed. During the pre-survey a total of seven resources were selected including the following: soils to undertake agriculture, rainforest (edible) animals, zapote trees, honey bee colonies, a group of species of trees of the rainforest, fish from local water bodies and a set of resources from the secondary growth forest such as large woodsticks, palm leaves and firewood.

Developing the final questionnaire format took considerable effort and was challenging because once it was fully developed and written in Spanish, it had to be carefully translated into Mayan. Therefore, there were many hours of careful revision of its wording, including checking a proper use of verbs in both Spanish and Mayan languages. Translation of the questionnaire was undertaken by the research team which included the author of this study and two native Mayan speakers who also assisted in interviewing people (see below).

Once the translation of the questionnaire was completed, three persons were selected to test the questionnaire; the first one was a male native Mayan speaker

from the research team, to obtain his opinion as both a Mayan *campesino* and as a field guide who would help in interviewing people; the second was a monolingual Mayan speaker *campesino* because it was necessary to test the questionnaire with non-Western literate people. Finally, the third selected person was a woman native Mayan speaker who was considered to be bilingual (Spanish/Mayan). No troubles were detected as a result of the testing of the questionnaire.

In order to elicit Mayan people's judgments on the relative importance of their resources, the questionnaire used a structured format and questions were arranged in accordance with the paired comparison method (Rutherford et al., 1998). The latter method has been primarily used in anthropology and in the behavioral sciences to rank objects (Bernard, 1995) but its use has been also extended to undertake economic valuations, for example, by Peterson and Brown (1998) and Rosenberger et al. (2002). The rationale of the paired comparison method has been explained previously in detail by several authors (e.g., Bernard, 1995). With this method, two scenarios are presented for consideration at a time. For each pair of scenarios, and given a specific context, interviewees are asked to choose (or state a preference for) one of them. More specifically, in this study, each question presented a pair of resource loss scenarios and from it, people were asked to select the resource loss which, if it should happen, was judged to be the most severe not only to each participant and his/her family but to the community, to the *ejido*, and to the environment in general. In particular, the selected resource loss scenarios were those which have actually occurred either recently or in the past, within The Mayan Zone, and were produced either naturally or man-made. For example, local natural resources such as secondary growth forest, trees producing edible gum (or "zapote"), honey bee colonies, among others, have been affected by man-made fires, overexploitation of resources and the growth of communities, as well as by extended droughts and hurricanes.

Once every paired comparison exercise was completed, this produced a reversed-order set of preferences, for each individual respondent, of the assessed resource losses. In other words, objects were ranked in a descending order, with the highest value (the most selected or most valued one) at the top and the lowest (the less selected or least valued) at the bottom. The total number of paired comparison questions needed was dependent upon the list of selected resources and was calculated from the following formula (Dunn-Rankin et al., 2004):

$$N = n(n-1)/2$$

where N is the total number of pairs and n is the number of selected resources. Moreover, all pairs of resources were arranged in the questionnaire after a randomization procedure had been performed. Furthermore, resources appeared side by side in the questionnaire, with their position (right versus left) also randomized (Chuenpadgdee, 1998; Peterson and Brown, 1998).

The process of choosing a resource loss allowed for no ties, i.e., an interviewee had to choose one of the two resource losses even if he/she felt the losses were approximately equally severe.

Thus, in this study, paired comparisons would reflect people's judgments of the relative severity of the potential loss scenarios relating to two different local resources. More specifically, the willingness of people to sacrifice a resource in order to retain another would define its economic value (Rutherford et al., 1998). In other words, value is defined as the relative importance or worth that people place on an asset in a given context (Brown, 1984) and therefore people's judgments were considered to reflect relative common values placed on resource losses (Vatn and Bromley, 1994).

The survey was undertaken from February 4 to March 15, 2005; it targeted a population of local resource users considered to be lay experts on local natural resources. From the latter, three subgroups of individuals were thought to represent diverse interests, primarily ranging across social and political status. In respect to the latter, people were grouped into the following 3 classes, *ejidatarios*, i.e., people with property rights upon land in the *ejido*; non-*ejidatarios*, i.e., people without property rights on land; and women, i.e., people with a traditional role in the community such as being a housekeeper, or working on traditional handcrafts, with little or no participation in political issues. In respect to non-*ejidatarios*, they were primarily *ejidatarios*' relatives, such as sons, brothers, cousins and fathers.

Nevertheless, according to law, non-*ejidatarios* and women can potentially become *ejidatarios* by inheritance of property rights. In fact, two participant women had the status of *ejidatarias*. [Despite this, while these individuals attended general assembly meetings, it was twice observed that they did not provide any opinion at all, except in those cases in which a voting event of all *ejidatarios* and *ejidatarias* was needed.

Finally, the study sought to compare the preferences and values of the inhabitants of a Mayan *ejido* with those of a group of scholars, namely scientists and resource managers with expertise on the local rainforest and Mayan communities, individuals who very often write and promote policies on development and/or on local resource management. To do so, a valuation exercise with the latter group was also performed – this valuation exercise consisted not in determining the values of the scholars themselves with respect to resource losses; but rather examining how the scholars thought the community would value their resources. In other words, it was an assessment to know the extent to which scholars knew or were aware of local people's concern and priorities on local resources. The questionnaires were left with the scholars to complete and were picked up several days latter (within 1 to 5 days).

Quota sampling was used to obtain at least 20 persons per group of participants (de Vaus, 1999; Dunn-Rankin et al., 2004). At the *ejido*, and with a couple of exceptions, potential participants were contacted twice; once to introduce the research team and to invite the individuals to participate in the research, and a second time to complete a previously agreed interview. In the case of the scholars, a first contact included the invitation to participate and a second one to personally deliver the questionnaire and the set of pictures representing the resources. In the Mayan communities, two native Mayan speakers were the translators into both Mayan and Spanish, accordingly, during the survey; a 23-year-old woman who was both a trainee in arts and hold a Bachelor degree in kindergarden education and a 23-year-old *campesino* whose father was an *ejidatario* in a regional *ejido*. The latter person had over 5 years of training as field guide in regional research projects.

Once the first exploratory analysis of collected data was performed, two community workshops were undertaken in the largest community of the *ejido*, during June 11-12, 2005. Both were undertaken mostly in Mayan language. The goal of the workshops was to get feedback on the first results from the participants. In accordance with local traditions, one of the workshops included only men and the other only women. During each workshop, the research team showed the results obtained from men (pooled values of both *ejidatarios* and non-*ejidatarios*) and women, and requested feedback, firstly, on whether the participants agreed with the results obtained in the survey, and secondly, on the reasons each group might have had for ranking the resources in the first, middle and last places.

Both the current study and the workshops were undertaken at a time when an extended drought was taking place in the study area. Thus, local people were very busy coping with this natural event. As an extended drought is an unexpected and sometimes traumatic event, it can be said that Mayan people's

livelihoods were at this time coping with a shock (see Chambers and Conway, 1992).

Data Analysis

After the final survey was completed, the paired comparison results were coded and analysed as follows (see Chuenpagdee, 1998). Every time a specific resource loss was selected over another by a respondent, a score or "vote" for it was recorded. Final scores or "votes" per resource loss were counted per individual participant and later aggregated for each specific group of users – *ejidatario*, non-*ejidatario* and women, as well as for scholars. The final scores per group were used to compute a group-specific scale of relative-loss-based importance of the compared resources (Rutherford et al., 1998). As previously stated, the latter also represented the non-monetary values of resources represented in this case by the specific scale of importance. In particular, the relative scale was obtained through psychometric scaling methods, and specifically through the variance stable rank method (VSRM). The VSRM is an adaptation of a two-way -or subjects by treatments - analysis of variance by ranks (Dunn-Rankin et al., 2004), wherein treatments in this case were the natural resource losses. In the VSRM, the minimum and maximum possible rank totals were used as a frame of reference within which the resource losses were scaled. The latter two extreme values were linearly transformed into zero and 100 respectively and the intermediate observed scores were normalized accordingly (Dunn-Rankin et al., 2004, p. 55).

To detect differences between treatments, the VSRM used the Wilcoxon and Wilcox's nonparametric method of multiple comparisons between treatments as follows (Dunn-Rankin et al., 2004, p. 57):

$$CR = E(S)\, Q_a$$

where CR was a critical range value and E(S) was the expected standard

deviation per group of users, which in turn was computed from:

$E(S) = \sqrt{(N\ (K)\ (K + 1)/12)}$

where N= number of judges or participants and K = number of treatments or natural resource losses.

Here Q_a was a value obtained from a table containing a Studentized range distribution for a given number of treatments (i.e., resource loss scenarios) and an infinite number of degrees of freedom (df) wherein a probability level of 0.05 was fixed (see table C in Dunn-Rankin et al., 2004, p. 217). Thus, any range difference among the values of scaled objects (i.e., the natural resources) that was equal or greater than the critical range, CR, was statistically significant.

In addition, the latter significance tests were used to build an index of relative scalability, SI. Relative scalability indexes are used to quantify the ability of different groups of people to distinguish between psychological objects (the natural resources) and were computed from Dunn-Rankin et al. (2004, p.58):

SI = Number of significantly different pairs / Number of total possible pairs

both Numbers within a paired comparison exercise.

Finally, in order to assess the degree of agreement of final relative scales of resource loss importance between groups of participants, a rank correlation method called Kendall's *tau* coefficient of agreement, *T*, was used (Dunn-Rankin et al., 2004).

4.3. Results

During the pre-survey, seven different natural resources were selected and the corresponding loss scenarios were constructed (Table 4.1). Therefore the total

number of comparisons (questions) included in the questionnaire was:

7 (7-1)/2 = 21

In addition, every selected resource was represented by a color picture, all being similar in size and quality.

Table 4.1. Local resources and loss scenarios included in non-monetary valuation.

Item #	Scenario
1	Loss of trees, including mahogany, cedar, *tsalam* and *ciricote*
2	Loss of large woodsticks*, palm leaves and fire-wood from secondary growth forest.
3	Loss of [edible] rainforest animals
4	Loss of soils from (*ju' che'*) secondary growth forest#
5	Loss of *zapote* trees
6	Loss of colonies of bees (both native and exotic species)
7	Loss of fish from local water bodies

* These woodsticks are primarily used for hut construction
# Soils are used to undertake traditional agriculture (or milpa)

A brief explanation of both local and Mayan words and resources is necessary here. Soils from *ju' che'* are those soils from secondary growth forest, which are used as the soils upon which traditional agriculture is practiced; *zapote* trees are a particular type of tree which are interspersed in the rainforest and are used for edible gum harvesting but also are acknowledged to have a key role in providing fruits (food) to the rainforest [edible] animals – which in turn include those that are used in hunting activities either inside or outside an agricultural field, such as deer, peccary, among others.

In regard to resource number 1, the trees mahogany, cedar 'tsalam' and 'ciricote' form a class of precious wood used in commercial-oriented activities at the *ejido* level. Every year, the Mexican government grants annual permits to several of the largest *ejidos* for logging based upon tree stock assessments. Profits from logging are supposed to reach all commons (*ejidatarios*) every year (i.e., profits should be divided among the total number of *ejidatarios*).

In respect to resource number 2, those raw materials (large woodsticks and palm leaves) are used for traditional hut building but also for sale in touristic cities in which huts are used in restaurants. This resource included also fire-wood because the same sites used to slash down large woodsticks are also the ones used to gather or slash down fire-wood.

A total of 105 people responded to the survey, 67.6% males and 32.4% females. In the *ejido*, 95 inhabitants were invited to take part in the study in the form of an interview. From this set, only 9.5% of inhabitants refused to participate. The average length of interviews was 15 minutes (standard deviation = 4.2 minutes). In general terms, it was observed that it was difficult for people to choose among the resources included in the questionnaire. The same happened to the group of scholars.

Languages used during interviews were: fully Mayan (n= 65), fully Spanish (n= 13) and a mixture of both Spanish and Mayan (n= 9). In particular, the mixture of Spanish and Mayan languages occurred because some local people wanted to be interviewed in Spanish but it happened that, at some point in the interviewing process, they did not understand an issue (as detected by the research assistants) and therefore the interviewer switched back and forth from Spanish to Mayan, resulting in a mixture of languages. The latter interviews, on average, were the ones that took more time to complete. In contrast, the majority of people who were fully interviewed in Spanish were fluent in Mayan but they were also

Western literate people, including a librarian, schoolteachers as well as people (males) pursuing seasonal migratory work.

The age of interviewees – both local participants and scholars – ranged from 16 to 65 years old with some variation within and among groups (Table 4.2).

Table 4.2. Demography of participants in the survey.

Group	Average age (years)	S.D.* (years)	Range (years)	n
Ejidatarios	46.5	13.91	32 – 65	37
Non- *ejidatarios*	28.9	12.04	23 – 35	17
Women	37.8	17.37	16 – 65	23
Scholars	42.0	8.1	31 – 60	20
Total of cases				*97***

* S.D. = Standard Deviation.
** Not ascertained = 8 cases.

The group of scholars included anthropologists, biologists, ecologists, forest engineers, agricultural engineers, natural resource managers, researchers on both natural and social sciences, and a trainee in arts. Except in one case, all the scholars had been working in The Mayan Zone for over 9 years. In respect to refusals to participate in the study, only 1 out of 21 scholars declined the invitation.

4.3.1. Relative Scales, Tests of Significance and Scalability Index

The scales of relative resource loss importance for the three community groups and the scholars are shown in Table 4.3. As it was necessary to take one of the community groups as the basis to order the other rankings and because *ejidatarios* was the group with property rights to the resources, this group was arbitrarily selected as the basis to undertake the ordering of other groups.

In respect to the similarities of the rank orders among the three community groups, it was found that all three regarded both "Loss of soils..." (from here onwards referred to as "soils"), and "Loss of large woodsticks..." (from here onwards referred to as "woodsticks"), in the first and second place of loss importance, respectively. Likewise, all three groups regarded both "Loss of colonies of bees..." (from here onwards referred to as "bees") and "Loss of fish..." (from here onwards referred to as "fish") in the two last places of importance in terms of the impact of losing the resource (or sixth and seventh places, respectively). In other words, the Mayan community groups regarded as their most valuable resource the "soils" and, in second place, "woodsticks". In contrast, the three community groups regarded as their least valuable resource the "fish" and, in the next place up in increasing level of importance or value, the "bees". In between the bottom and top pairs of resources were the remaining 3 resources (Table 4.3).

Using the above results as a point of reference to examine the scholars' results (Table 4.3), this latter group thought that the Mayan people regarded "soils" as their most valuable natural resource but they were not able to agree on the second most valuable resource. Also, they gave more scores to both "bees" and "fish" than the community groups did and considered that both "fish" and "bees" were the least valuable resources to the Mayan people in approximately the same level of importance (see Table 4.3).

In respect to multiple comparisons between treatments (the natural resource losses), results differed among the three groupings, namely, *ejidatarios*, non-*ejidatarios* and women (Tables 4.4, 4.5 and 4.6, respectively).

Table 4.3. Aggregated scores per group of participants (rankings are shown in parenthesis).

Scenario	*Ejidatario*	Non-*ejidatario*	Women	Scholars
Loss of soils from secondary growth forest	88.9 (*1*)	77.5 (*1*)	83.3 (*1*)	77.7 (*1*)
Loss of large woodsticks, palm leaves and firewood	56.0 (*2*)	59.2 (*2*)	62.8 (*2*)	50.0 (*4*)
Loss of zapote trees	55.6 (*3*)	50.0 (*5*)	47.4 (*5*)	29.2 (*5*)
Loss of [edible] rainforest animals	54.3 (*4*)	58.3 (*3*)	53.2 (*4*)	68.3 (*2*)
Loss of trees, including mahogany, cedar, "tsalam" and "ciricote"	45.3 (*5*)	53.3 (*4*)	54.5 (*3*)	68.3 (*2*)
Loss of colonies of bees (both native and exotic species)	41.9 (*6*)	39.2 (*6*)	37.2 (*6*)	28.3 (*7*)
Loss of fish from local water bodies	8.1 (*7*)	12.5 (*7*)	11.5 (*7*)	29.2 (*5*)
Number of cases	*39*	*20*	*26*	*20*

Tests of significance are examined here, to analyze whether each of the scaled objects (natural resources) come from the same "population stimuli" (Dunn-Rankin et al., 2004, p. 59). Such tests are helpful in making decisions on whether interviewees grouped objects in the same or in different classes of objects. For example, according to the *ejidatarios*' test of significance results (Table 4.4), this group of people was able to distinguish that the resource "soils" was different from the remaining 6 resources, namely "woodsticks", "zapote", "animals", "trees", "bees" and "fish" (see column under "soils" heading, Table 4.4). In other words, *ejidatarios* regarded "soils" and the remaining 6 resources, each as belonging to different classes of resources. In statistical terms, the latter is

explained by the computed critical range, CR ≥ 56 and the fact that all the values in the comparison matrix data for "soils" were greater than CR (Table 4.4).

On the other hand, for the resources other than "soils", comparing each of these to the others (see columns with headings from "woodsticks" to "fish", Table 4.4), the *ejidatarios* were only able to differentiate those resources from the "fish" (see row tagged with "fish", Table 4.4). In the latter respect, and complementing these results with data on the relative scale of resource loss importance for *ejidatarios* (Table 4.3), the results suggested that this group of people was able to differentiate "fish" from a bundle of the remaining resources. In other words, of the resources other than "soils", "fish" was seen to belong to a different class of resources from the others, being considered the least valuable resource (Table 4.3).

The results of tests of significance for non-*ejidatarios* are shown in Table 4.5. When comparing "soils" to the remaining 6 resources (see column of "soils", Table 4.5) the results showed that this group was only able to distinguish "soils" from both "bees" and "fish" but not from the remaining resources ("woodsticks", "zapote", "animals", and "trees"). In other words, in comparing "soils" to the remaining 6 resources, the results suggested that non-*ejidatarios* were dealing with two classes of resources one represented by the group of "bees" and "fish", and the other by "soils", "woodsticks", "zapote", "animals", and "trees". In statistical terms, in this case, CR ≥ 40 and therefore values equal to or above this number were statistically different (Table 4.5).

Table 4.4. Multiple comparisons: Matrix of rank differences for *Ejidatarios*. Ri is the rank sums (i.e., the non-normalized values).

Loss of:		**soils**	**woodsticks**	**zapote**	**animals**	**trees**	**bees**	**fish**
	Ri	**208**	**131**	**130**	**127**	**106**	**98**	**19**
soils	**208**	_						
woodsticks	**131**	77*	_					
zapote	**130**	78*	1	_				
animals	**127**	81*	4	3	_			
trees	**106**	102*	25	24	21	_		
bees	**98**	110*	33	32	29	8	_	
fish	**19**	189*	112*	111*	108*	87*	79*	_

*Significant at the 0.05 probability level, critical range, CR ≥ 56.

Again, if we re-examine data on the relative resource loss importance for non-*ejidatarios* in Table 4.3, and compare results with the current test of significance (Table 4.5), it can be said that, when comparing "soils" to other resources, non-*ejidatarios* only were able to distinguish the less valuable resources (i.e., "bees" and "fish") from what they considered the more valuable ones (i.e., "soils" "woodsticks", "zapote", "animals", and "trees").

In comparing the remaining resources, namely "woodsticks" to "fish" (Table 4.5), and except for the comparison of "bees" and "fish", the non-*ejidatarios* were similarly only able to differentiate those resources from the "fish" (see row tagged with "fish", Table 4.5).

In respect to the test of significance results for women (Table 4.6), results showed that, when comparing "soils" to the remaining 6 resources, this group of users was able to differentiate two groups too – but with different composition, i.e. one comprising "animals", "zapote", "bees" and "fish" and the other by "soils", "woodsticks" and "trees". In statistical terms, the women's results had CR $\geq$ 40 and therefore values equal or above this number were statistically different (Table 4.6). Again, combining the latter results with those obtained for the relative scale of resource loss importance for women (Table 4.3), the results suggested that women were able to differentiate their four less valuable resources ("animals", "zapote", "bees" and "fish") from their more valuable ones ("soils", "woodsticks" and "trees").

Again, further comparison of resources ("woodsticks" to "fish") produced results similar to that obtained by non-*ejidatarios* i.e., except for the comparison of "bees" and "fish", women only differentiated the various resources from the resource "fish" which, according to them, was their least valuable resource too (see Tables 4.3, and 4.6).

Table 4.5. Multiple comparisons: Matrix of rank differences for Non-*ejidatarios*. Ri is the rank sums (i.e., the non-normalized values).

Loss of:		soils	woodsticks	animals	trees	zapote	bees	fish
	Ri	**93**	**71**	**70**	**64**	**60**	**47**	**15**
soils	**93**	_						
woodsticks	**71**	22	_					
animals	**70**	23	1	_				
trees	**64**	29	4	3	_			
zapote	**60**	33	25	24	21	_		
bees	**47**	46*	33	32	29	8	_	
fish	**15**	78*	56*	55*	49*	45*	32	_

* Significant at the 0.05 probability level, critical range, CR ≥ 40.

Table 4.6. Multiple comparisons: Matrix of rank differences for Women. Ri is the rank sums (i.e., the non-normalized values).

Loss of:		soils	woodsticks	trees	animals	zapote	bees	fish
	Ri	**130**	**98**	**85**	**83**	**74**	**58**	**18**
soils	**130**	_						
woodsticks	**98**	32	_					
trees	**85**	45	1	_				
animals	**83**	47*	4	3	_			
zapote	**74**	56*	25	24	21	_		
bees	**58**	72*	33	32	29	8	_	
fish	**18**	112*	80*	67*	65*	56*	40	_

* Significant at the 0.05 probability level, critical range, CR ≥ 46.

Results on the relative scalability index (SI), which were computed from the tests of significance, are shown in Table 4.7. Relative scalability indexes are utilized to quantify the ability of different groups of people to distinguish between psychological objects (in this case the natural resources) (Dunn-Rankin et al., 2004).The highest SI value was obtained by *ejidatarios* and the lowest by non-*ejidatarios*. Also, a pooled value of SI for all three community groups yielded a higher value than each computed individually.

Table 4.7. Relative index of scalability (SI) for 3 community groups and the scholars group.

Group	**Scalability Index**	**n**
Ejidatarios	0.52	39
Non-*ejidatarios*	0.29	20
Women	0.38	26
Pooled	0.57	85
Scholars	0.24	20

Finally, and because scholars were only expressing the extent they knew the priorities of Mayan people, their SI is only shown for illustrative purposes. [In this case, the SI for experts was 0.20, a result obtained from test of significance in which the Scholars perception was that Mayan people were able to differentiate only 5 out of 21 pairs of natural resource groups.]

Generally speaking, based upon the results of both the test of significance and the SI, it is suggested that *ejidatarios* were able to distinguish more clearly between soils and the remaining 6 resources than the other two community groups and, also that the majority of Mayan people regarded "fish" as being in a different class of resource, in that it is seen as the least valuable compared to the other 6 resources.

4.3.2. Rank Correlations

The matrix of rank correlation coefficients is shown in Table 4.8. In all cases, the correlations across the 3 community groups were significant, at a probability level of at least 0.05. These results can be interpreted as indicating that the relative ranking scales or values of local resources of the 3 community groups were similar.

Table 4.8. Matrix of Kendall's *tau* rank correlation coefficients.

	Ejidatarios	**Non-*ejidatarios***	**Women**	**Scholars**
Ejidatarios	_			
Non-*ejidatarios*	0.810*	_		
Women	0.714*	0.905**	_	
Scholars	0.451	0.651*	0.651*	_

* Correlation was significant at the 0.05 probability level.
** Correlation was significant at the 0.01 probability level.

In contrast, the scholars' relative ranking scale correlated with that of the non-*ejidatarios*' and women's but not with the group of *ejidatarios*. In other words, the scholars' ranking scale were similar to that of non-*ejidatarios* and women but different from the *ejidatarios*'.

Given the correlated nature of the 3 community groups, a pooled scale of resource ranking importance or resource values was able to be obtained (Table 4.8). Finally, and in order to evaluate whether the latter pooled scale would correlate with that of the scholars, a Kendal's *tau* correlation test was undertaken (Dunn-Rankin et al., 2004). However, this showed that there was no correlation between them (i.e., they were not similar). Therefore, only the rankings of the Mayan people (in the 3 groupings) were pooled (Table 4.9).

Table 4.9. Pooled scores of the Mayan people (community) and Scholars group. Rankings are shown in parenthesis (in both cases, round values are presented.)

Scenario	Community	Scholars
Loss of soils from secondary growth forest	85 (*1*)	77 (*1*)
Loss of large woodsticks, palm leaves and wood fire	59 (*2*)	50 (*4*)
Loss of [edible] rainforest animals	55 (*3*)	29 (*5*)
Loss of zapote trees	52 (*4*)	68 (*2*)
Loss of trees, including mahogany, cedar, "tsalam" and "ciricote"	50 (*5*)	68 (*2*)
Loss of colonies of bees	40 (*6*)	28 (*7*)
Loss of fish from local water bodies	10 (*7*)	29 (*5*)
Number of cases	*85*	*20*

4.3.3. Community Workshops

At the women's workshop (a Saturday afternoon) there were 16 attendees, 15 of which were people who had participated in the research through an interview. The sixteenth participant was an elder woman, the grandmother of the project's *campesino* field guide, but she did not give any opinion on the results, as she was only listening to the other attendees' opinions. The following paragraphs summarize the results. [Note that because this research did not ask or obtain authorization to use actual quotations of local people, results are presented only as statements or opinions.]

After attendees had examined the rank order of the pictures of resources, most of them highlighted both the top and bottom positions, "soils" and "fish" respectively. Overall, there were several comments of agreement on these two rankings. Also, an elder (first) woman remarked that all the (assessed) resources were important, but soils for agricultural purposes were the most important because

agriculture was the key activity of the *ejido*'s inhabitants. This motion or statement on the importance of all resources was sustained by a Western-literate (second) woman who after repeating the statement also added that local resources were used seasonally, switching from one to another when it was appropriate. Moreover, she added that even though fish was placed at the bottom of the rankings, they should still conserve them. Furthermore, she acknowledged herself as a worker on local tourism who knew the total number of fish inhabiting their largest lagoon. In respect to the importance of fish, a third woman acknowledged that this resource, as a source of food, had its highest relevance during the Holy Week. Another two (fourth and fifth) women commented on the size of fish in their largest lagoon, which they both acknowledged as very small in size. The latter points were agreed upon by the majority of attendees. Afterwards, the research team asked whether there would be any specific condition or event under which one of the low and middle resources would move to a higher place. Before any answer was heard, some attendees warned the research team that the top position of soils would not change; it would stay fixed. Once people attempted to respond to the question, two women spoke up. One of them (a sixth woman) suggested that colonies of bees could become an important resource to them because they might earn cash from it. As a result, several other women replied simultaneously to this participant that, because of the extended drought, currently there was no honey production on their lands. Also, in trying to respond to the former question, the (first) elder woman commented that should she have nothing left for food, firewood would be a resource she would gather for sale.

The next part of the women's workshop consisted in comparing men's and women's rankings. After attendees had noticed their agreement upon both pairs, the two top-ranked and two bottom-ranked resources, the research team asked them to what would one attribute the fact that the two scales differed in ranking "animals", "trees" and "zapote". The (first) woman elder replied that differences were perhaps because several of the resources are mostly harvested or gathered

by men and not by women. Afterwards, both the research team and attendees compared the ranking of men and women in detail; and, it was found that "animals" [which are used by men in hunting] was a resource more valued by men and a bit less by women, and the same happened with the "zapote", a tree that is used by men in gum harvesting (see Table 4.3). Nevertheless, it was found that in the case of "trees", women valued it a bit more that men. In this respect, the Western-literate (second) woman replied that perhaps it was because women were more concerned with caring for the environment (conservation) than men. A more general comment by a (seventh) woman was that during the interviewing process, some women perhaps only selected certain resources because their husband relied upon them for bringing income to the household.

Among all the above discussions, there were other feminist as well as political comments too. For example, in regard to the latter, the (first) elder woman stated that it was not easy for outsiders to ascertain the importance of their resources. In explaining this statement she went further and provided the following example: She argued that politicians did not know anything about the importance of their resources either because local people can tell any politician to feed upon "zapote" and, he, knowing nothing about it, would do it for sure. [What the latter woman meant was to laugh at politicians because zapote tree is not an edible tree.] The same elder woman commented once that perhaps, differences between the ranking of men and women had resulted because men did not really know what they were replying to, or what the interview was about. However, this feminist perspective[2] was regarded only as a joke because everybody laughed after it was heard.

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[2] The author of this study understood that the participant woman wanted to purposively laugh at men's capabilities to select among the resource scenarios and therefore, she considers it to be a "feminist" perspective or a competition between women and men in which women portrays men as less capable than women to do things right.

At the men's workshop (a Sunday afternoon) there were only 7 attendees, including 4 *ejidatarios* and 3 non-*ejidatarios*. All except 1 out of the 7 attendees had participated in the survey. Nevertheless, because the non-participant was an *ejidatario*, he decided to attend the meeting to see what it was about. Among the people who participated in the survey, there were two local authorities, one from a remote and another from a nearby community.

Once attendees had examined the rankings of the resources, as presented in pictures, a general comment followed that they were not surprised in realizing that soils were at the top of the ranking scale. The next comment came from an authority which was also an elder *ejidatario* (from here onwards referred to as "first elder *ejidatario*") who let the research team know that soils for undertaking traditional agriculture were the most important resource because the latter activity was the sustenance of local households. The other attendees backed up the last statement. In addition, this *ejidatario* added that going to work in the agricultural fields was important because they were able to pursue multiple activities, either inside or in nearby areas. Thus, besides going to sow corn, beans and squash they were able to slash down large woodsticks and pursue hunting.

In respect to fish being in the bottom-ranked position, men simultaneously commented that, at their nearest lagoon, fish was both small in size and low in abundance, and therefore this resource was not regarded as very important. Another (second) *ejidatario* added that, besides the matter of fish size and abundance, in his opinion, the taste of peccary was better than that of fish.

In respect to the other natural resource's rankings, the men's opinions were similar to those of the women because they stated that all of their resources were important but soils for undertaking agriculture was the most important. In fact, the only Western-literate *ejidatario* was able to tell the audience the importance of the resources, one by one, located between soils and fish.

Afterwards, the research team asked attendees whether there would be any specific condition or event under which one of the low and middle ranked resources would move to a higher place. Men discussed the issue for a while and replied that there was no resource which could replace soils in the top place.

In view of the latter response, the author of this study raised a further question with the attendees. She stated that she understood their opinion on the importance of soils, but was not able to understand the fact that many other local people had said that currently, field plots were relatively low in production compared with several decades ago, yet native agriculture was nevertheless their most important activity. This question was responded to by the only Western-literate *ejidatario* who commented that it was true – approximately thirty-five years ago, their agricultural plots used to produce enough sustenance for their households, but for approximately the last decade or two, rains not only do not arrive on time but they are not enough in quantity to result in a good harvest. Despite the latter fact, he stated that native agriculture was their most important activity. Moreover, he added that the agricultural field was also a source of rainforest (edible) animals too. Also he commented that they were aware that several of their resources were about to become depleted. The latter included the trees used for logging. Therefore he concluded that should they overuse their resources, their rainforest, little by little they were damaging themselves.

The next stage of the men's workshop was about comparing the men's and women's rankings. But before this was done, through one of the (whispering) comments of the Western–literate *ejidatario*, the audience knew that at least two men were already aware that the women's results were similar to that of men's.

In a similar way as happened at the women's meeting, the men recognized that differences in rankings of the resources were because women do not work primarily in the rainforest as men do. For example, gum harvesting was an activity that women would never practice. Thus, as men were more in close

contact with these resources than women, they argued that they knew better their importance than women.

Within the above discussion there were opinions related to both 'machismo' and politics. In respect to the former, and during the discussion of the comparative results of men's and women's rankings, two *ejidatarios* suggested that women are most concerned about the money they earn.

In respect to politics, the first elder *ejidatario* was very grateful because according to him, this study gave him new understandings of the ranking of their resources. Another *ejidatario* (the one who had not participated in the survey) backed up the latter point and, added that the research team should send these results to Mexico City. He also added he wanted to let the Mexican government know the results of this study because they had to know which natural resources are important to local people. The Western-literate *ejidatario* backed up this point too and added they wanted the Mexican government to know that traditional agriculture was the most important activity in The Mayan Zone. In particular, he commented that governmental officials who lately had delivered agricultural subsidies (i.e., grants in support of the diminishing production of agricultural soils) used to yell at them, calling them lazy people ("flojos"). Thus, their conclusion was that those governmental officials just did not know the importance of native agriculture to them or the current problems with delayed rainy patterns.

At the end of both workshops, people were concerned about the benefit of this type of studies to them. In particular, they wanted to know what would be the benefit they would gain or receive should they grant researchers authorization to undertake any study on their lands. The research team responded that both pictures of these results and non-technical publications would be delivered to local schools and the library, and that a copy of the final report of the project would be delivered to their communities as soon as possible.

4.4. Discussion

In respect to the use of pictures in the valuation exercise, Peterson and Brown (1998, p.245) had noted that as in any other method, the paired comparison method "requires effective specification of the goods for which we require choices". In other words, a correct description of the objects under consideration must be provided to interviewees in such a way that their responses are attributable to a correct perception of the best choice or judgment. Thus, it is suggested that by using pictures to represent the resources, the questions used in this study were directly related to the resources being assessed. Also, although not systematically recorded, the positive contribution of pictures was acknowledged by many participants from the *ejido*, including the project's *campesino* field guide who has had 5 years of training as a field guide, including interviewing rural people. In addition, most people of the group of experts or scholars) commented to the author of this study that the questionnaire with pictures was very amenable to the specific situation in Mayan lands, and two of them highlighted the importance of using pictures to represent resources within a rural context.

Related to the same topic on pictures, and because the author had undertaken 70 previous interviews in The Mayan Zone (see Chapter 2), it was also observed that once people paid attention to pictures, the stress or degree of shyness of interviewees during the interviewing process lessened. In other words, this type of interviews, with pictures, progressed in a smoother manner than those in which no pictures were used.

In respect to the relative importance and common values of natural resources, the item "soils" was the first in the ranking order and therefore it, as compared to other 6 resources, was the most valuable item to three groups of Mayan people from *ejido* X-Maben. During two community workshops, local people provided extremely valuable insights on the importance of their local resources. In those workshops, both men and women from the *ejido* noted that all local resources

were important but soils were their most important (and hence valuable) resource, simply because it was needed to undertake their most important productive activity, namely traditional agriculture. Moreover, given the diminishing yields of agricultural plots during the last two decades – which, based upon local knowledge, was associated with both extended droughts and an unusual pattern of rains – local people were concerned that the Mexican government should know about the importance of local resources to them, and most importantly about the importance of the soils to undertake traditional agriculture.

According to Bello-Baltazar et al. (2001), who undertook a comprehensive study on livelihoods in a regional Mayan *ejido*, local people organized major traditional festivals around the seasonality of native/traditional agriculture. Moreover, key food and beverages used at festivals were made of products harvested from the agricultural fields, including, of course, corn (Velazco-Te, 1999). In addition, the traditional agricultural system allowed for the practice of additional productive activities of secondary relevance – such as hunting, honey bee production, fishing, and gathering, among others – which were pursued in accordance to the seasonality of the farming activity (Bello-Baltazar et al., 2001).
The second most valued resource, "woodsticks", included a bundle of resources used for traditional hut repairing and building. It was also usually used during festivals, for building temporary stands and "rodeos" and, finally, as a source of cash, from the regional tourism industry. Thus, the two most valuable resources, "soils" and "woodsticks", seemed to have major roles in supporting both livelihood and culture.

Generally speaking, it was striking that the three community groups ranked "soils" and "woodsticks" in the first two places, and "bee" and "fish" in the last two places. Hence, given the last outcome, their scale of relative importance were not statistically different or alternatively, their common values upon the assessed resources were similar. Nevertheless, a more detailed analysis, including the test of significance and the scalability index, revealed that *ejidatarios* were able to

distinguish more clearly among their resources than were both women and non-*ejidatarios*.

The latter could be explained because the former group, as the owner of local natural resources, are those who have been accounting for their resources closely since the *ejido* was established. More specifically, they sit on Councils (or authorities), the General Council and the Security Council, which are in charge of local community-based natural resource management. For example, the Security Council is in charge of undertaking journeys to verify the stocks of precious wood, which in turn are useful to setting community quotas on logging (D.V., *ejidatario*, 2004-2005, personal communication).

In addition, it was recorded that *ejidatarios* are the ones who verify the limits of their land either to fill out government forms or to resolve any conflict on land limits with a neighboring *ejido*. They have also been the ones who, in the past, intensively worked on gum harvesting, which usually is located in remote areas, in the middle of the rainforest. Therefore, they are more knowledgeable about their local resources than both women and non-*ejidatarios*.

On a more general level, the non-monetary valuation undertaken here should not be seen as static, because there are at least two potential issues which may affect the current and future values of resources, namely, the status of rainforest conservation and the market. In respect to the former, local people were aware that local resources, particularly precious wood stocks, have been diminishing at a higher rate than they would desire. In fact, during 2004, the Mexican government was not able to grant a logging permit to this *ejido* because its stock of precious wood was too small in size and the government's technical assessment recommended not granting a permit for logging (D.V., *ejidatario*, 2004, personal communication). Unfortunately, over the last decade, other regional *ejidos* have also been witnessing a decreasing stock of their precious

woods, and this has posed economic problems to *ejidatarios* and their families (J.P., *ejidatario*, 2005, personal communication).

Taking into consideration the market, scholars in anthropology acknowledge that 40 years ago, sap harvesting (i.e., derived from zapote tree) was the commercial-oriented activity which to a great extent sustained local economies in The Mayan Zone (M. Molina, 2005, personal communication). Hence if the current valuation exercise had been undertaken 40 years ago, most likely the results would had been different to those obtained at the present.

In respect to the participation of scholars in this study, other studies based on damage schedules have relied on scholars' opinion and judgments to value local resources (see the "experts" in Chuenpagdee et al., 2002). In contrast, the current study elicited those people's opinions not of the non-monetary values of resources *per se*, but rather of what are the priorities of the Mayan people in terms of valuing the resources. In this regard, the results suggested that scholars had some idea of what are, from a Mayan perspective, the most ("soils") and least ("fish" and "bees") important resources, but the scores arising for the two latter resources differed from those obtained by the community groups, and therefore, except in two out of four cases, the scholars' overall rankings were not found to be similar to the community's rankings, in statistical terms.

Given that this study found that, most often, scholars' opinion on natural resource conservation and valuation differs from lay people in several respects (e.g., Chuenpagdee et al., 2002), it was considered important to test the degree of awareness of scholars on community concerns. The rationale for this was that in order for scholars' conservation proposals to be listened to by those inhabiting the rainforest, they must be aware of the priorities and concerns, both in terms of livelihoods and culture, of the indigenous Mayan people – the owners of common property lands wherein Quintana Roo's rainforest is located. Once these matters are understood by the scholars, it would be expected that new solutions might be

possible concerning support for both sustainable livelihoods and conserving biodiversity.

Finally, and given the degree of marginalization and conflict prevailing in Mayan communities, the author of this study highly recommends that both community capacity building and partnering agreements between scholars and indigenous and rural communities be included in future measures.

Chapter 5

Livelihoods II: The Contribution of Fishing to Mayan Livelihoods in Quintana Roo, Yucatan Peninsula

5.1. Introduction

The ancient indigenous Mayan people originally settled in Southern Mexico, Guatemala, Belize, and the northern part of El Salvador, developing into what are currently 23 different Mayan language groups – which, except for some words, are not mutually intelligible (Valverde-Valdés, 2000). The present-day Mayan communities are primarily settled in rural areas and rely on local natural resources for livelihoods. In general terms, the major sources of livelihoods of the Maya have been reported as being traditional agriculture, farming and the harvesting of timber and non-timber products (Schwartz, 1990; Atran, 1993; Wilk, 1997). Most often, studies of Mayan livelihoods have reported that people pursue an array of different categories, including both primary and secondary productive activities. In other words, the Mayan people pursue multiple livelihoods (see Wilk, 1997; Bello-Baltazar, et al., 2001; but see also Chapter 2).

Most studies of Mayan livelihoods have primarily focused on major livelihood components whereas relatively minor or secondary sources of livelihoods have only appeared in descriptive accounts (see Atran, 1993; Jorgenson, 1993). This study focuses on those secondary sources of livelihoods of the Mayan people from The Mayan Zone of Quintana Roo, southern Mexico. In that region, minor livelihoods include honey bee production, small-scale cattle, gathering of non-timber products, and freshwater fishing, among others (Bello-Baltazar, 2001; see also Chapter 2). Particular attention is paid here to freshwater fishing.

Several authors have acknowledged that in the whole Mayan area, from Mexico to El Salvador, the topic of fishing has been little addressed in the literature (Toledo et al., 2001). For example, a literature review, including published and unpublished reports from 1850 to 2000, undertaken by Toledo et al. (2001) found

that of 497 references on topics of use and/or management of natural resources by the Maya, studies on agriculture and ethnobotany represented 31% and 17% respectively, whereas fishing represented only 2%.

Indeed, the lack of attention to freshwater fishing as a source of livelihood is a broader phenomenon, with several authors having noted that this activity is underreported in several parts of the world (Drammeh, 2001). Perhaps this is partially because official government statistics are biased towards recording natural resource uses that are transacted in large markets, with subsistence activities or sales in local markets being viewed as of less importance (Ratner, et al., 2004). Nonetheless, it could also partially be that in low and middle income countries, many natural resources are still at the inventory phase (i.e., researchers being still listing out both species and their abundances) as is the case in the whole Mayan area.

Knowing in greater detail the contribution of fishing to local livelihoods is of relevance for both scientific and natural resource management purposes. Also, at regional and community levels, results from this type of studies can also serve the needs of local people. For example, a detailed account of Mayan livelihoods undertaken on a local common property land (*ejido*) by the author of this study in 2004, provided both the community and a state secretariat with a clearer distinction among the major and minor community livelihoods. Based on those results, the secretariat's staff was able to understand the livelihood composition of Mayan households as well as their resource base, subsequently leading to their proposal of a community project in response (A.C., *ejidatario* and local authority, 2005, personal communication).

This study has three aims including (i) assessing the contribution of fishing to livelihoods at three Mayan *ejidos*; (ii) relating the results found in (i) to the availability of local water bodies at each studied *ejido*; and (iii) undertaking research into other aspects of secondary Mayan livelihoods, including the

cultural, traditional, recreational and religious contribution of fishing to Quintana Roo's Mayan Zone. This Chapter is organized as follows: section 5.2 describes the methods used, followed in section 5.3 by the results obtained, and section 5.4 contains a discussion of the results.

5.2. Methods

5.2.1. Study Area

This study was undertaken in common property lands called *ejidos* located within the limits of the municipality of Felipe Carrillo Puerto in Quintana Roo, México. It is important to note that although Quintana Roo shares the Yucatan peninsula with neighboring states of Yucatan and Campeche, the Mayan people inhabiting rural communities in Quintana Roo regard themselves as different from Mayan communities in Yucatan state in several respects (and with a few exceptions). In particular, in Quintana Roo's Mayan Zone (La Zona Maya), people are tied to the Mayan Church, an institution formed during "The Caste War" by the Mayan rebels, the immigrants who had fought against the Spaniards since 1847 (Villa-Rojas, 1992). Therefore, most rituals and festivals of Quintana Roo's Mayan Zone which are related to the Mayan Church are not present in Yucatec Mayan communities. In addition, and because of regional differences, there are several Mayan words that are used differently between Mayan people in Quintana Roo and Yucatec Maya (including Mayan people in Campeche).

In Quintana Roo, entering the Mayan *ejidos* to undertake research was difficult for several reasons. First, and as it was described in Chapter 2, the Mayan people of Quintana Roo currently live under a high degree of marginalization. Second, for several years now they have been coping with both shocks and stress. In the former case, two extended droughts hit the area in the last decade, and in the latter, the rainy patterns do not arrive on time and related to this, their agricultural fields' production has been slowly diminishing (INEGI, 2000; Bello-Baltazar, 2001; see Chapter 2). Third, many local people, especially men, suffer from alcohol addiction which in turn affected their families and their community.

And fourth, as it was observed during this study, most often the *ejidos'* internal organization suffered from conflict and hence, was weak.

5.2.2. Approach

Given the difficulty in entering Mayan *ejidos* to undertake research, the study sought out and obtained the moral and scholarly support of a native social and humanities group working in the studied area (see Chapters 1 and 2). Besides introducing the research team to three *ejidos'* authorities using Mayan, this advisory group helped with fieldwork in two of the *ejidos* and provided advice and guidance to solve problems and concerns throughout the research period. In addition to having external advice, this study's approach used concepts and methods from both the social and the natural sciences. The former was typically represented by development studies and anthropology, and the latter by fishery science. Additionally, ethnoecology was used because traditional or indigenous knowledge complemented the research (after Toledo, 1992).

Fieldwork and sampling

Fieldwork took place over two time periods. The first one, in which a social survey was undertaken, lasted from September 15, 2004 to January 25, 2005. In this first period, three Mayan *ejidos* from the Municipality of Felipe Carrillo Puerto were selected to undertake a detailed study on the contribution of fishing to livelihoods. The time period was supplemented by an additional two-day period, March 10-11, 2006, for resolving concerns in the communities and for data corroboration through open interviews with local authorities and *ejidatarios*.

The second time period was undertaken at five indigenous Mayan *ejidos*, including the former three plus other two. It was more related to obtaining qualitative data, and included observational records undertaken during fieldwork and fishing events as well as from open interviews of local people, all data which had been recorded in a journal (after Cohen, 2001). This second time period comprised April 1998 and from August 1999 to August 2001.

In several respects, results from both the above time-periods complemented each other. Moreover, this study drew on the results and understandings of Chapters 3 and 4, which address, respectively, the situation of data-sparse fisheries in Quintana Roo, and a non-monetarian valuation of natural resources used for livelihood.

Except for one *ejido* in which a head of the municipality with about 17,500 inhabitants is located, all *ejidos* in the study area were composed of relative small populations ranging in size from about 250 to 3,500 inhabitants. In order to protect the confidentiality and privacy of participants, no reference to an *ejido*'s name is made in this Chapter, except in the specific cases of the three *ejidos* in which the detailed study (i.e., the social survey) was undertaken but even in this case, the following three pseudonyms in Mayan are used: "Junp'éel", "Ka'a p'éel" and "Óox p'éel" (after Gómez-Navarrete, 2002). Note that these three *ejidos* were the same studied sites reported in Chapter 2.

To accomplish the first research objective – to assess the contribution of fishing to livelihoods in three Mayan *ejidos* – this study undertook a household survey which amount of sampling varied across sites [given the difficulty of entering the *ejidos* together with the reluctance of some local people to take part in the study. See Chapter 2.] Therefore, a census of households was undertaken in *ejido* "Ka'a p'éel" and a sample of 30% and 15% in "Óox p'éel" and "Junp'éel", respectively. Thus, while at the first of these *ejidos*, the sampling was quantitative in nature, at the latter two sites it was qualitative (see de Vaus, 1995).

The household survey took into consideration the insights of Chambers (1997) related to using local materials and participatory research to get information from rural or indigenous people. The details of the household survey were fully described in Chapter 2 but are summarized in this Chapter to ensure completeness of the description of methods used here. The household survey

consisted in interviewing a head of a sample of households (or his/her spouse) on livelihood issues. The interview was based on a questionnaire having 7 closed questions, and interviewees were asked to allocate their household annual income, both cash and in kind, to their several sources of annual income (including activities pursued on-farm, off-farm, through self-employment, migratory work, among others), using a fixed number of corn seeds. Moreover, people were asked to undertake the income allocation for a "normal" year, or not taking into consideration years in which their work and income were affected by natural events such as hurricanes.

In order to relate the results found in the survey to the availability of water bodies at each *ejido*, data on the location of water bodies, as recorded during both fieldwork and fishing events - Chapters 3 and 4 and 6, were thoroughly reviewed. In addition, any other information from the qualitative data was used where relevant to this Chapter. Finally, the third research objective ("research into other aspects of secondary Mayan livelihoods, including the cultural, traditional, recreational and religious contribution of fishing to Quintana Roo's Mayan Zone") was undertaken from data primarily gathered during the second research time period.

Data analysis

With the aid of a codebook, data from the survey were systematized and later stored in a database (after Thiessen, 2001). The matrix of the survey was composed of cases and variables represented, respectively, by households and by a demographic component together with the income categories. The resulting general matrix could also be partitioned to analyze the data by *ejido*.

Although the analysis was performed to assess the contribution of fishing to livelihoods, all households and their sources of income went through the same procedure, as follows. In order to estimate the percentage contribution of every source of income to the household, the total number of corn seeds utilized by

every interviewee was regarded as representing 100% of his/her household's annual income and the corresponding percentage for every occupational activity was estimated subsequently. Afterwards the occupational activities were arranged in a descending rank order to show those making the highest and lowest contributions to household income per *ejido* (Turkenik, 1976). In addition, the number of households engaged in each of the occupational categories was concurrently ordered in a descending rank order.

Finally, the total number of households with the income category "fishing" was determined, and the data for these households were subsequently used in a more detailed and comparative analyses – see the results section of this Chapter. In addition, the qualitative data on fishing, as derived from open interviews and systematic observation, were arranged within every section of the results.

5.3. Results

During the household survey, a total of 123 heads of households were invited to take part in the study and 83.7% of them accepted the invitation. Of the resulting 103 interviews that were completed, only 99 had enough information to be used in this study. The number of surveyed households in each of the 3 *ejidos* was 59, 22 and 18 in "Junp'éel", "Óox p'éel" and "Ka'a p'éel", respectively.

5.3.1. On the Contribution of Fishing to Livelihoods

To provide a larger picture of the primary productive activities undertaken by people of the studied *ejidos*, data on 11 income categories were compiled; these are presented in Table 5.1. The income categories include natural resource based sources, as well as government grants and the annual *ejido*'s income, where provided. The sites "Ka'a p'éel" and "Óox p'éel" did not have any *ejido*'s income because their land extensions were of less than 5,000 hectares, on average, and therefore, they did not receive logging permits as was the case in other larger *ejidos*, including "Junp'éel".

Before a close examination of Table 5.1 is undertaken, it should be recalled that only data from "Ka'a p'éel", in which a household census was undertaken, could be regarded as definitely representative of the *ejido*, whereas data from both "Óox p'éel" and "Junp'éel" are qualitative – with the results representing only the sampled households, and thus not necessarily capable of extrapolation to all the *ejido*.

Table 5.1. Primary sector livelihood activities (including *ejido*'s income and government grants), showing income category with number of households (n) per *ejido* and their averaged income household contribution in %.

	"Óox p'éel"		"Ka'a p'éel"		"Junp'éel"	
Category	n	(%)	n	(%)	n	(%)
Milpa	19	20.1	18	19.2	51	18.3
"Oportunidades"	19	15.3	14	15.5	45	12.3
Backyard livestock	18	14.4	15	17.5	36	12.1
"Procampo"	16	18.7	14	18.9	49	15.2
Vegetable growing	9	21.8	11	15.9	11	12.4
Orchard	7	15.6	9	14.9	14	11.8
Hunting	4	8.0	3	12.0	23	10.3
Fishing	2*	15.2	8	11.4	16	7.4
Honey bee production	2	11.1	0	0.0	14	18.8
Sap harvesting	0	0.0	0	0.0	14	12.4
Ejidos's income	0	0.0	0	0.0	33	8.5
Total households =	*22*		*18*		*59*	

*As some local people considered fishing to be a recreational activity, it was not reported by 6 households (A.C.C., authority, personal communication, 2005). Therefore in the sample there were 2+6= 8 households with fishing as income.

Not considering the income category of government grants, the two major livelihoods in the three *ejidos*, in terms of number of households engaged in the activity, as well as of average income contribution of income categories being present in at least 50% of surveyed households, were slash-and-burn agriculture ("milpa") and backyard livestock. The set of activities reflecting minor sources of livelihoods in the data were similar for both "Ka'a p'éel" and "Óox p'éel", including hunting, fishing and orchards. Nevertheless, a thorough examination of the data (i.e., the database) showed that there were two households which pursued

fishing as a major livelihood, one in each of "Ka'a p'éel" and "Óox p'éel", with fishing representing 18.6 and 20.9 % of annual household income, respectively.

Also in examining data from "Óox p'éel", it was noted that some of the heads of households who had previously participated in the study on data-sparse fisheries (Chapter 3) had also participated in the household survey, but in the latter case they did not acknowledge fishing as part of their annual household income. Therefore, the author asked a local authority which was able to confirm that 6 local households had not reported fishing in the household survey. Moreover, according to the authority, those people (including himself) regard fishing more as a recreational activity than a formal livelihood (e.g., pursuing fishing seemed not to be a job at all). He also explained that many of those people would also pursue fishing whenever a member of their family wishes to eat fish. Thus, the data from "Óox p'éel" on the number of households engaged in fishing in Table 5.1 could be misleading (i.e., an under-estimate), but nevertheless fishing would still be considered a minor livelihood in this *ejido*.

At "Junp'éel", the sample of households showed that, in terms of number of households engaged in minor livelihoods, there were 5 activities including vegetable growing, orchards, sap harvesting, honey bee production and fishing (Table 5.1). In terms of annual averaged household income, the activities contributing the least income were *ejido*'s income and fishing (Table 5.1).

5.3.2. Relating the Contribution of Fishing to the Availability of Water Bodies

The number of water bodies available on each land or *ejido* varied among the three studied sites (Table 5.2). Although an attempt was made to record all available water bodies per *ejido*, in some cases it was not possible to get the geographical location of the most remote sites. Hence, some of the fishing sites, either at these three study locations or at the several other *ejidos* reported in Chapter 3 were only described by field guides or by authorities and local people.

Moreover, from the data in Table 5.2, it can be observed that not all local water bodies were used for fishing. In many cases the latter resulted because there were no large fish species inhabiting the site.

Table 5.2. Number of water bodies located at three Mayan *ejidos*.

	Ejidos		
Number of water bodies	"Junp'éel"	"Ka'a p'éel"	"Óox p'éel"
Based on local information	15	3	2
Visited (by the project)	10	2	2
Used for fishing	12	2	1

As authorities from both "Ka'a p'éel" and "Óox p'éel" had accompanied the research team to record the geographical location of their water bodies, for these two *ejidos*, their water bodies were fully recorded. In contrast, in "Junp'éel", several of the water bodies were distant from the communities and, as the roads to reach them had been in extremely bad condition, it was not possible to visit them all.

In "Junp'éel", the majority of the communities (i.e., 4 out of 6), including the largest, with approximately 3,500 inhabitants, were located relatively close (~ 1 to 8 km) to some water bodies that this study found to have fish species (e.g., Cichlasoma urophthalmus) that did not surpass 12 cm in total length, on average, or 150 g. in weight, as on average. On the other hand, other relatively remote water bodies of this *ejido* were inhabited by larger fish species (e.g., Petenia splendida), with total lengths of 27 cm on average and weights around 400 g

Therefore, relating the household survey's results on fishing to the availability of water bodies provides an understanding that, in spite of this *ejido* having 12 sites used for fishing (Table 5.2), its communities relied primarily upon the more nearby fishing areas that have relatively small-size fish. In fact, according to

results reported in Chapter 3, 43.7 % of people from this *ejido* that practice fishing acknowledged that bringing up to 5 kg of fish to the household was considered a "good catch".

Moreover, in this *ejido*, it was observed that it was young people (approximately 20-30 years old) who visited the most remote areas during the dry season. It was also recorded that a pair of more remote water bodies was located close to a "chicle" or gum harvesting camp, and two elder *ejidatarios* acknowledged that in the past, these water bodies had served the needs of gum harvesters for both water and fish supply.

In respect to "Ka'a p'éel", although it had only two fishing sites, they both were the home of medium-sized (C. urophthalmus; C. friedrichsthali) and large sized (P. splendida) fish species [of 15 and 22 cm total length, on average, respectively]. In addition, both water bodies were located only about 1.5 km from their community and therefore, people's reliance on fishing seemed relatively higher than the reliance of people from "Junp'éel" upon their closest water bodies.

Finally, "Óox p'éel" had only one water body at which fishing was pursued. Moreover, compared to the other water bodies observed in the study area, this one was the shallowest (approximately 1.5 m depth) and had relatively low fish abundance. In fact, most often, local people used to pursue fishing at sites fully located out of their land, in neighboring *ejidos* (see Chapter 3).

5.3.3. On the Traditional, Religious and Recreational Contribution of Fishing to Livelihoods

In spite of the remoteness of many of the water bodies of The Mayan Zone that have relatively high fish abundance, it was ascertained that Mayan people have pursued fishing in the past as well. The earliest record in one indigenous *ejido*

suggested that approximately 54 years ago, fishing was already a livelihood in Quintana Roo's Mayan Zone.

According to an elder *ejidatario*, it was a time when no bikes or automobiles were used to move into the rainforest and therefore, people, including his father, stayed several days at any site of the rainforest before they came back to the community to bring any produce. As people stayed for several days outside their communities, they used to both pursue fishing for several days and grilled the captured fish ("asaban el pescado"). Therefore, these people used to bring to the community a big bag (approximately 1 m length) of grilled fish. Moreover, the elder was able to recall that the most common fish species brought by his father into his household was a cichlid locally called as "bocona" (P. splendida) [the most valued fish in many *ejidos* of the area – See Chapter 3].

A second Mayan interviewee, a man of 43 years, noted that approximately 35 years ago, his father had taught him and his brothers how to grill fish ("asar el pescado") in remote fishing sites. Moreover, at that time, they also used to bring grilled fish into The Mayan Zone. In the latter case, once the bag of fish had been brought home, his father used to send it to Yucatan's markets for sale.[In one of the fishing events undertaken in a remote site, the research team found and took pictures of a traditional wooden-made grill. Later on, its full picture -with fish in it - was verbally described by the last interviewee, as shown in Figure 5.1.]

Additionally, two elder *ejidatarios* commented that approximately 40 years ago, when hunting for crocodile was still allowed in Quintana Roo, they themselves, in several groups of men, used to undertake journeys into the wetlands, lasting from 5 to 7 days, targeted at hunting crocodiles. One of these *ejidatarios* later added that during these journeys, since fish was very abundant in the wetlands, they used to feed primarily upon fish.

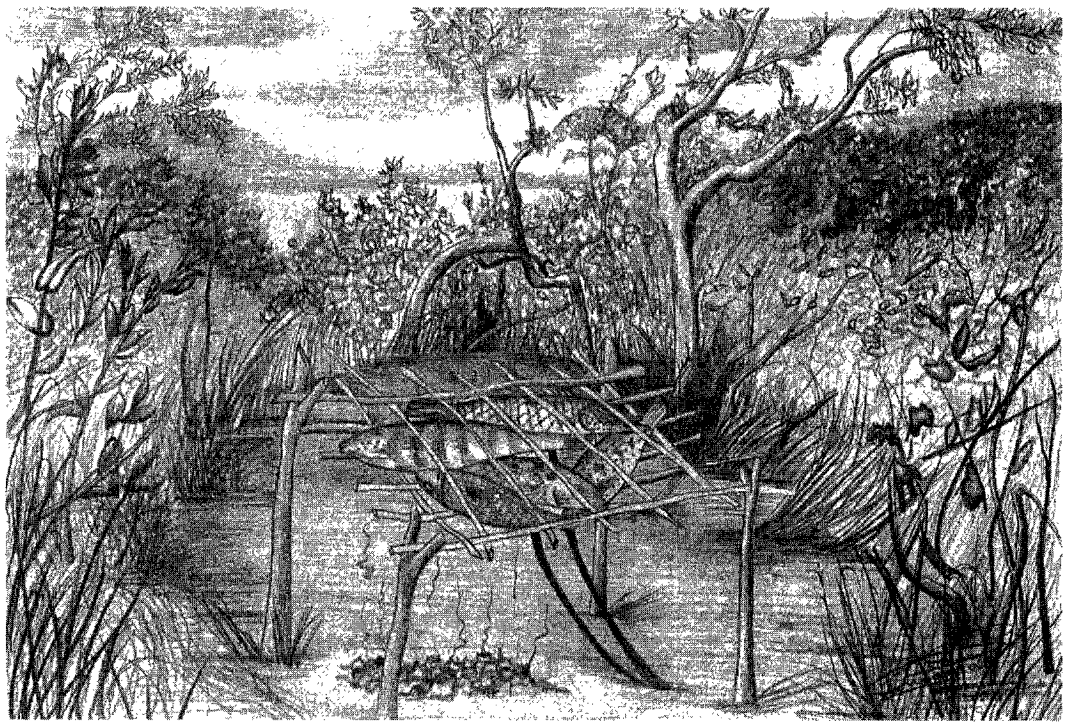

Figure 5.1. Grilling fish in a remote fishing site of a common holding or *ejido* in Quintana Roo, Yucatan Peninsula, Mexico (drawing by María Magdalena Noriega Guevara, 2006).

In respect to traditions of cooking the captured fish, over the period from 1999 to 2001, specifically during the dry seasons (from February to May), a research team that included the author of this study had accompanied local people, from one of the 5 indigenous *ejidos* reported in Chapter 3, to pursue fishing. After the journey had ended, or every time they returned back to the community, and provided they brought fish with them, the members of the research team were invited to have diverse meals made of fish in three different Mayan households. The two most common recipes were fried fish and fish soup. The former recipe could include two variants; one, in which small or juvenile fish were fully fried in such a way that the fish bones can be readily eaten; and a second one in which large or adult fish were fried but the bones were not eaten.

A third recipe was only used during the Holy Week and included smoking the fish, chopping the meat up and mixing it into a white sauce made of corn meal. The fourth but less frequent fish recipe involved using a very large sized fish, usually a tarpon (Megalops atlanticus). Once the fish had been eviscerated, people added (i.e., by marinating) a sauce made of the seeds of a native plant locally known as "achiote" (Bixa orellana) together with other spices. Afterwards, the fish was wrapped up in aluminum foil and put on the grill, like a barbecue meal is made. Generally speaking, and except for the last-noted recipe (with a large-sized fried fish), these recipes seem to be local to within The Mayan Zone because their taste are not usually found in the state's main city of Chetumal. Nonetheless, in the case of the marinated fish with "achiote", a similar recipe can be found across the whole Yucatan peninsula, but using several marine fish species.

In respect to the reasons why many local men might either not pursue fishing or stop their fishing, there were several responses recorded. Many men, including the youth, adults or elders, did not pursue fishing for a variety of reasons but as the level of importance placed on these reasons varied by *ejido*, they are only presented in a descriptive form in the next paragraphs.

One of the reasons for not practicing fishing was because many men did not know how to swim; this reason was recorded in 4 out of the 5 indigenous *ejidos* reported in Chapter 3. As was noted in the latter source, most fishing is undertaken barefoot with the water level reaching half of the body of those pursuing fishing. [Nevertheless, on occasion, non-fishing people might still accompany their friends and/or relatives on fishing journeys. But at such times, those people may either pursue hunting near the water body or help in cleaning up and cooking the captured fish.] Unfortunately, during the time period of the current research, at least 4 deaths were caused by drowning; in all cases, the people were male adults entering water bodies who were not able to swim. Additionally, during the same period, two interviewed people from the study

reported in Chapter 3 acknowledged they almost drowned on a fishing trip; one of them, who had been fishing alone, managed himself to reach the shore alone and the other one was rescued by one of his accompanying relatives. Moreover, in one of the *ejidos*, the drowning was still recalled of an 8-year-old boy who, during a local festival, had visited the *ejido* with some of his relatives. Thus, overall, drownings were recorded in 3 out of the 5 indigenous *ejidos* reported in Chapter 3. Generally speaking, entering the water bodies is locally viewed as something which is deserving of respect.

Another reason for not pursuing fishing was because some people regard themselves as unskilled at fishing; this reason was recorded in 3 out of the 5 Mayan *ejidos* reported in Chapter 3. In this respect, several men commented that it was very frustrating to see that their fishing buddies were able to capture not only one but a dozen fish yet they were not able to capture any. It was noted that men acknowledged as "very-good-at-fishing-people" have high prestige in their community. However, this study also found that other less-skilled-at fishing people did not care about prestige and every dry season they pursue fishing to bring income (food) to their household.

Another reason for not pursuing fishing was related to the remoteness of those water bodies having relatively high fish abundance. Several men acknowledged that, because of the high temperatures registered in the study area during the dry season, going into the rainforest during this period was difficult. According to several of them, it was even worse to get into the muddy wetlands, arrive at a fishing spot and then realize that there were virtually no fish. Recalling results in Chapter 3, the latter happened when, even if fish abundance was relatively high at the beginning of the fishing (dry) season, the fish in the water bodies became depleted by the end of the fishing (dry) season. Two men around 40-45 years old acknowledged that, given the difficult time they used to have on remote fishing journeys, they had already "retired" from fishing.

In respect to the religious importance of fishing to the Mayan livelihoods, people of both the Catholic and the Mayan Church religions follow the traditions of the Holy Week. Thus, during a time period after "Ash Wednesday" (i.e., Lent), some local people avoided eating red meat on Fridays until the arrival of the Holy Week. During this time period, they ate fish instead which, most often, is brought from their water bodies. Therefore, although only a minority of men pursued fishing, those who did provided a source of fish to many others in their communities. The supply could be either by selling the fish or giving it as gifts. In particular, it was recorded that in 4 out of the 5 indigenous *ejidos* reported in Chapter 3, some of those who fished would sell fish in their communities (in fact, those not pursuing fishing were happy to acknowledge that they would rather buy the fish from their friends and relatives in their communities). Moreover, in the same communities, people pursuing fishing often gave fish as gifts to close relatives. Strikingly, and in only 1 of the Mayan *ejidos*, fish was never thought of as being sold but only given as gifts. The latter situation was noted by the project's field-guide in the *ejido* where local people had valued local fish in seventh place, below 6 other natural resources (see Chapter 4). Indeed, the guide was particularly puzzled about why people from other *ejidos* may sell their fish, because according to him it should only be given as gifts.

Finally, with respect to the recreational contribution of local fishing, this had been reported in Chapter 3, and in the present study the recreational meaning of fishing to some people of *ejido* "Óox p'éel" has been noted already. Indeed, the recreational role of fishing noted in the above-noted Chapter would be clear to those who have frequently visited the Mayan communities during the dry season. This is because during that season, one of the topics of conversation relates to recognizing when is the right time to pursue fishing. Moreover, during this time period, the regular users of fishing sites could be seen preparing their hand lines, seeking buddies for the next fishing journey and, overall, discussing the number of Fridays still to pass before the arrival of the Holy Week. Furthermore, according to Arce-Ibarra and Estrada-Lugo (2000), during the dry season, the

Mayan people of Quintana Roo have little or no work to do in their native agricultural fields, and therefore, they can easily spare time for fishing trips.

5.4. Discussion

According to Ratner et al. (2004), in several parts of the world, aquatic resources which support secondary (minor) rural livelihoods are often overlooked by outsiders. For example, a study of hunting undertaken by Jorgenson (1993) in 1993 in one of the *ejidos* of The Mayan Zone reported fishing as an occasional activity. However, later studies at the same site showed that the *ejido* had nearly 28 available water bodies, 18 of which were used for fishing (Rojas-García, 1999).

At present, in Quintana Roo, the contribution of fishing is overlooked by both governmental secretariats and scholars working in The Mayan Zone. In respect to the latter, scholars studying aspects of anthropology and archeology in this area seemed surprised whenever the topic of local people pursuing fishing was brought into formal conversations by the author of this study (M. Molina, 2001 personal communication; A. Velázquez, 2006, personal communication). The latter could partially be because there are few if any reports of fishing being part of local livelihoods, but also because few scholars would accompany *campesinos* to remote areas and hence they are not aware either of there being karstic water bodies with abundant fish or of there being local people pursuing fishing.

In general terms, the contribution of fishing to local communities and *ejidos* is dependent on the availability of water bodies in which fish size and abundance are sufficient to support a regular harvest. Thus, there were some *ejidos*, for example "Ka'a p'éel", in which people relied more on fishing than is the case in other *ejidos*, such as in "Óox p'éel". In this respect, the relative value of fishing as compared to other local resources will also depend somewhat on two variables – the proximity and the ease of access of water bodies with enough fish biomass in them. This reality helps us to better understand an issue that was previously

raised in Chapter 3, namely the occurrence of local people granting fishing rights to outsiders. More specifically, because not all *ejidos* had water bodies which could support a regular fish harvest, some people were willing to grant fishing rights to people coming from neighboring communities. In this respect, it should also be recalled that most often, the Mayan people have relatives or friends in other neighboring communities and therefore, fishing would be part of the socializing undertaken by neighbors.

Results from both observational records and the household survey supported the argument that fishing is a minor but still relevant livelihood to the Mayan people. This is also supported by people who, although ranking the value of local fish in seventh place, relative to 6 other natural resources, commented that all local resources were important to them (see Chapter 4).

In respect to Mayan traditions, it is clear that in both the dry season and the Holy Week, fishing is an activity traditionally pursued in The Mayan Zone (see Chapter 3) and this fact backed up again the suggestion that fishing supports the cohesiveness of the *ejidos*' communities.

Returning to the issue of the government overlooking fishing as an activity in the study area, and given the unfortunate drownings that have occurred there, it would be very important to implement courses to teach people how to swim, as well as how to rescue people from water bodies. This is another reason why a government acknowledgement of fishing as a tradition in The Mayan Zone would benefit local people.

Finally, topics for further research related to fishing would include assessing the current status of fish populations that support fishing, as well as assessing whether any of the local subsistence activities impact on water bodies and on fishing. Local people and researchers should use the precautionary approach and assess local fishery resources, and human impacts on them, before they

become at risk. In other words, although fishing is a relatively minor component of the Mayan livelihoods, the people wish to avoid having their resources fall into a depleted state – and it is important as well to avoid "the tragedy of the commons" (Hardin, 1968) or the overuse of common property resources from occurring in their fisheries.

Chapter 6

Rural People and Natural Resources: Combining Local and Scientific Knowledge to Study the Karstic Water Bodies of Quintana Roo, Yucatan Peninsula, Mexico

6.1. Introduction

Approximately 10% of the earth's surface is comprised of karstic landscapes. Although their chemical composition may vary from one continent to another, they are generally made of soluble limestone, and this in turn has led to the formation of caves, pools and sinkholes (González-Medrano, and Hernández-Mejía, 1998). In Mexico, the Yucatan Peninsula is a flat landform of karstic origin that emerged from the sea during the Miocene-Pleistocene periods and is comprised primarily of calcium carbonate and dolomite (Gaona-Vizcaíno et al. 1985; Schmitter-Soto, 1998a). In most of the Yucatan Peninsula, the only sources of freshwater are water-filled sinkholes (or 'cenotes'), caves and non-permanent ponds (Gaona-Vizcaíno et al., 1985).

The importance of studying karstic systems arises from several angles. From a livelihood point of view, these systems are considered to include approximately 25% of the world's freshwater (González-Medrano and Hernández-Mejía, 1998). Moreover, in Quintana Roo, one of the three states in the Yucatan peninsula, these systems provide rural people with sources of both animal (fish) protein and recreation (see Chapters 3 and 5). With respect to biodiversity conservation, these water bodies have been regarded as unique and fragile systems, and as "islands of aquatic life" because they are typically inhabited by a range of endemic or rare species, including vertebrates and invertebrates (Yager, et al., 1994; González-Medrano, and Hernández-Mejía, 1998; Cervantes-Martínez, 2001; Schmitter-Soto, et al., 2002, p. 215).

This study of the karstic water bodies of Quintana Roo, and how they are used, has a two-fold goal. First, it is about linking social and natural sciences methods to study the interaction of rural people and natural resources within the Quintana

Roo rainforest. Second, it is about combining the local knowledge of people in the area with scientific assessments, so as to better understand these karstic water bodies. In the latter respect, the study was aimed at (a) recording the uses that rural people of Quintana Roo made of karstic water bodies; (b) determining whether people pursuing fishing have noticed any change over time related to this activity and (c) determining the basic limnological attributes of water bodies and its fish community structures. The latter in terms of species diversity and trophic structure. The Chapter is organized as follows; section 6.2 describes the methods used, sections 6.3 presents the results, and section 6.4 provides a discussion of those results.

6.2. Methods

6.2.1. Study Area

The study was undertaken in Quintana Roo, located in the Yucatan Peninsula of Mexico. Eight common property holdings, locally known as *ejidos*, were examined, but their actual names are not used here to protect the confidentiality and privacy of the local people. Five out of the 8 *ejidos* were primarily inhabited by indigenous Mayan people; one by two types of people, indigenous and non-indigenous whereas the remaining two were inhabited primarily by rural immigrants, coming from several states of Mexico.

Currently, Quintana Roo is one of the few Mexican states in which the rainforest is still well preserved. Quintana Roo's rainforest has karstic water bodies interspersed within it, referred to locally as "aguadas", "cenotes" and "lagunas". The altitude of the study area varied from approximately 10 to 25 m above sea level; with an annual precipitation ranging from 1100 to 1500 mm (Macario-Mendoza, 1991; Schmitter-Soto, 1998a). The regional weather is rainy-tropical with the rainy season starting in Summer and ending in Fall. Although the weather could be simply classified into both wet and dry seasons, most authors define three seasons; the dry season, usually ranging from February to May; the

rainy season, from June to November and, the "north winds" (or cold fronts) season from November to February (Vega-Cendejas, et al., 1997).

6.2.2. Approach

This study used methods from anthropology, ecology and limnology, as well as from ethnoecology. The latter field was applied to the use of traditional or local people's knowledge to understand the karstic water bodies (after Toledo, 1992). In order to record the various uses of the water bodies, the author used systematic observation as well as open interviews with rural people (Bernard, 1995). To accomplish the remaining two research aims, two surveys were undertaken (a social and a limnological one) between 1999 and 2005. More specifically, the social survey aimed to study freshwater fishing, involving indigenous and non-indigenous people as users of karstic water bodies for fishing – it was undertaken from January to September, 2004. The survey targeted at studying aquatic ecosystems was undertaken during two periods, from January 1999 to December 2001 and from January 2004 to April, 2005.

The characteristics and timing of the social survey have been described in Chapter 3. During this survey, and in order to build rapport with local people, a color catalog of regional fishes was shown to every interviewee who then was specifically asked whether he/she had seen any of the depicted species at the individual's traditional fishing sites. The latter knowledge was cross-validated with information from other people knowledgeable about fishing, as well as from fish sampling and a review of the literature (e.g., Schmitter-Soto, 1998b). For the purposes of the present study, the social survey addressed the following question: As far as you can remember back in time, has there been any change related to fishing? Should participants respond affirmatively to this question, they were immediately asked to describe the kinds of changes they were aware of.

During the limnological survey, not all water bodies were equally sampled because, except in three cases, water bodies were located on seasonally flooded

areas to which access was primarily restricted to the dry season (approximately from February to May). Thus it was not feasible to enter these ecosystems to take water and fish samples throughout the year. The physical and chemical parameters, including water transparency (Secchi disk, in m), conductivity of water (mS cm^{-1}), temperature (C°) and pH, were measured *in situ* at 1 m depth during the dry season. The type of data logger used to measure the latter parameters was a Hydrolab Sonde model Recorder. In addition, two other parameters, the maximum depth (m) and maximum width, were obtained in two ways; first, for 8 ecosystems, they were obtained during a concurrent study on limnology undertaken by a regional research institute (Cervantes-Martínez, 2001) and second, the remaining ecosystems were measured with a leaded rope.

To assess the similarity of water bodies in terms of limnological attributes, a hierarchical cluster analysis was undertaken with all, except one, of the physical and chemical variables. The similarity index used was the squared Euclidean distance and the method of 'complete linkage' (Dunn-Rankin et al., 2004).

In respect to fish sampling, and in order to select appropriate gears for capturing fish in morphologically heterogeneous environments, several gears were tested during samplings – with fish species being counted nonetheless at these times (see Schmitter-Soto and Gamboa-Pérez, 1996). Given the different gears used, species diversity was measured using two parameters, namely the species richness or the number of fish species (S) per water body, and a diversity (log-log) index, called *iota*, ι which was represented by the following formulae (Hayek and Buzas, 1997):

$$\iota = \ln (S) / \ln (N)$$

where S and N are the number of fish species and the total number of captured fish during the sampling period (e.g., during a fishing event), respectively.

The estimation of the total number of species (S) was complemented with local people's knowledge on the distribution of fish, but included only up to 3 species and only in 4 out of 19 visited water bodies.

In order to obtain a first estimate of the fish community composition or its structure per water body, fish species were grouped into the categories of herbivores, omnivores and carnivores (after Schmitter-Soto, 1998b, and FishBase, 2006). The corresponding abundances of these categories per site were converted into proportions and subsequently represented graphically.

6.3. Results

6.3.1. Uses of Water Bodies

The social survey included 59 interviews; 58 structured and one in open format. The languages used in the structured interviews were Spanish (75.9%) and Maya (24.1%). The open interview was completed in Spanish. The age of interviewees ranged from 14 to 66 years old [and only one woman participated in the survey].

In total, there were 7 local uses of water bodies identified, with five direct uses and two indirect ones (Table 6.1). All the uses were related to subsistence activities as pursued by rural and indigenous people of Quintana Roo.

Table 6.1. Recorded uses of karstic water bodies in Quintana Roo.

No.	Direct Use	No.	Indirect Use
1)	Water for agriculture, vegetable growing		
2)	Drinking water for cattle	6)	Bees & other fauna
3)	Fishing		
4)	Tourism use (rural tourism)		
5)	Swimming & Holiday (family gatherings)		
		7)	Hunting areas

6.3.2. Changes to Fishing over Time

In exploring whether practitioners of fishing were aware of any changes related to fishing at their traditional fishing sites, 68.4% of them responded affirmatively (Table 6.2).

Table 6.2. Responses on any change related to fishing.
(n= 58 structured interviews; DNK = 'Do Not Know')

Issue	Response (%)			Total
	Yes	No	DNK	-
Any perceived change to fishing?	68.4	26.3	5.3	100.0

Not ascertained= 1

Those who responded affirmatively to the question belonged to 7 out of the 8 *ejidos* and described changes related to fishing which could be grouped into four classes. The response "currently there is less fish abundance than in the past" had the largest percentage (almost two-thirds) of respondents (Table 6.3).

Table 6.3. Kinds of changes perceived in the water bodies (n= 39 cases).

Type of change noted	Response (%)
a) Currently there is less fish abundance than in the past:	66.7
b) Variability in fish abundance between years:	7.7
c) Variability in fish abundance within a year:	7.7
d) Environmental changes related to fishing[1]:	17.9
Total	100.0

[1] Including: extended droughts which affected fish distribution, lower levels of water bodies than in the past, and deforestation near to water bodies.

Changes related to variability in both intra- and inter-annual fish abundance were also noted, and nearly 18% of interviewees observed environmental changes that were affecting fishing, including extended droughts.

Furthermore, those who perceived changes related to fishing provided the names of 16 water bodies from the study area, which, according to them, currently had less fish abundance than in the past.

6.3.3. Limnological Attributes of the Karstic Environments

To assess the limnological attributes of the karstic water bodies, a total of 38 sites were visited at least once, but given the remoteness of some of them, only 19 were sampled (water and fish) at least twice. Therefore, results on the limnological attributes of water bodies will refer to only the 19 sites. Although two out of the 19 water bodies were not used for fishing, their communities' fish structures were analyzed nonetheless.

Water bodies varied in shape, with maximum depths ranging from 3.0 to 47.0 m and with maximum widths from 15.6 to 180.0 m. Only two water bodies had sub-saline waters (3.7 and 3.8 mS cm^{-1} average conductivity) whereas the others were freshwater. Their water transparency was between 0.8 and 9.7m, and their pH values varied from 7.4 to 9.6 and therefore, their water were regarded as hard water.

A hierarchical cluster analysis of limnological data, including species richness, was carried out and is represented by a dendogram in Figure 6.1. For the analysis of the clusters, it is suggested to cut the dendogram at the 5.5 coefficient (see axis of rescaled distance, Figure 6.1.).

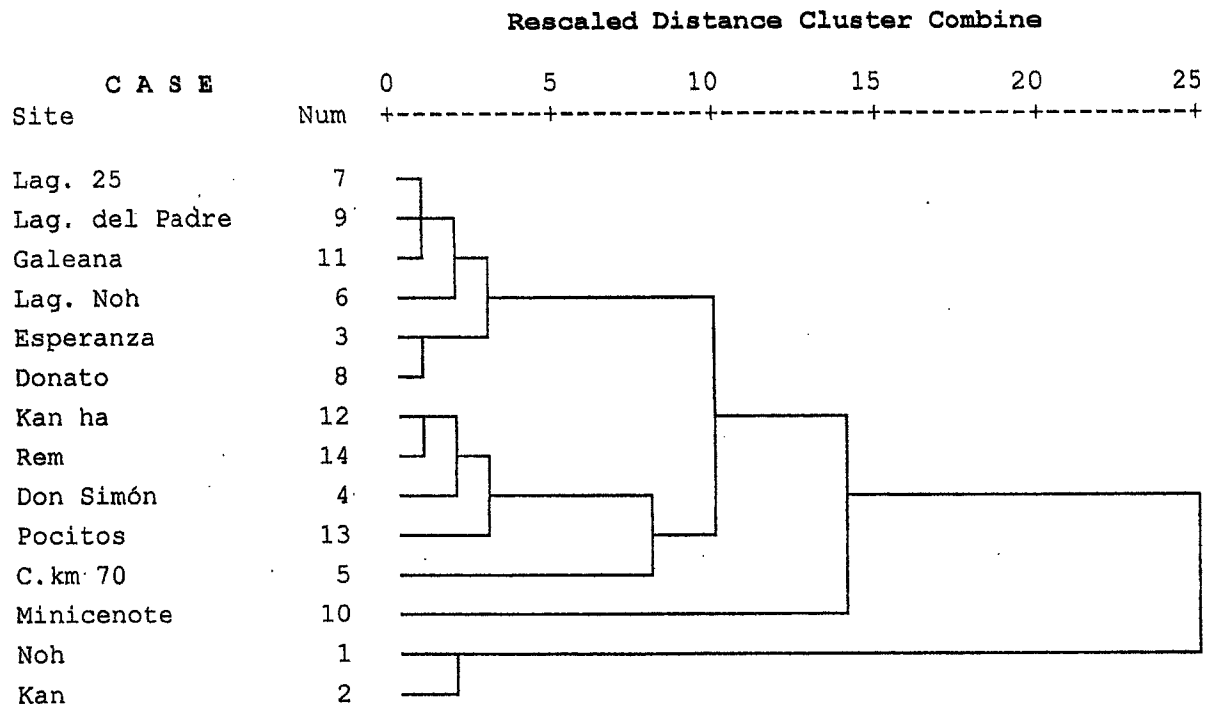

Figure. 6.1. Hierarchical cluster analysis of 14 water bodies from Quintana Roo, using complete linkage.

In this manner, we found that 5 clusters could be identified, with three of them composed of more than one water body and the remaining two composed of only one site. One of the clusters contained two water bodies (sites number 1 and 2, Figure 6.1) which were the only ones located in swamps, and which were surrounded by mangroves (Rhizophora mangle). For these, year-round data would typically be difficult to obtain because of their location. [In fact, in these sites, fishing halted once the rainy season arrived.] The water in these locations was sub-saline and had the highest values of species richness (S= 18 and 16). At these two sites, subadults of a migratory marine fish (Megalops atlanticus) arrive every wet season, once the area has been flooded and connected to the sea (Schmitter-Soto et al., 2002). Some skilled indigenous and non-indigenous people catch this and other species, while co-existing with medium sized crocodiles during the dry season (see Chapter 3). Unfortunately, these sites were also among those fishing areas where people had perceived a diminishing in fish abundance.

The other 4 clusters identified were located inland, and although access roads suffer from muddy conditions during the wet season, from these sites year-round data would be possible to obtain using 4 x 4 vehicles. One of these latter clusters was composed of 4 water bodies (sites number 4, 12, 13 and 14, Figure 6.1) in which species richness ranged from 4 to 7; water transparency was between 2.3 and 3.5 m; conductivity of water ranged from 1.0 to 2.75 mS cm^{-1}; and pH values ranged from 7.4 to 8.7. Of the 4 sites in this cluster, only one was listed by local people as having less fish abundance than in the past.

A second cluster was composed of 6 water bodies (sites number 3, 6, 7, 8, 9 and 11, Figure 6.1) in which species richness varied from 6 to 10 fish species; water transparency ranged between 1.5 and 6.5 m; and pH values were the highest in range, from 9.0 to 9.7. Only 2 of these 6 water bodies were noted by local people as having problems with current fish abundance.

The last two of the 5 clusters were each comprised of just a single water body. One of these, as site used for fishing, was in fact the deepest site (at 47 m) and had a transparency of 6.4 m; a conductivity of 1.7 mS cm^{-1}; a pH of 8.4, and a species richness of 5 (site number 10, Figure 6.1). The 5^{th} cluster involved a site not used for fishing, with only 2 recorded species and with the highest water transparency, at 9.7 m (site number 5, Figure 6.1.)

6.3.4. Fish Diversity and Trophic Structure

In examining the relative fish diversity index of the karstic ecosystems, two groups of water bodies could be identified (Table 6.4); one in which over 100 fish

Table 6.4. Fish diversity in terms of *iota* diversity index (I), species richness (S), and species richness including local people's knowledge. n= number of fish sampled. Sites with relatively low fish abundance are marked with an "X".

Site No.	I Diversity	n	S	S + Loc. Knowledge	Less fish abundance
1	0.42	747	16	-	X
2	0.28	583	6	-	
3*	0.22	513	4	-	
4	0.48	414	18	-	X
5	0.28	207	4	-	
6	0.13	199	2	5	X
7	0.21	191	3	-	X
8	0.38	178	7	-	
9	0.53	111	11	12	
10	0.45	107	8	-	
11	0.40	89	6	-	
12	0.54	69	8	10	X
13	0.51	57	8	-	X
14	0.65	35	10	-	
15	0.59	34	8	-	
16	0.51	33	6	-	X
17	0.63	27	8	-	
18	0.65	16	5	-	
19*	0.26	15	2	-	

* Sites not used for fishing.

were sampled, and in which diversity values ranged from 0.22 to 0.53, and the other in which less than 100 fish were sampled, with diversity values ranging from 0.26 to 0.65.

In those two groups, local people's knowledge perceived problems with fish abundance in both relatively low (e.g., 0.13, 0.21) and medium (e.g., 0.42 and 0.48) diverse environments (Table 6.4).

A total of 22 fish species were recorded in the 10 sites in which over 100 fish had been sampled; but their distribution varied among sites (Table 6.5). Moreover, fish community trophic structure (showing the proportional composition of herbivores, omnivores and carnivores) is shown in Figure 6.2 for each of these 10 sites.

Although it was found that omnivorous fish were present in all the 10 sites, they were the most abundant in 7 out of 10 (range = 0.75 to 1.) Carnivorous fish were the second most abundant trophic structure being recorded in 9 out of 10 sites but only dominated in only 2 of them (range = 0.64 to 0.99). Finally, herbivores were present in 5 out 10 sites but with proportions of less than 0.20 (range = 0.04 to 0.18.) Therefore, results suggest that the 10 studied karstic environments had fish community structures dominated primarily by omnivores followed by carnivores and herbivores..

Additionally, based on both local people's knowledge and systematic observation, it was found that some fish species exhibited habitat partitioning in the water bodies. For example, at one cenote located in a swampy area (site number 4 in Table 6.4) it was recorded that adult cichlid of the species P. splendida were distributed in deeper waters than adults of two other cichlid species, "C". syspilum and "C". urophthalmus. Also, juveniles of all three of these species were distributed in generally shallower waters (approximately from 0.5 to 2 m) than their corresponding adults.

Table 6.5. List of fish species recorded in 10 sites [with its presence (x) or absence (-) marked].

Species	Water bodies									
	1	2	3	4	5	6	7	8	9	10
Cichlasoma synspillum	x	-	x	x	-	-	-	-	x	x
Thorichthys meeki	x	-	x	x	-	-	-	x	x	x
T. affinis	-	-	x	x	-	-	-	x	x	x
Gambusia yucatana	x	-	x	x	-	x	x	-	x	-
P. mexicana	x	x	-	x	x	-	-	x	x	x
Dorosoma petenense	-	-	-	x	-	-	-	-	-	-
Garmanella pulchra	x	-	-	x	-	-	-	-	-	-
Phallichthysfairweatheri	-	-	-	-	-	-	-	-	x	-
C. urophthalmus	x	x	-	x	x	x	x	x	x	x
Astianax aeneus	x	-	-	x	-	-	-	x	x	x
C. robertsoni	x	-	-	x	-	-	-	-	-	-
Rhamdia guatemalensis	x	-	-	x	-	-	-	x	-	-
Ophisternon enigmaticum	-	-	-	x	-	-	-	-	-	-
G. sexradiata	-	x	-	-	x	-	-	x	-	x
Belonesox belizanus	x	-	-	x	-	-	-	-	x	-
Gobiomorus dormitor	x	x	-	x	-	-	-	-	-	-
Archocentrus octofasciatus	x	-	-	x	-	-	-	-	-	-
C. salvini	x	-	-	x	-	-	x	-	x	x
C. friedrichsthali	x	x	-	x	x	-	-	x	x	-
Petenia splendida	x	-	-	x	-	-	-	-	x	x
Atherinella sp.	-	x	x	-	-	-	-	-	-	-
Megalops atlanticus	x	-	-	x	-	-	-	-	-	-

Comparing the fish diversity index (Table 6.4) with the community's trophic structure of Figure 6.2 indicated that site number 6 (Figure 6.2), with the lowest fish diversity index (I= 0.13 Table 6.4), had only one category of fish, namely omnivores ones, that was represented by only 2 species. Strikingly, the latter site had been reported by local people as having fish abundance problems (see Table 6.4).Furthermore, sites with higher fish diversity indexes (0.42, 0.48 and 0.53) had all three categories of fish within their trophic structure – i.e., herbivores, omnivores and carnivores – and had a higher number of species (respectively, 18, 16, and 11). However, two of those sites (number 1 and 4 in both Table 6.4 and Figure 6.2) had also been noted by local people as having problems with fish abundance.

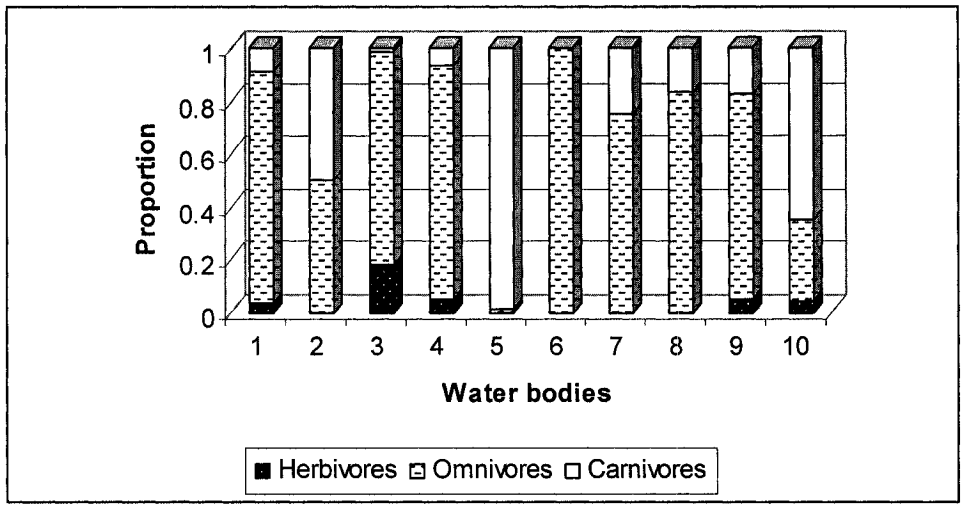

Figure 6.2. Proportions of herbivores, omnivores and carnivores in each of the ten water bodies in which more than 100 fish were sampled.

6.4. Discussion

The set of recorded uses of water bodies in The Mayan Zone support both rural livelihoods and the fauna of the rainforest. In this study, a further link of livelihoods to the water bodies arose through the observation that, frequently, soils near water bodies were used for agriculture and vegetable growing.

Unfortunately, this location of plantations near water bodies created an impact on the aquatic ecosystems, because it was observed that once the nearby vegetation had been removed (i.e., at the beginning of the process of the slash-and-burn agriculture), the arrival of the rainy season brought silt into the water. Potential impacts on the water bodies and their flora and fauna could also arise from the pesticides and fertilizers used in plantations, although no study has addressed this. A further environmental impact was the litter this research found to have been left in and around the water bodies, as a result of both family gatherings and fishing events. Thus, given these observations, and the uniqueness of karstic systems (Cervantes-Martínez, 2001), this study argues that there is a pressing need for educational and capacity building programs for local

people, promoting improved management of natural resources and particularly water bodies.

The results obtained in this paper on changes perceived by local people in the fish abundance at their traditional fishing areas calls out for further research on these local karstic systems. Such studies would need to encompass some sites with both relatively low and medium fish diversity indexes, because there were some of each of these types reported as having fish abundance problems (see Table 6.4). This work should use both local and scientific knowledge, seeking to cross-validate the observations of the local people.

Unfortunately, given the remoteness of many water bodies, it would be difficult to undertake the monitoring needed to identify medium or long term changes in community fish structure and related biological parameters. In other words, it would be difficult to replicate the sort of long term studies that took place on demersal fish communities subject to fishing, as it occurred for example, in the North Sea, from 1925 to 1996, which study showed that the mean growth rate of fish tended to increase, while the mean age at maturity, as well as the maximum length and the length at maturity, all decreased (Jennings et al., 1999).

At the local level, the Meso- American Biological Corridor Initiative is interested in promoting programs in Quintana Roo and elsewhere, in which communities might be involved in monitoring changes in some of their resources (C. Pozo de la Tijera, researcher, 2004, personal communication). However, it needs to be ascertained whether local people would be interested in participating in this type of work.

With respect to the fish diversity indexes (I) obtained at 19 sites, the values for sites with less than 100 sampled fish should be regarded as preliminary estimates. It would be expected that as more fish are incorporated into the total

sample (n), the values of these indexes would tend to stabilize around their final values (Hayek and Buzas, 1997).

The results obtained from this study have shown that traditional local knowledge and scientific knowledge can be complementary in working on data-sparse and remote water bodies. Loisselle et al. (2000) reported a similar study in which local people's knowledge complemented their research in remote wetlands of Argentina.

While the aggregate of information obtained in this study cannot be considered to provide definitive conclusions about the impact of fishing and other local uses on the water bodies, and on fish populations inhabiting karstic waters, nevertheless the results of this study should be of interest to authorities and to *ejidatarios*. This will help them understand the possibility of a diminishing fish abundance at traditional fishing sites, and provide some information needed in seeking out long-term solutions.

Chapter 7

Conclusions

This Chapter contains both conclusions and a general discussion and implications of the overall research. It is organized as follows. Section 7.1 summarizes the conclusions of the research for each of the research questions of this dissertation (see Chapter 1). It is followed by section 7.2 with a discussion of the methods used, its adequacy and some of their limitations. Section 7.3 addresses the implications of the results to both The Mayan Zone in Quintana Roo and the rainforest conservation in general, and finally, section 7.4 presents a proposal of future research needs for the study area.

7.1. On the Research Questions

A broadening of research interest in natural resource sectors from studying only the resource themselves to also include the users of the resources necessarily entailed a move into disciplines dealing with the human dimension and, in this case, into the social sciences.

The conclusions to the following research question "what is the income diversity and relative resilience of Mayan livelihoods in three *ejidos*?" are:
The Mayan livelihoods at common property lands (*ejidos*) of Quintana Roo were multiple, seasonal and dynamic in which people did cope with both stress (e.g., a diminishing in milpa yields) and shocks (e.g., an extended drought). To a great extent, the Mayan livelihoods relied upon the rainforest of the study area which provided two sources of income, one which could be readily accounted for by interviewees because it comprised their occupational categories, and another that was only qualitatively recorded by the research team, that included gatherings of produce and raw materials from the rainforest.

In the occupational categories, fifty two sources of income were recorded in the studied *ejidos* and, from a development studies point of view, income diversity was highest in *ejido* "Junp'éel" with 49 sources of income, followed by *ejidos* "Óox p'éel" and "Ka'a p'éel" with 22 and 18 sources, respectively. However, from a functional resilience point of view, income diversity was slightly higher at "Ka'a p'éel" followed by "Junp'éel" and "Óox p'éel". Although the approaches used and results were complementary to fully understand Mayan livelihoods, it is suggested that results of functional resilience represents more adequately the resiliency of livelihoods because it integrates its diversity (number of sources of income) with both, its scale (location) and function (purpose).

Taking into consideration at least a 50% of surveyed households of three sites, the income category most frequently recorded was slash-and-burn agriculture ("milpa") followed by backyard livestock, two items which were traditionally present in most meals, rituals and ceremonies of the Mayan households throughout a year.

Generally speaking, The Mayan Zone of Quintana Roo is acknowledged as a marginalized area in which people live under a deprived condition including that over 50 % of their people live in extreme poverty, implying that these people do not have the daily income to cover at least their daily food needs. Hence, what is currently being sustained at this area is a deprived livelihood. For the latter reason, this study contends that people inhabiting The Mayan Zone are far from pursuing a truly sustainable livelihood or one in which people are able meet their basic human needs (see WCED, 1987).

In respect to the question "what are the natural resource base, ecosystems, users, and general management regulations comprising freshwater fisheries at *ejidos* in Quintana Roo?" the conclusions are:

The inland fisheries of the study area were classified as artisanal or small-scale with use of very low technology, notably the use of hook and line gear in which the activity was undertaken barefoot along the shores of water bodies and often, with the aid of rafts and canoes.

The seasonality of fishing was primarily during the dry season (February to May), because accessibility of sites were in good condition but also because of both the arrival of the Holly Week and the fish abundance was high.

The users of the inland fishery resources were both indigenous and non-indigenous people, ranging in age from teenagers to senior adults and which major occupation was primarily slash-and-burn agriculture. The fishing activity was mainly male oriented but some women were also registered as users of the fishery in 5 out of 9 of the studied *ejidos*. Moreover, the key motivation of users pursuing fishing was subsistence followed by recreation.

The natural resource base used for fishing was composed by 16 bony fish species and to a lesser extent by turtles and crustaceans. Also, forty-eight water bodies were recorded as being used for fishing in 9 *ejidos*, including 16 lakes, 14 cenotes, 11 ponds, 2 channeled wetlands, 2 lagoons with slight marine influence and 1 flooded savanna.

There were not found to be any explicit and organized management regulations for the fishery. Nevertheless, compared to both access rights of soils to undertake agriculture and logging precious wood, which are exclusive rights of entitled persons or *ejidatarios*, the access rights to pursue fishing at water bodies within an *ejido* were more flexible and therefore more "permeable" than the former two. In this respect, it was found that both *ejidatarios* and non-*ejidatarios* acknowledged that other people could pursue fishing at their sites but also that they were allowed to pursue fishing at neighboring *ejidos*. Overall, this study found that, except in one indigenous *ejido*, two groups of people were found in

the studied *ejidos*, one who were willing to grant fishing rights to outsiders and another who were not willing to do so.

The conclusions reached in the question "what are the relative values that Mayan people place upon natural resources used for livelihoods?" are:
The three community groups – *ejidatarios*, non-*ejidatarios* and women, of a Mayan *ejido* regarded "soils" (for agriculture) followed by "woodsticks" as their two most valuable natural resources from a set of 7 assessed resources. Likewise, they also regarded "fish" following up in ranking importance by "bees" as their two least valuable ones.

Statistical analyses of rank correlation methods revealed that among the three community groups, the values they placed upon resources were similar. In contrast, the interviewed scholars could only ascertain the non-*ejidatarios* and women's natural resource values but not the values of the *ejidatarios* nor the pooled community values.

Furthermore, given that *ejidatarios* are the ones with property rights upon land and resources; that they sit on the councils who are in charge of accounting their resources, they were able to distinguish more clearly among the assessed resources than the two other community groups (non-*ejidatarios* and women); particularly "soils" from the remaining resources ("woodsticks", "zapote", "animals", "trees", "bees" and "fish"). Generally speaking, the three community groups were able to distinguish two classes of resources, the most and the least valuable ones.

During two community workshops, participants from the study stated that all their natural resources were important to them but "soils" to undertake slash-and-burn agriculture was their most important (and hence valued) resource because agriculture was the most important activity to their communities.

The conclusions to the question "what is the contribution of fishing to Mayan livelihoods in three *ejidos*?" are:

Because the number of water bodies per *ejido* varied, the extent of the contribution of fishing to Mayan livelihoods varied also. In general terms, the contribution of fishing to livelihoods was dependent upon the availability of water bodies in which fish size and abundance were sufficient to support a regular harvest.

Except in two out 99 Mayan households, fishing was part of the minor livelihoods in the three *ejidos* studied. Moreover, some households did not report fishing as part of their livelihood because it was considered more as a recreational activity than a "job". Furthermore, four people provided knowledge related with fishing having a relevant role to local livelihoods in the past, especially in the camps of sap harvesters and during journeys to hunt for crocodiles, 40 years ago.

During the dry season (February to May) which is very much coincident with both the Lent and the Holy Week, fishing was an activity traditionally pursued in The Mayan Zone. Moreover, this study found that fishing was part of the socializing system of the latter area and therefore, it contributed to enhance the cohesiveness of its communities. Thus, although currently government and scholars overlook this activity, it, as a minor source of livelihood was relevant to the Maya because it contributed to subsistence, traditions, religious observances and recreation.

A state government acknowledgement of fishing as a tradition in The Mayan Zone of Quintana Roo will benefit local people in several ways. First, the resource base for fishing needs to be considered in conservation efforts and people should receive training on the best fishing practices, as well as on the impact that other subsistence activities have upon their aquatic resources. And second, because local people was in need of training on how to swim and also

on how to rescue others who potentially may suffer an accident during a fishing event.

Finally, the conclusions to the question "what are the limnological attributes and the fish community structures of karstic water bodies in Quintana Roo?" are:

The limnological attributes of 19 karstic water bodies were as follows. Maximum widths ranged from 15.6 to 180 m and maximum depths from 3 to 47 m. Two out of 19 sites had sub-saline waters whereas the remaining ones were freshwater. All sites had water transparency between 0.8 to 9.7 m in which the pH values (7.4 to 9.6) indicated that they were hard water.

Species richness of 19 sites ranged from 2 to 18 fish species whereas the fish diversity (iota) varied from 0.13 to 0.65. Moreover, 10 out of those 19 water bodies recorded 22 fish species which fish community structures were dominated by omnivores followed by carnivores and herbivores.

From a combination of local and scientific knowledge it was understood that local people perceived problems with fishing in water bodies with both, relatively low (0.13) and medium (0.42) fish diversity indexes. More specifically, thirty-nine out of 58 people from seven *ejidos* reported they have perceived changes related to fishing in at least 16 traditional fishing sites. The most frequently reported change was that at present there is less fish abundance than in the past, followed in second place by environmental changes (e.g., extended droughts) affecting fishing. Additionally, in respect to uses of water bodies by local people, seven uses were recorded- 5 of direct use and 2 of indirect ones – all related to subsistence activities of people from 8 *ejidos*.

7.2. An Assessment of the Approach and Methods

The use of similar concepts among the social and natural sciences and ethnoecology, together with their methods captured a more accurate and

comprehensive picture of the several topics posed in the research questions of this dissertation. Therefore, this study contends that should disciplinary approaches –either from the natural or the social sciences- alone be used to address these research questions at complex settings such as those from the study area, several issues and understandings would likely be missed.

With respect to the usefulness and adequacy of methods used in this thesis, the survey methods used (Marsh,1982; de Vaus, 1995) yielded information on the several questions addressed, including topics of livelihood strategies and household income, data-sparse fisheries, non-monetary valuation of resources, contribution of fishing to livelihoods, current or potential problems related to fisheries, and limnological attributes and fish community structures of karstic water bodies. A literature review on the use of surveys elsewhere provided an understanding that in other data-sparse situations, including rural and indigenous settings, the approach of such surveys was one several researchers had relied upon. For example, the data-sparse fisheries of the Amazonian *varsea*, in Peru, has been assessed through household surveys and semi-structured interviews by Pinedo et al. (2000). Additionally, the Lake Titicaca fisheries were studied by Levieil and Orlove (1990) using field surveys and interviews, and the Mekong River's pond-based fisheries, in Lao (PDR), were studied by joint research of the Australian Centre for International Agricultural Research (ACIAR) and the International Development Research Centre (IDRC) in partnership with both national and provincial governmental agencies from Lao (PDR), using survey methods (AMRC, 2000, 2001).

Nevertheless, although a useful method for the characteristics of The Mayan Zone, the survey has some shortcomings of which researchers need to be aware. One of these concerns informant accuracy (Presser, 1984; Freeman et al., 1987; Presser and Traugott, 1992). In particular, this study recorded three different types of inaccurate responses, all of which were recorded in the data-sparse fisheries study undertaken at 9 *ejidos* (Chapter 3). Those inaccuracies

were detected through both observation and cross validation of data with others knowledgeable about fishing.

One of the inaccuracies corresponded to the number of users of the fishery resources at two *ejidos*. In particular, two interviewees, one in an indigenous *ejido* and another in a non-indigenous one; both local authorities representing the state government, under-reported the number of users at their local water bodies. For example, one of them had reported that only 5 people were users of the local fisheries but the remaining interviewees reported from 35 to 232 users. The author of this study stayed in that *ejido* for several months undertaking fieldwork and was able to realize that there were far more than only 5 persons using the fishery resource and, therefore, she had considered such a response to be an "outlier" in her fishery data. Thus, in both cases, it is suggested that these two authorities were concerned about indicating to outsiders (i.e., the author and her research team in this case) that there were "many" local users of the fishery resources.

The second informant inaccuracy occurred in questioning about the "good catch range". In particular, one of the regular fishery users in one of the indigenous *ejidos* had responded that, to him, a "good catch range" was a catch up to 5 kg. Nevertheless, this person had been acknowledged by two other interviewees (from a neighboring *ejido*) as one who, during the Holy Week, used to sell approximately between 15 and 20 kg per day at some of the local communities.

Finally, the third recorded inaccuracy was related to the use of harpoon, a fishing gear which, according to several people, was acknowledged to "harm" the fish population because it allows users to catch many fish very quickly from the water. In particular, the author of this study once had been asking about who in one community used harpoon during fishing trips. A local person –an authority, provided the name of one of his relatives as a user of harpoon. Nevertheless,

when an interview was completed with the latter individual, he explicitly stated that he did not use harpoon when fishing.

Thus, generally speaking, in this study, informant inaccuracy was related to specific sensitive issues and, in this case, it seemed to be related to avoiding a portrayal of the local fishing activity as one which could negatively affect the fishery resource. Besides the above reported informant inaccuracy issues, no other "outliers" or inaccuracies were detected in the remaining addressed topics, which also were more descriptive, in choosing the natural resource losses which would be more severe to people, and on the contribution of income categories to livelihoods. The responses to such questions, it is hoped, will be reasonably accurate.

Another tool equally useful for data-sparse situations is the local knowledge of those in the communities. In this study, such knowledge was recorded in regard to several topics of the research, including data-sparse fisheries, non-monetary valuation of local resources, and changes over time related to fisheries in the karstic water bodies (see Chapters 3, 4, 5 and 6). Local people provided both expertise and knowledge, using their own terms and most often their own worldviews. The translators of the technical meanings of the local knowledge were two native Mayan speakers who were the project research assistants. On occasion, other local people, including the family who fed the research teams, helped in explaining local meanings too. Moreover, results based on traditional knowledge were cross-validated with as many sources of knowledge as possible, as suggested by Haggan et al. (1998), including other knowledgeable local people and from data gathered from observation and literature review. In this way, this study has been compatible with the points raised by several authors that local or traditional knowledge should be used to help in data-sparse situations, and also so as to include the cultural values of local people (Sallenave, 1994; Emery, 1997; Johannes, 1998; Loiselle et al., 2000).

Nevertheless, the use of traditional knowledge in research or in policy planning has some constraints of which scientists need to be aware. First, traditional knowledge and scientific knowledge are not directly comparable (Berkes, 1999); hence, research scientists should be cautious when trying to discriminate biological or ecological truths from local myths (Ruddle, 1994). Second, it has been argued that one of the major barriers in complementing or integrating traditional and scientific knowledge is "perceptual", because very often what is 'true' and relevant for Western-trained scientists might not be for local and/or indigenous people (Sallenave, 1994, p.5). Third, several external pressures such as Westernization, globalization, and urbanization threaten to change local knowledge systems; hence sometimes these systems are becoming hybridized with new imported concepts (Ruddle, 1994). Therefore, traditional knowledge systems should not be considered static; rather, they change through time and it is necessary to be aware of and to account for any such change.

Despite the issues with ethnoecology related to the above discussion of local knowledge, in this study both ecology and ethnoecology yielded useful and complementary results on fish inhabiting water bodies and their ecological characteristics.

Lastly, besides the several constrains posed above with the survey method and the local or traditional knowledge, other research processes in which errors could be involuntarily introduced to the overall research were, among others, the following: a) during the collection and coding of the data by interviewers during social surveys; and b) during the analysis and interpretation of data by the author. Moreover, the qualitative data including observations of local customs, the fishing journeys, among others, had the potential error of whether observations were interpreted correctly by the author of this study. In the words of Clifford Geertz (2000), were they interpreted "thick" (i.e., accurate, reliable) or "thin" (i.e., superficial, partial or perhaps inaccurate)?.

7.3. Implications of Results to both The Mayan Zone in Quintana Roo and the Rainforest Conservation

Turning to the broader implications of this research, the results obtained in this study demonstrate that the approach and methods used can serve as a model to continue research in The Mayan Zone and perhaps in other areas with similar settings, namely, in places wherein indigenous marginalized people dwell upon forested areas in Mexico and Central America.

In respect to the livelihood challenges found and the conditions in which the Mayan indigenous people are currently living, a literature review provided understanding that unfortunately, the Mexican government has not been addressing the problems of marginalized people in a comprehensive way (e.g., Bello-Baltazar et al, 2002). For example, while in July 2005, that government began its Second Indigenous Week, including the delivery of financial resources and infrastructure to communities, this was done without a long-term program of capacity building (see Vargas, 2005). Thus, it seems as if in Mexico, the goals of equity and respect for local indigenous cultures established for the United Nations' First International Indigenous Decade (United Nations, 2005), never actually arrived.

As a contribution to solve current problems of indigenous people in Mexico, the results of the present study are useful to redirect the government policies presently in place in indigenous and rural settings and particularly in The Mayan Zone. In particular, new policies need to be devised, in which the shocks and stresses that these people have been coping with in the last decades should be considered. Moreover, if future policies are geared towards promoting development and lessening marginalization, they have to consider the two most important income categories recorded in the area –slash-and-burn agriculture and backyard livestock, both which primarily supported the subsistence, traditions and overall the culture of these people. Furthermore, those policies need to be complemented by long-term programs on capacity building, and given

that currently. most people of The Mayan Zone are organized into common property lands or *ejidos*, a training in community-based natural resource management will be suitable for them. Furthermore, future policies should include education and training on non-Western cultures and on the implication of working rainfed agriculture for the Officers in charge of rural and indigenous governmental programs.

The following paragraphs will turn to the implications of the research's results to the rainforest, the natural areas that sustain the livelihoods of the Maya and other indigenous people settled close to tracts of rainforest in Mexico.

Although many common property holdings (*ejidos* and "comunidades") in Mexico are entitled to log the forest, several authors have reported that there is also a problem with illegal deforestation pervading the logging areas, for several reasons. First, it has been reported that in order to protect the forest, the Mexican government had increased the number of permits that must be filled out to apply for a logging permit, resulting in some people preferring to cut trees illegally rather than following a long bureaucratic process. Second, several natural protected areas (NPA) of Mexico have been established, in part to protect some endangered species, but the Mexican secretariats that established some of those areas did so without consultation with traditional users and thus local people do not respect the NPA's borders and still continue logging. Third, as some of these people have nearly depleted their forests, government stopped issuing logging permits, but as it has no personnel to enforce the logging rules, illegal extraction of logs has taken place in many areas (Chodkiewics, 2003; Bray and Merino Pérez, 2004).

The problem of deforestation in Mexico is not new. In fact, in Latin American countries, Mexico is acknowledged as a country with one of the highest annual deforestation rates, estimated at between 6,780 and 7,460 km^2 yr^{-1} during the beginning of the 90's (Cairns et al., 1995). For example, in the Mayan highlands

of Chiapas, inhabited by the Tzeltal and Tzotzil Mayan peoples, Ochoa-Gaona and González- Espinosa (2000) estimated an annual deforestation rate of 2.13% over the period 1984-90. Unfortunately, the latter Mayan people, also live in highly marginalized and populated areas, and indeed, if compared to the Mayan people of Quintana Roo, have even less rainforest areas to dwell in (see Parra-Vázquez and Díaz-Hernández, 1997; Gaona-Ochoa and González- Espinosa, 2000). Thus, at least in terms of availability of local rainforest, the Mayan people in Quintana Roo seemed wealthy compared to the Mayan people in Chiapas.

The problem of deforestation in Mexico became worst with economic globalization because, it has been reported that after the North American Free Trade Agreement (NAFTA), many international (globalized) companies settled in Mexico, resulting in higher degradation of forests than previous to NAFTA (Chodkiewics, 2003). Thus, should current neo-liberal economic models, including economic globalization, continue neglecting the benefits that rainforests and natural resources in general, provide to rural and indigenous minorities such as the Maya around the world, the situation in Mexico with marginalized people and rainforest conservation will not likely improve (see Chodkiewics, 2003).

In respect to the local deterioration of forests, a situation noted by *ejidatarios* surveyed, and recognized by the government in their ending of the issuing of logging permits to some *ejidos* (D.V., *ejidatario*, 2004, personal communication; A.C.C., local authority, 2005, personal communication), the results of this study are not in agreement with Bray et al. (2004). That study argued that rainforests of the *ejidos* located within the Municipality of Felipe Carrillo Puerto have shown little change (0.01%) in forest cover over the last 25 years and therefore, could be called a sustainable landscape. The contradiction between these results could be due to the methodology used; Bray et al. primarily used satellite Landsat images to assess forest cover whereas the current study used primarily fieldwork including open interviews and observation of community dynamics on logging.

In spite of the problems faced in managing the forest, there are several successful cases of community-based corporations doing so, especially in the center of Mexico but also in Quintana Roo state (Bray and Merino- Pérez, 2004). Strikingly, however, in the study area - 9 *ejidos* of Quintana Roo - no government program was found on capacity building related to community-based natural resource management, including forest resources.

During the present study, from January 2004 to June 2006, it was most often observed that the studied *ejidos* (7 out of 9) had accountability problems, with many people having serious problems of addiction to alcohol and/or there being a weak internal organization.

In the long term, both governments and scientists should acknowledge that deprived livelihoods will, in the long term, result in deteriorated forests and associated resources. Put in the words of social scientists, viable natural resources need viable communities (Jentoft, 2000). Therefore, as this study has shown and several authors have pointed out, throughout the whole Mayan area, including the Mesoamerican Biological Corridor, there is a pressing need to address both deprived livelihoods and deforestation (WRI, 2002).

7.4. Future Research Needs

Given the importance of rainforest to rural and indigenous *ejidos* in Quintana Roo, the main future research need is to assess the status of local forest and associated resources. In this regard, researchers should consider the latter contradiction on forest degradation obtained between Bray et al. (2004) and the current study.

The specific lines of research are to study the current status (i.e., sub-exploited, overexploited, depleted) of local inland fisheries of Quintana Roo. Nevertheless, as it will be very expensive to study them all, some specific sites could be

selected, for example those which according to people do show and do not show some degree of degradation.

In respect to valuing local resources, the same or similar method to the one used here should be used in other *ejidos*, to assess whether fishing is more valued in *ejidos* with a larger number of water bodies used for fishing.

Moreover, the potential impacts on the water bodies and their flora and fauna derived from the use of pesticides and fertilizers of plantations nearby water bodies, should also be addressed. Furthermore, as these aquatic systems are the only sources of water in the region, it will be important to devise programs on community-based natural resource management geared toward increasing awareness about current problems on the part of both indigenous and non indigenous people, as well as on researchers interested in working with these people and their resources.

All new lines of research should consider, to some extent, the global, regional or local impact of global warming upon forested areas and associated fauna, as well as on soils used to pursue slash-and-burn agriculture. Indeed Mexican researchers are delayed in addressing the effects of global warming on natural resources and communities.

Finally, future efforts along new research lines as well on natural resource management and conservation should take into consideration indigenous worldviews, their customs and traditions.

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Appendix A

Total Income of Occupational Activities

Table A.1.Total income of occupational activities by class of income from *ejidos* Junp'éel, Ka'a p'éel and Óox p'éel with number (n) of households engaged in each one.

Class	Activity	Junp'éel (n)	Ka'a p'éel (n)	Óox p'éel (n)
Farm	Milpa	51	18	19
	Vegetable growing	11	11	9
	Honey bee production	14	0	2
	Hunting	23	3	4
	'Chicle' (sap harvesting)	14	0	0
	Orchard	14	9	7
	Freshwater fishing	16	8	2
	Cattle	7	2	5
Ejidatario & NTP*	Ejido´s income	33	0	0
	Sisal's fiber seller	0	0	10
	Palm leaves' gatherer	0	6	1
	Woodsticks ('palizada')	4	1	2
	Sawmill	2	0	0
	Firewood seller	3	0	0
Non-Farm	Embroidery	7	0	0
	Knitting	3	0	0
	Hammock sewing	12	0	0
	Tailor	3	0	0
	Food for sale	1	0	0
	Backyard livestock	36	15	18
	Other Arts & crafts	1	1	2
	Grass cutter	1	4	2
	Aesthetic plants	1	0	0
	Bike repair	2	0	0
	Hair cutter	2	0	0
	Chicken butcher	1	0	0
	Rock and sand seller	1	0	0
	Hut (palapa) builder	2	0	2
	Carpenter	1	0	1
	Minor electricity repairing	1	0	0
	Lettering	1	0	0
	Corn meal machine	1	0	0
	Baker	2	0	0
	Convenience store	13	1	4

Class	Activity	Junp'éel (n)	Ka'a p'éel (n)	Óox p'éel (n)
	Bricklayer	3	2	0
	School teacher	3	0	0
	Car repairing	1	0	0
	Librarian	1	0	0
	Nurse assistant	0	1	0
	Public transportation	3	0	1
	Pickup	1	0	0
	State's employee	1	0	0
	Policeman	1	0	0
	Bond paper, pencil &photocopies store	1	0	0
	Tourism	2	0	0
	Aquaculture (fish)	1	0	0
	Field guide (research)	2	0	0
	Authority/community	2	1	1
Governmental grants	'Procampo' grant	49	14	16
	'Oportunidades' grant	45	14	19
Off community	Migratory work	8	2	6
	Remittances	1	0	0

* NTP= Non-timber products.