ADAPTATION TO RESOURCE SCARCITY IN A MEXICAN FISHING COMMUNITY

By

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LIST OF ABBREVIATIONS

CINVESTAV	Centro de Investigación y de Estudios Avanzados
CONAPESCA	Comisión Nacional de Acuacultura y Pesca
PAN	Partido Acción Nacional
PEMEX	Petróleos Mexicanos
PRI	Partido Revolucionario Institucional

Abstract of Dissertation Presented to the Graduate School
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ADAPTATION IN A SMALL-SCALE MEXICAN FISHING COMMUNITY

By

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Globally, the marine environment is experiencing stress and fisheries are declining. In this dissertation, I address the problem of declining marine resources by focusing on the concept of adaptation. A better understanding of how fishermen adapt to resource scarcity can contribute to improved fisheries management.

This dissertation examines the adaptations to resource scarcity among a group of lobster divers on the Gulf coast of the state of Yucatán, Mexico. There, small-scale fishermen are experiencing a decline in their primary resource, the Caribbean spiny lobster. Working with the members of the local fishing cooperative, I identify adaptive strategies employed by the fishermen as they respond and adapt to scarcity. I then examine the strategies against a conceptual framework of intensification and diversification. Although the analytical model predicted that fishermen adopt more reversible behaviors (diversification) prior to less reversible behaviors (intensification), the results of this study found the opposite to be true. In the study community, the principle adaptive strategy exemplifies intensification, where the fishermen adopt greater personal risk in their immediate response to resource scarcity. I then explore how social relationships within the fishing cooperative relate to the adaptive behavior of individual fishermen within the community.

An objective of this study is to contribute to the development of a model of adaptation to marine resource scarcity that can be used comparatively in other settings. This research also contributes to the study of common property resources by examining how human actors respond when faced with finite resources. In fisheries management, policy is principally based on available data for the species to be managed; data on how policy would impact resource users is often unavailable or not emphasized by policy makers. Yet, fishery policy that incorporates data on how resource users make decisions is more likely to be successful. By understanding how people perceive scarcity and respond to resource decline, the results of this study can be used to better integrate fishers into fisheries policy.

CHAPTER 1
INTRODUCTION

"Soy buzo," Kai[1] replied when I asked what he does for a living. "I'm a diver." He could have answered that he is a fisherman,[2] and both captain and owner of his fishing boat. The fact that he identifies himself first as a diver is significant. For one, he catches his community's most important resource, spiny lobster, by diving with compressed air. On the north coast of the Yucatan peninsula, Mexico, however, lobsters are becoming increasingly scarce. Yet, despite this scarcity, Kai continues to dive and adapts by intensifying his diving activity. He searches out new caves where lobsters may be found in deeper waters, farther from shore. When he cannot find lobsters, he targets other species, spearfishing grouper and hooking octopus, both of which are illegal practices and he risks getting caught by state fishery agents.

Diving entails an interaction with the marine environment that is qualitatively different from other fishing methods. Rather than fishing for an unseen prey below an opaque liquid surface, the diver enters the aquatic environment of his prey. While technology is required in all fishing endeavors, nets, lines, bait, etc., diving requires technology for the most basic human function: breathing. While diving, Kai is tethered to the boat by a hose through which air is supplied. Should the hose kink or a problem develop with the onboard compressor, his air supply will be cut off immediately, forcing him to abort the dive and make a rapid ascent.

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[1] As is common in many parts of Latin America, the fishermen of San Felipe give each other nicknames (*apodos*) as children and are often known by these names as adults. To preserve anonymity of my informants, I have given pseudonym nicknames for the fishermen mentioned in this work.

[2] I use the gendered term f*isherman* and *fishermen* throughout the text as fishing is the domain of men in the research community. I address women's involvement in fishing in Chapter 3.

Such an ascent exemplifies one danger in diving. The technology of diving with compressed air involves greater personal risks than other fishing methods. Over the years, Kai has been rushed to the hyperbaric chamber in Tizimin with symptoms of decompression sickness at least five times. Usually, symptoms manifest as intense pain in the knee or elbow, where a nitrogen bubble has lodged itself in his bloodstream. Given the increasing scarcity of lobsters and additional risks with diving, it may seem economically irrational for Kai to continue diving.

Other studies of fishermen note the association between particular personality characteristics and success as a fisherman including masculinity and strength (Robben 1989), independence (Acheson 1988[3]), and the ability to make decisions quickly (Kottak 2006 [1983]). If these characteristics are required of a surface fisherman, they are exaggerated in the successful commercial diver. Yet, these characteristics noted for fishing success are also seen as an obstacle to the successful organization and cooperation among small-scale fishermen (Pollnac and Poggie 1991, Poggie 1980). In Kai's community, membership in the local fishing cooperative is required to legally dive for lobsters. The lobster permits issued by the Mexican government are held by the cooperative; lobster permits are not granted to individual fishermen and are not valid outside of the cooperative. Yet, although Kai is a member of the cooperative, he regards himself as an independent fisherman first. When I asked him what the function of the cooperative was, he answered that it helps him to interact with the larger bureaucratic institutions of the state and helps him to procure benefits, including health insurance and a pension. Nearly all of the cooperative members are in agreement; the cooperative

[3] Acheson notes that such characteristics are stereotypes that fishermen are aware of and subscribe to themselves.

is an intermediary between themselves as individual producers, and institutions at a broader scale. The cooperative functions so long as individual interests are fulfilled.

The importance of spiny lobster (*Panulirus argus*) to the cooperative and to the identity of the community of San Felipe is reflected in its prominent position on the community's crest (Figure 1-1). The high economic value of lobsters is obviously important, but the practice of catching them, by diving, has cultural importance as well. Not all members of the cooperative choose to dive. In this culture of machismo, those who do not dive due to fear are, surprisingly, not afraid to share that fear. One fisherman readily admits that he does not dare to dive since the day an octopus ripped off his mask while he was underwater, causing him to shoot to the surface in a panic. Another fisherman states quite frankly that although he is a captain, he, too, is afraid to dive. He owns his own boat and employs others to dive for him. Nevertheless, most members of the cooperative are divers and for them, diving is preferred to other types of fishing. Some explain that they like to see the marine life; others claim that they just enjoy the feeling of weightlessness while diving.

In the early years after the spiny lobster fishery began in 1970, the population of San Felipe grew dramatically as many people moved to the community, attracted by the money that could be made from diving. By the 1990s, an increasing number of local fishermen, and a growing industry for spiny lobster throughout the Gulf and Caribbean resulted in smaller catches per fisherman. The fishery retracted under new state regulation and after the cooperative stopped accepting new members. Local conflicts over political control began and the cooperative eventually split into two. A major hurricane in 2002 devastated the community but in the process of reconstruction, and

under the first mayor of the PAN (*Partido Acción Nacional*) party, the people of San Felipe created a new sense of pride in their community (Figure 1-2). Nevertheless, local conflicts have deepened and further divided the community in some ways. What is important to recognize, however, is the resource scarcity now perceived by the fishermen is not occurring in a moment of cultural equilibrium. The community and its resources are constantly experiencing change and they in turn, are changing their environment.

Kai and the other members of the cooperative believe that lobsters will become increasingly scarce in the future. As their primary resource increases in scarcity, they adapt. Adaptation concerns how people deal with change; it is a process that links humans with their environment. The fishermen draw from their cultural, social, and economic resources when they adapt to change in the socio-ecological system of which they are a part.

Change is a constant process, but people do not adapt based on rigid models of economic rationality. Lobsters have a high exchange value which is of economic importance, but lobsters also have cultural significance for the community. The fishermen are members of a cooperative, responding both as a group to the scarcity, and behaving as individuals in their adoption of adaptive strategies. Yet, their individual behaviors are driven not only by self-interest and personal preferences, but by socio-cultural norms of behavior. Some, like Kai, continue to dive. Others look for work on shore, such as tending cattle on nearby ranches, the community's second most important industry after fishing. Some will subsist on whatever marine resources they can harvest, cutting expenses and lowering consumption.

There are always a few fishermen who continue to land good harvests, consistently more than the other fishermen. Although these fishermen's harvests also experience peaks and slumps, they rarely return to shore with a catch valued at less than the day's expenses: fuel and food. Ultimately, fishermen with certain shared characteristics are most successful and are the least likely to leave fishing for other economic activities.

While the individual fishermen engage in these different adaptive strategies, as a group, the cooperative is attempting to manage its resources locally. The proximity to other fishing communities makes it difficult to exclude outsiders, and enforcement of agreed upon usage rules is also problematic. Federal management laws are inconsistent and lack enforcement. One of my aims in this study is to provide small-scale fishermen with information to help improve local resource management by better understanding how they respond to resource scarcity.

In this study, I examine how a group of small-scale fishermen adapt to marine resource scarcity. Using observed strategies, I propose a model of adaptation to marine resource scarcity in order to analyze this study's context and compare and contrast it to a model of adaptation offered by McCay (1978). The purpose of this study is to contribute to the development of a model of adaptation to marine resource scarcity that can be used comparatively in other settings. I argue that a better understanding of human responses to scarcity through the development of such a model will contribute to more successful resource management.

This study is based on 13 months of field research conducted with the members of a fishing cooperative in San Felipe, a small-scale fishing community on the north

Yucatan coast of Mexico. The research included a series of four interviews conducted with a sample of the cooperative members, participant observation, and the collection of daily production totals and fishing strategies of the member fishermen.

Identifying the Research Problem

My advisor once told me that there are two types of cultural anthropologists: those who are attached to a research topic and must find the place to conduct the research, and those who are attached to their research site and then look for something to study in that place. In developing this study, he was sure that I fell into the second category. I had conducted research for my Master's thesis in San Felipe and knew I wanted to return there for my doctoral study. I had developed strong relationships with many local fishermen and their families. Many of my fellow graduate students had struggled with their fieldwork, finding it difficult to build rapport in places distrustful of researchers. I considered myself lucky to have found a community in which I felt welcome.

Yet, prior to my Master's research, the place-or-problem attachment was the other way around. My attachment was to study local resource management in a small-scale fishing community and I was in need of a place for the study. During two exploratory field trips, I visited numerous fishing communities along the coast of Belize, north then west following the coast of the Yucatan in Mexico until I finally stepped off the bus in San Felipe. By the end of my first day in town, I already had an invitation to go fishing.

My focus on marine resources developed alongside my interest in anthropology. While working as a SCUBA divemaster on the south west coast of Thailand one day in 2001, our boat arrived at our best offshore dive site just as an Indonesian fishing boat had dynamited parts of the reef. This fishing technique kills all the fish in the area with some fish floating to the surface to be scooped up by waiting fishermen. An estimated

90% of the fish killed sink to the bottom among the damaged coral (Djohani 1997). Fishermen using dynamite do not observe the destruction; they only see those fish that reach the surface. On this day, I asked our captain, Sin, about the Indonesian fishermen coming to Thai waters to fish and dynamiting the reefs. He responded that the fishermen were just trying to feed their families; they were working, like he was. I recognized that as a foreigner, I had the luxury to travel to the other side of the world and work this job, just because I loved diving. Captain Sin was saying that tourists' interests should not supersede the needs of people trying to feed their families.

Djohani (1997) and Guard and Masaiganah (1997) argue that fishermen are often pressured to use such destructive fishing techniques by middlemen up the market chain who provide the dynamite and pressure them to do so. Dynamite is cheap and the middlemen can switch industries completely and search for new profits if fish become scarce and fishing unprofitable. Unfortunately, it is not so simple for the fishermen to find a new occupation once the fish are gone.

Captain Sin's words made sense to me and reinforced many ideas that I had explored during the previous years I spent living and traveling in Southeast Asia. I was interested in the relationship between fishermen and fish and the factors that influence the decisions of small-scale fishermen who are usually at a marginalized end of the market chain. After studying local resource management for my Master's thesis, I concluded that many of the problems manifested at the local level were a result of pressures originating from the broader regional and global scale (Lasseter 2006).

In thinking about the research for my dissertation, I first returned to San Felipe to ask the fishermen for their input on what I should study. I wanted their concerns about

their fishery to drive my research questions. Most answers concerned projects to develop new fisheries in the area or to identify a market for locally abundant species. I recognized an underlying common theme: a perceived scarcity of their primary resource and an awareness that they needed to do something about it.

The local problem of resource scarcity in San Felipe is not unique. Globally, marine resources are declining as a result of anthropogenic activities including overexploitation, contamination, ineffective management, and degradation of marine ecosystems (Kooiman et al. 2005, Garcia and Moreno 2003, FAO 2000, Wingard 2000). Of the estimated 38 million people worldwide who fish for a living, roughly 90% are classified as small-scale. An additional 100 million people are estimated to be engaged in fisheries post-harvest, most living in rural areas with few other income options (Béné et al. 2007). Although small-scale fisheries provide more food for more people, with a higher number employed and a significantly lower reliance on costly fossil fuels than large-scale industrial fisheries (Pauly 2009, FAO 2000, Poggie and Pollnac 1991), industrial fisheries receive the majority of capital investments, investments to which rural small-scale fishers do not have access. Rather, small-scale fishing communities in the developing world are subject to what Béné et al. describe as “the general lack of economic, political, and institutional development that affects rural areas in which fishing communities tend to live” (2007:9). While overexploitation, and thus fishers’ behavior, is most often blamed for the decline of marine resources, the problem is more complex, involving global and local issues of human-environment relations.

This was similar to the problem of the Indonesian fishers dynamiting reefs. Just as numerous factors, social, political, economic, contributed to leading the Indonesian

fishers to dynamite this reef in Thailand, so the fishermen of San Felipe are engaged in adaptive behaviors that reflect a complex set of factors and responses to a problem in their environment. The fishermen, experiencing change, are adapting to resource scarcity; I wanted to know how they are adapting and what influences them to adapt in particular ways. This, I felt, was important to understand before implementing some program of reform and regulation, i.e., management.

In examining adaptive responses, this became a study of human behavioral responses to resource scarcity. It was clear to me that the fishermen of San Felipe respond to change in their environment and contribute to change, both cultural and ecological. Also, their social relationships, values, and fishing culture shape the behaviors that I identify as adaptations. In studying adaptation, I am examining a constructed concept where my observations form the framework where I categorize and operationalize the behaviors of fishermen into a concept called ‘adaptation.’

The Research Strategy

This research addresses a particular human-environment interaction that entails two central issues in ecological anthropology and in broader interdisciplinary research: adaptation as a human response to environmental change, and human usage of common property resources. The human-environment interaction is exemplified here as a group of resource users that is responding to common property resource scarcity. Adaptation is the process by which people respond to change and in turn, affect change in their environment, both biophysical and social.

In this section, I explain my research strategy conceptually and methodologically. I begin with a discussion of conceptual approaches to human-environment interactions then lay out how I translate this approach into my research strategy. I next explain how

the two issues that are the focus of my study, adaptation and common property resources integrate with this framework by addressing the applied component of this research: how the study of human adaptation is important to improved common property resource management.

Conceptual Approach to the Study of Human-Environment Interactions

The sub-discipline of ecological anthropology addresses human-environment issues from an anthropological perspective. Ecological anthropologists engage in numerous approaches to examine human-environment interactions such as cultural ecology (Steward 1955), human ecology (Bennett 1993), political ecology (Greenberg and Park 1994), cultural materialism (Harris 1979), or the ecosystems approach (Moran 1990). These approaches involve different epistemologies and methodologies and the sub-discipline should perhaps be named ecological anthropologies. In constructing my framework to address the research questions of this study, I draw from these ecological anthropologies. In turn, my contribution to the sub-discipline is the construction, testing, and reworking of a model of adaptation to common property resource scarcity.

Idealism vs. Materialism

Bennett (1976a) classified three fields of investigation in cultural anthropology: (1) *thought*, emphasizing study of human ideas, values, and goals as shaped by a cultural group, (2) *interhuman activity*, emphasizing relationships between and among individuals, such as within situations of conflict or cooperation, and (3) *adaptive behavior*, which emphasizes the realization of "individual and social objectives through the mobilization of social and material resources." These correlate with research strategies in cultural anthropology where Bennett's first field concerns studies that apply an interpretivist analysis of ideas and values in order to describe or explain sociocultural

phenomenon. In the second, the social component of human culture is emphasized; these are studies that address our social nature as the driver for cultural behaviors. Finally, Bennett's third field of adaptive behavior mirrors a cultural materialist research strategy. Here, human behaviors are related to resources of the material world. Bennett stops short of making Harris' cultural materialist claim that the material world shapes human culture.

Bennett's classification of studies in cultural anthropology roughly corresponds with the research strategies identified by Harris (1979) which reflect a deep-rooted conceptual divide in the discipline: idealism versus materialism. Bennett notes that the three categories of anthropological studies in his typology do not represent isolated fields of study; there is overlap. (While Harris (1979) also acknowledges that neither a purely materialist nor purely idealist approach is capable of explaining the "whole truth" about human culture, he nevertheless scolds those who overlap strategies.) In Bennett's own work, he focuses on adaptive behavior as his topic of investigation where the material world remains the starting point for his understanding of the human-environment interaction, yet he incorporates the examination of ideas, values, and social relationships into his analyses. Adaptive behavior is seen as a human response to a material, physical world that is shaped, in part, by social relationships.

Regardless of this attempt at holism, anthropological research seems rooted in one camp or the other and this remains a divisive issue within the discipline. A materialist epistemology underlies much of the work in ecological anthropology in its focus on human-environment interactions. From the adoption of concepts from the physical sciences, humans are interpreted as another organism in the socio-ecological

system. Yet important studies of the human-environment interaction arise from an idealist, or post-modern perspective, too. The idealist argument that human cognition and culture drives behavior has led to studies that encourage the examination of the researcher herself, demanding her to reflect on the validity of the constructed concepts in the study of the other and cautioning against reification of these constructions. Tsing's (2001) work, in which we are reminded that our own ideas give rise to and influence culture and our approach to the study of the environment, is an example which shapes my approach by reminding me that the concepts I define and measure are not a product of the material world, but rather a product of the study of that world.

Methodological Approach

The difference between a nomothetic and idiographic approach is mirrored in an underlying ideological split in anthropology that separates humanistic and descriptive analyses from positivist, law seeking approaches. Ingold (2008) expresses this as what differentiates ethnography (limited to idiography) from anthropology (ultimately a nomothetic venture), arguing that ethnography is the descriptive component of anthropology. In this study, I begin with an inductive, ethnographic approach to examine behavior that responds to resource scarcity (Chapter 4), then apply a nomothetic analysis of the behaviors that I document in order to examine, and then build on, a model of adaptive responses to resource scarcity (Chapter 5).

A central epistemological issue in cultural materialism is to identify the distinction between etic and emic data. Originally coined in anthropological linguistics, etic refers to the observer's perspective (the scientist) and emic refers to the study participant's perspective. These terms are preferred as opposed to the terms "objective" and "subjective" (Harris 1979).

Because the concepts I am examining, adaptation and common property resources, are etic constructions, I rely heavily on my etic observations to recognize and define adaptive strategies. Yet, it is from an emic perspective that the common property resources are declining. There is also an emic understanding of adaptation and adaptive strategies although this is not an overtly conceptualized process. For example, when I ask fishermen about '*estratégias adaptadas*" to the decline in lobster availability, my informants knew what I was talking about and could describe various coping behaviors. Nevertheless, the idea of an adaptive strategy is still an etic concept.

Research Objectives

This study has three research objectives. The first is to identify the adaptive strategies used among the cooperative fishermen of San Felipe in their response to resource scarcity. Second, the identified adaptive strategies will be analyzed using a model of adaptation to marine resource scarcity, proposed by McCay (1978). Finally, using the analysis in the preceding objective, I will propose a model of adaptation to resource scarcity that can be analytically applied to examine adaptation to resource scarcity in other small-scale fishing communities.

Applying Adaptation to Resource Management

Common property resources are a class of resources that are especially problematic for management. Management is not seen as necessary for things that are infinite, without value, or unreachable; that is, for things that have no use or exchange value. Common property resources are not managed until a sense of scarcity, or their finite limit, is perceived by some class of users. Until that point, users' consumption and use of the resource is not likely to be regulated. The irony is that once scarcity is perceived, it can be a difficult task to implement rules that require behavioral change.

Once a need for management of common property resources is perceived due to scarcity, management of resources can occur at many different scales. Prior to state management, many systems of management existed among communities in order to define access and user rights to shared resources. Yet, such local systems of resource management are weakening under pressure from external factors (Berkes 2001), such as pressure for production for the global market. This occurs when it is difficult for a small community to regulate access to its resource, for example, when new users arrive. When a resource, locally managed as common property, has an exchange value outside of the local community, on the global market, for example, new producers may arrive and contest the authority of local communities to determine user rights to the resource.

Although there is recognition as to the importance of involving local stakeholders in the management process, for this involvement to be successful requires an understanding of the local context, culture, and people's perspective. How are decisions made? How does local knowledge, social structure, stratification, and capital investment influence who does what and why? Where is the seat of local power?

Through a systematic analysis of adaptive decision making, this research develops a framework for enabling policymakers to better incorporate human dimensions in fishery management. It is generally accepted that marine resource management needs to do a better job of integrating humans into the regulatory equation. An important part of the problem is to better understand how common property resource users behave when faced with resource decline.

Field Methods

This study is based on fieldwork I conducted in San Felipe, Yucatan state, Mexico, over a period of 13 months and organized into two phases. Phase I, from June to December 2007, was funded by the American Philosophical Society's Lewis and Clark Fund. Phase II continued from February through July 2008 with funding from a National Science Foundation Doctoral Dissertation Improvement Grant. Following the two phases, I have returned to the community to conduct follow-up data collection, share results, and visit with my research informants. Research was conducted entirely in Spanish.

From the Master's to the Ph.D.

I had spent time in San Felipe prior to beginning my doctoral fieldwork. I first visited the community in December 2004, on an exploratory trip around the Yucatan coast to identify a field site for my master's thesis research on local marine resource management. After visiting several fishing communities along the Caribbean and Gulf coast of Yucatan, I selected San Felipe because of its small population size, lack of foreign tourism, and active small-scale fishing industry. Additionally, during my visits to the docks in other communities, locals solicited tours, often aggressively. On the other hand, on my first day in San Felipe, after explaining my research interests to a fisherman I met on the docks, I was immediately invited to accompany him to check his nets that afternoon. This example came to typify the hospitality extended to me ever since.

I returned to San Felipe the following summer with funding from the Tropical Conservation and Development Program at the University of Florida, and spent three months conducting fieldwork for my master's thesis. A Mexican colleague of a UF

professor gave me the name of one of the cooperative members as a preliminary contact. This fisherman introduced me to the officials of the cooperative who generously agreed to let me conduct my research with them. That summer, I got to know the members of the cooperative, participated on fishing trips, and conducted an interview with a random sample of 34 members of the cooperative (Lasseter 2006).

I visited the community two more times over the following year. First, while working as the graduate coordinator for a study abroad program based in Mérida, the state capital, I presented a poster of my research results to the president and officials of the cooperative. A few months later, with the support of a Practitioner's Award from the Tropical Conservation and Development program, I returned and made a presentation of my thesis results to the cooperative during one of their assemblies. This assembly was also the bi-annual election of new cooperative officials (*directivos*), so I was able to observe an election and congratulate the winners. The newly elected officials invited me to continue working with the cooperative.

During these visits I also conducted a study of fish names and classification with 40 informants and presented the results at the Society for Anthropological Sciences (SASci) conference in February 2007. This project served as the basis for an assessment on local marine knowledge that I conducted concurrent with the study at hand and helped inform my understanding of local adaptation to changing resources.

During these periods of fieldwork, I also developed contacts with Mexican research institutions including UADY (Universidad Autónoma de Yucatán), the largest state university, and CINVESTAV (Centro de Investigación y de Estudios Avanzados), which conducts ecological, biological, and anthropological research in the region, as

well as with CONAPESCA (Comisión Nacional de Acuacultura y Pesca), the Mexican bureau charged with enforcement of the federal fishing laws. Additionally, I have attended meetings and participated on marine excursions with the officials of CONAPESCA and CINVESTAV.

By the time I returned to San Felipe in June 2007 to begin my doctoral research, I was a familiar face in the community. The cooperative and its officials extended their full support and I was granted access to the cooperative office and production facility (*planta*). In the office, the secretary, who became a good friend, provided me with records of daily production. In the production facility, I could observe the fishermen returning with their catch, having it weighed, measured, and entered in the logbook. While waiting their turn and talking amongst themselves, I would ask about their day, questions they would patiently answer, day in and day out. I generally split my time between these two places as well as on the docks in front of the production facility and the street corners where the fishermen would congregate in the late afternoons to talk about their day. I also visited many fishermen and their families in their homes.

Although everyone in the community knew that I was working on a research project with the fishermen, no one seemed able to remember that I was an anthropologist. No matter how many times I would remind even my closest friends, I would overhear them telling weekend visitors that I was a biologist studying the fishermen. People seemed to equate anthropology with archaeology, and everyone knew I was not studying ruins. Overall, there was no real interest in my project. I was frequently asked if I was writing a book about San Felipe, with everyone expressing hope that I would tell people about them. Yet, no one ever asked what I was writing

about. The fishermen have experience with researchers from Mérida who come to the community and ask questions. The researchers are remembered by name and referred to as friends from Mérida. The people of San Felipe always appear comfortable and welcoming of these visitors, including myself, yet their generosity with their time and information never ceased to amaze me.

I finished data collection and returned to Florida at the end of July 2008. In January of 2010, I again returned to San Felipe to update the production data and follow-up on the status of the fisheries. It was also time for the yearly *gremios* (religious guilds) and a perfect opportunity to catch up with friends.

Research Design

One objective of this study is to develop a model of adaptation to resource scarcity that can be applied in other communities to examine how people adapt to environmental change. In order to accomplish this objective, I needed to identify the adaptive strategies used by the fishermen as well as to recognize who engaged in which strategies. I collected data on adaptive strategies by observing how the fishermen adapted to the perceived resource decline and investigating their emic explanations for these behaviors. From this inductive process of identifying adaptive strategies from behavior, I then interviewed a sample of fishermen about their use of the strategies.

In order to tackle the research objective, I planned to collect data on several factors I felt influenced how the fishermen adapted to resource scarcity. From the literature on factors influencing change in socio-ecological systems and from my own observations during prior fieldwork, I selected three factors to measure: local marine knowledge, social relationships, and investment in capital. I conducted separate interviews on each of these factors, detailed below. I conducted the social relationships

interview first, with the entire population of the fishing cooperative. This enabled me to speak with each member individually, early during the project. Following completion of this interview, I conducted separate interviews on marine knowledge and capital investment, including household socio-economic status. These interviews were conducted with a random sample of the population (detailed below). Finally, I conducted a fourth interview with this same sample, which investigated perceptions of the environment and how the fishermen were adapting to the decline in their primary resource.

Although I originally assigned the three factors to be the independent variables in the study, I relinquished them to supporting data for the duration of this study. For example, through participant observation detailed below, I came to understand that capital investment is actually a dependent variable; that is, it is one of the adaptive strategies that the fishermen use, at the long-term scale, in adapting to resource scarcity. The rest of this chapter details the field methods used in data collection. Participant observation, the four interviews, and collecting fishing production records are addressed in turn with relevant analyses taken up in subsequent chapters.

Participant Observation

As is common to anthropological fieldwork, participant observation was my central research tool. I lived in the community full-time and rarely left. Once every three weeks, I would make a day trip to Tizimin, a one hour bus ride to the south, to make purchases and use the internet. The fishing cooperative served as my host institution and I typically spent my weekday mornings in their office with the secretary. During the afternoons, I loitered around the production facility and docks, talking with the fishermen as they returned from the day's fishing. In the evenings, I would return to the office where the

fishermen arrive to receive cash for the day's catch and to settle their account and debts. When not in the office, I would find fishermen at their street corner hangouts or visit homes to conduct interviews.

I also participated on fishing trips, including lobster diving, using bamboo outrigger poles (*jimba)* to catch octopus, longline (*palangre*) for grouper, trolling for barracuda,[4] and different types of net fishing. On these trips with fishing crews, I asked questions and took notes on their skills, knowledge, and use of technology. I also documented how they responded spatially to changes in the resource abundance during the fishing season by recording GPS waypoints for fishing locations. I also went with the women who wade in the estuary at night for the crabs used as bait to catch octopus. I traveled to Mérida with the cooperative officials in the refrigerated truck to sell their catch to the regional exporter. There, I was able to watch the unpacking of the truck and learn about the company to whom the cooperative is obligated to sell all of its lobster. Finally, I attended all cooperative assemblies which helped me understand how the cooperative worked and the politics behind decision-making.

The fishermen of the community, my research informants, were not financially compensated for their participation in this study. I did give out small gifts such as SCUBA dive flag stickers and American baseball team caps to informants who invited me fishing or who spent additional time with me, answering my countless questions beyond the interview schedules. Given the difficulty I had in buying a round of drinks

[4] The risk of ciguatera poisoning that is common to barracuda and other upper trophic level species elsewhere in the Caribbean and south Atlantic is not a problem in San Felipe. This is likely due to the relative lack of coral in the Gulf of Mexico. Without tropical coral, the dinoflagellate that produces the ciguatera toxin (and that lives within the corals) is not present to pose a health risk.

when it was my turn in social gatherings, I believe that most fishermen would have felt awkward in taking money from me.

Many of the fishermen are members of softball teams and I regularly attended their weekend games in the *campo* at the edge of town. I was jokingly nominated to be the godmother (*madrina*) of one team. The wives of this team's members became my closest female friends: a group of women also in their 30's, all with children. Because of the size of the group and number of children, there seemed to be a birthday or some other reason to have a gathering at least once a week. We would eat *botanas* (snacks) that the women would bring, pot-luck style; the men would make sure everyone's beer was cold by constantly replacing half-consumed bottles with new ones.

During the first few months of fieldwork, in all of the settings mentioned above, I engaged in informal conversations with the fishermen about their livelihoods and perceived changes in the fishery. These conversations built on data collected in 2005, for my master's thesis. I talked to fishermen about the types of things they did when fishing was bad. I asked them about why they thought their catch was poor and how they make decisions on where and how to fish from one day to the next. I observed how some fishermen seemed to always return to port early; others always returned late. Many fishermen were still fishing with the same crew since I first met them years before, while others changed crews each season. I asked them why they fished with a particular crew, or why they had changed crews. I listened to what they talked about with each other while waiting to weigh the day's catch. With these observations, I began to develop a list of adaptive strategies that the fishermen seemed to use. Then, I began talking with them about the list, inviting their corrections and opinions.

Interviews

In addition to the data collected from participant observation, I conducted a series of four interviews. The first three separately addressed factors that I felt influenced adaptive decisions: social relationships, marine knowledge, and capital investment. Although I originally intended these factors to be the independent variables in the study, I relinquished them to supporting data as the study became too big for one dissertation. The fourth and last interview addressed how fishermen were adapting to the decline in their primary resource. Because I knew from prior fieldwork that the fishermen were mistrustful of recording devices, interviews were not recorded. Rather, I took extensive notes during the interviews.

The 124 members of the fishing cooperative[5] made up my sampling frame and I began by acquiring a list of the full names for all members from the cooperative's secretary. While I had met most of them, I could not attach names with faces for all 124 fishermen. I began, then, by adding the nicknames to the list of fishermen. As is common in many places in Latin America, most people are given nicknames (*apodos*) when they are children and often, these nicknames remain for life. Carrying my list of 124 fishermen to the office in the evenings, I began asking the groups of waiting fishermen to help me fill in each other's nicknames. This exercise helped me to reconnect with those fishermen I had interviewed previously and to begin building rapport with those with whom I barely knew. There was competition to explain the origin of various nicknames and in the process of verifying the names with their owners, I found that some, in fun, had used the opportunity to try to assign new nicknames.

[5] One member died four months after I began fieldwork, as discussed below. For this reason, only 123 fishermen were interviewed about their social networks.

It was my experience that all of the fishermen were open to participating in my interviews. Some of the older men were more difficult to locate, but were always patient with my questions. In fact, once an interview began, I was usually the one who had to end the interview due to another appointment. There is one thing that can never be underestimated: fishermen enjoy talking about fishing.

Social Relationships Interview

During Phase I (June to December 2007), I conducted the interview on social relationships with all cooperative members using the list of cooperative members' names and nicknames. This social network analysis interview was designed as a whole network study, meaning that every member of the population was interviewed and asked about other members in the population. The purpose of the interview was to elicit information about the social relationships among the members of the community, looking specifically at structures of trust and flows of information and knowledge. The cooperative had 124 members when I began, however, one member died in a tragic dive accident before I had interviewed him (see Chapter 4).

I consciously decided to conduct this interview first. Because this was the only interview that I would conduct with the entire population of fishermen, it would provide me the opportunity to have at least a short conversation, individually, with each cooperative member at the beginning of the study. By the time I was finished, I could easily recognize and name everyone, and because we had spoken one-on-one at least briefly, I felt comfortable approaching them on the docks or around town, to ask about fishing.

I began each interview by asking the informant about kinship with other members, past service as an elected official in the cooperative, and crewmates. Then, the

informant was provided with a laminated list of the cooperative members' names (and nicknames) and given a hypothetical situation where they are asked to identify five other members to whom they would go to 1) for emergency financial assistance, 2) to discuss regional and national politics, 3) to discuss local issues and politics of the cooperative, and 4) to talk about fishing, such as locations and strategies (Scott 2000). Finally, each participant was asked who they believe to be the five most successful (*mejores*) fishermen in the cooperative. After they named the five people, I asked why each of those fishermen was the 'best.' This interview took approximately 10-15 minutes for each fisherman.

Sampling

I left the field for approximately one month before beginning Phase II in February 2008. While I was away from the community, the cooperative held an assembly in which seven members were expelled for insufficient production or for not selling their catch to the cooperative. Applications for new members were under consideration when I returned. This was a highly unusual action on the part of the cooperative and I had to decide how to proceed with my interviews. I planned to conduct the remaining three interviews with a random sample of the cooperative members. Before taking the random sample, I removed the names of those cooperative members who had been expelled, one member who had died, and the names of the officials of the cooperative, as they do not fish while serving their term and thus, would have no current fishing data for me to use in subsequent interviews. I was left with 111 individuals in my sampling frame, from which I took a random sample of 50 fishermen, representing 45% of the population. I ultimately removed three individuals from this sample owing to unforeseen difficulties.

That month, one of the sampled fishermen had a dive accident that left him paralyzed from the waist down. Despite the prognosis of several doctors that he would never walk again, when I visited in 2010, he had rehabilitated himself enough to walk with assistance. Nevertheless, it is unlikely that he will be able to return to fishing, let alone resume diving. As my neighbor, I talked with him and his wife frequently over the next few months, but I removed him from the interview schedule. It did not feel appropriate to interview him about adaptive strategies as the fishery declined. His wife has since opened a small café on the side of their home and is building up a good local business. This move was clearly in response to her husband's inability to economically provide for their family.

Two other fishermen from the sample are among the oldest members of the cooperative. In general, I found it more difficult to schedule interviews with these members, as they usually send younger crew members to weigh in the day's catch and to collect the day's money. These fishermen also do not frequent the gathering spots as often as do the younger men. One of the two owns a ranch where he spends most of his non-fishing time, while the other, when I could find him, continually told me to come back tomorrow to be interviewed. Unfortunately, he was never home "tomorrow." I had frequent conversations with each of them over the year and they were always generous to provide whatever information I asked. However, I was not able to complete the formal interview schedules during these times. I therefore conducted the following interviews with 47 of the sampled fishermen.

Marine Knowledge and Capital Investment Interviews

The knowledge and capital interviews were conducted from February to July 2008. I enlisted a field assistant, a local young woman who had completed high school and

was planning to begin college in Cancún in the fall, to assist in conducting these two interviews.

The marine knowledge interview was based on Garcia-Quijano's (2006) Ecological Knowledge Assessment, used in his doctoral fieldwork in Puerto Rico. Garcia-Quijano asked a series of questions about 16 salient species for the fishing communities he studied. He asked, for each of the species:

1. In what kind of environment are they found? (asked as open-ended question and asked as multiple choice question)
2. At what time of the year are they found?
3. Are the species found alone, in groups of the same species, or in groups with other species?
4. What kind of fishing gear is used to capture each species?
5. Are the species responsible for ciguatera poisoning?
6. At what depth are the species caught?

I selected the 16 salient species from a free-listing exercise I completed during a field visit in 2006. From informal interviews and participant observation, and then reinforced when I pretested the interview, I found that questions number two and four were common knowledge within the community. Because these are the most salient species, even non-fishers knew when they were available and how they were caught. Due to the lack in variation regarding this knowledge, I eliminated these questions from the interview schedule. I also suspected that I may not find great variation in knowledge for the remaining questions.

Question number five posed another dilemma—there is no known occurrence of ciguatera poisoning along this part of the Gulf of Mexico coast. I had discussed ciguatera poisoning with San Felipe's fishermen, all of whom expressed awareness of

the toxin affecting fish caught in waters surrounding coral reefs in the Caribbean, but not in local waters. From my interview conducted in 2005, the most frequently cited environmental toxin on this coast was red tide. I therefore replaced the question about ciguatera poisoning with a question about the cause of red tide events. Finally, I added one other question about marine knowledge, designed to illicit knowledge of trophic relationships among marine species.

During data analysis following fieldwork, it became clear that the data from this interview did not contribute to my examination of adaptation. I had expected to find the fishermen with the highest level of cultural consensus to be the most knowledgeable, as had been shown in work by Boster and Johnson (1989). Instead, there was very high cultural consensus among the fishermen of San Felipe for most of the knowledge I investigated. Those individuals who deviated from the consensus are actually the most successful in terms of consistently good catches; when most other fishermen have poor fishing trips; these individuals still find fish. These very interesting results will be pursued elsewhere as they do not inform my particular question on adaptation. I mention it here because (1) knowledge was a factor tested in the field and, (2) the divergence from cultural consensus correlated with my observations of fishing success and I will return to discuss the case of these fishermen in Chapter 4.

A separate interview collected data from the same individuals in the random sample, concerning their investment in fishing and terrestrial (i.e., ranches) capital. The interview also included socio-economic questions about household members, their income activities, and household ownership of consumer goods (cellular phones, household appliances, etc). This interview provided data to compare adaptive strategies

of investment: some fishermen are investing in terrestrial capital such as cattle and ranches while others invest in additional fishing equipment such as nets and new GPS devices.

Fishing Production Data

With the daily assistance of the cooperative's secretary, I collected the daily production data for each of the sampled fishermen for the entire 2007-2008 fishing season. Because of the importance of lobster to the community, the beginning of each year's season is recognized on July 1, the start of the lobster season. Therefore, the 2007-2008 fishing season extends from July 1, 2007 to June 30, 2008.

At the time of research, the cooperative's accounting was conducted using a DOS operating system on a very temperamental computer. The secretary was only able to grant access to the production records via printed hard copies that she would produce for me. This required many hours of tedious data entry, and research assistants helped greatly in digitizing this body of data. Additionally, to monitor crew composition, I needed to code the handwritten daily logs from the production plant. This task fell entirely on me, as I learned the secretary's handwriting and was able to decipher his shorthand for the 124 members of the cooperative.

I thus maintained a spreadsheet of the daily harvest totals of all members, including crewmates. This data reveals who fishes together each day, how much was caught of each species and how the catch was divided. The day's fishing technology is also evident from the data based on the species present. For example, some species are caught only by diving (hogfish, lobsters) or nets (sea trout). I also asked fishermen what gear they were using at particular times, or observed the gear present in their boats for clarifying gear types.

During the months of April, May, and June, few cooperative members are regularly engaged in fishing. The seas are rough, the water is turbid, and the limited catches available do not regularly cover operating costs, such as fuel. Most of those who continued to fish did so for subsistence production, especially the harvest of *campechanas* at night. Campechanas are a type of whelk. They are one of several species that are commonly eaten in the Yucatan, usually boiled and used in *ceviche*, a regional specialty. Both men and women will harvest campechanas, taking small, motorless boats (*alijos*) into the estuary at night and wading in the shallows where the animals are found.

Using the production data I had collected since July, I compiled production reports for each fisherman in my random sample during this time of slow fishing activity. The reports included the total kilograms of lobster caught per month of the season and the total number of days per month that he went to sea. I also included his daily production including how many kilograms of each species was sold to the cooperative since the previous July and with whom he fished each day. As I compiled each individual report, I added questions particular to that fisherman's activity. These questions addressed changes in crew composition and reasons for changing gear type as well as other questions I had for the participant based on observations I had made of their fishing activities. I then used these reports in the adaptive strategy interview discussed next.

Adaptive Strategies Interview

I conducted all of the adaptive strategy interviews with the sampled fishermen from May to July 2008, beginning with those who had ceased fishing completely by that time. This interview involved two components. One was a standard interview schedule administered to all participants. This interview consisted of Likert-type questions to

investigate the use of various adaptive strategies and open-ended questions that investigated perceptions of the environment and changes in fishing behavior in response to decreasing harvests and resource scarcity. I compiled the list of adaptive strategies from informal interviews and observations made throughout the preceding months. For the second component, I used the individual report created for each fisherman's production and wrote questions regarding the particulars of that individual's fishing activity, as noted above. The report was used to elicit a narrative of the fisherman's activities throughout the season and to aid in informant recall.

Reflections on Being a Researcher

When I initially decided to study small-scale fishing communities, my primary concern was whether it would be possible to conduct fieldwork as a woman. Where I worked in Thailand, it was taboo to have a woman on a fishing boat. Although in many small-scale fishing economies, women are engaged in production once the catch reaches shore, they do not go to sea. I was concerned that local norms of gender roles would limit me, as a woman, from building rapport and conducting in-depth ethnographic observations in small-scale fishing communities.

Reflecting on my social interactions in San Felipe, I found it very easy to develop relationships with people in the community. My attendance at non-fishing activities, such as the softball games, enabled me to meet the wives and families of many of the fishermen, as well as people in the community who were not engaged in the fishing industry. I was frequently asked about my marital status and why I did not yet have children. As I was in my early 30's, everyone did their part to help identify local bachelors with whom I should marry so that I could stay in San Felipe forever. Despite

my comfort in the community and the friendliness of the people, I was always unsure about my social position in the community.

I felt that my experiences in San Felipe were not the norm for anthropologists. While there are many anthropologists that build rapport in the communities of their research, beginning lifelong work with their informants, many also struggle to build trust and to feel welcomed. Many people in rural communities are suspicious of outsiders who come to do research on them. While writing this manuscript, I am working in a fishing community in Florida where I frequently encounter suspicion as to my agenda. Upon hearing I am a scientist, people specifically ask me to explain my agenda before agreeing to share information. In their experience, science and advocacy blur producing results that never side in their favor. Alongside these issues of trust, female anthropologists working principally with male informants face additional issues that can be tricky to negotiate.

In San Felipe, I knew my ability to talk with fishermen about my experiences and knowledge of diving, catching lobsters, and marine life helped me to build rapport with my male informants. The questions I posed in formal interviews and informal conversations related to their concerns in fishing livelihood or their knowledge of marine life. I never had trouble getting the fishermen to talk to me about fishing. I could sit in the park under the cypress trees with the fishermen and gossip with them, or hang out on the street corner where they gather in the evenings showing off photos and music on their cell phones.

Yet, although I was able to attain a very comfortable social position among the fishermen, I recognize that locally, for a woman to be friends with men, in the way that I

regarded many members of the cooperative as my friends, violated cultural norms of behavior. The fact that I appeared to accomplish this level of friendliness and also maintain my standing among the community's women, speaks to the fact that I continued to be viewed as an outsider. I was someone to whom a different set of rules applied. These places that I engaged the fishermen in conversation, under the cypress trees and on the street corner, were male spaces. Women in the community did not socialize in these spaces with the men. A wife who might need to send a message to her husband, approaches the space but maintains her distance. Her husband sees her and leaves the space to go to where she waits, often on an idling motorbike.

While I could visit these spaces where groups of men were present, I noticed that if the group had trickled away and I was left alone with but one individual, he would politely excuse himself and depart for home. The set of unspoken rules that defined my position in the community extended to the homes of the fishermen. If I arrived at a home to conduct an interview when the wife was out, my informant would carry two plastic chairs onto the front porch for us to sit and talk in public view.

I did not find these unspoken rules restrictive to my research. Rather, they seemed to be people's way of negotiating me into their lives in a socially acceptable way. This was not an overnight process. I worked hard during my early months in the community to alleviate the concerns of some fishermen's wives, eventually becoming friends. Overall, however, I believe that my success in negotiating gender roles in order to work with male informants had less to do with my own efforts, than with the generosity and warmth of the people who opened up their lives to me.

Outline of Dissertation

In the following chapters, I explore the concept of adaptation to resource scarcity in San Felipe. I begin, in Chapter 2, with a theoretical review of the concept of adaptation, both within anthropology and other disciplines, focusing on conceptualizations that are relevant to examining how humans respond to environmental change in the form of common property resource scarcity. Chapter 3 describes San Felipe as a fishing community in Yucatan, Mexico, and I provide an ethnographic account of the community itself. In Chapter 4, I use the theoretical framework of adaptation to narrate the stories of how several fishermen are adapting to resource decline. I also discuss the factors that circumscribe the available options, including cultural, economic, and political. Chapter 5 applies the adaptive strategies of the previous chapter to a model of adaptation to marine resource scarcity proposed by McCay (1978) to make a comparative analysis. In Chapter six, I place the examination of human behaviors in the social context. Here, I discuss how the social structure of the community of fishermen, defined as the cooperative, intersects with the adaptive strategies of the individual members. Chapter 7 brings the study up-to-date, two years after departure from the field. I revisit the concept of adaptation and discuss how recent changes are positively affecting community management.

Figure 1-1. San Felipe's coat of arms depicts the three most important industries of the community: fishing, ranching, and tourism (represented by the beach with palm trees). The pre-Hispanic name of the community (*Actan Chuleb)* is also included.

Figure 1-2. Hurricane Isidore struck San Felipe in 2002 and caused extensive damage to homes. Following the storm, the people rebuilt and later won recognition as Yucatan state's cleanest community, an award recounted to me numerous times. The sign above says, "San Felipe is a clean municipality and is our pride." In the foreground is a *triciclo*, the preferred transport of fishermen for shuttling their fishing gear to the boats in the morning.

CHAPTER 2
ADAPTATION

Human Adaptation to Common Property Resource Scarcity

This dissertation focuses on the concept of adaptation as a mechanism for addressing how humans respond to common property resource scarcity. The concept of adaptation has had a long history in anthropology where it was been heavily criticized and ultimately avoided. Recently, the concept has seen a revival, principally within the literature on resilience and environmental change, although now it is being used more frequently by anthropologists as well. I defend the use of the concept where it is used in a clearly defined way, to discuss the human-environment interaction to change. In the second part of the chapter, I situate the conceptual examination of adaptation within the literature of common property theory and political ecology in order to contextualize the problem as a regional and global issue. I then lay out my approach to operationalizing the concept and discuss how it is applied in my study of human adaptation to resource scarcity.

Adaptation in Biology and Evolution

Many of the issues with the concept of adaptation arise from its earlier use in evolutionary biology where it is defined as a process of change at either the individual physiological scale or at the multi-generational evolutionary scale (Alland 1975). When taken out of biology and evolution and applied to socio-cultural phenomenon, tenets of the concept become misunderstood. Lamarck offers a well-known example from the early 19th century (Barnard 2000), arguing that individual organisms change to better adapt to their environment, and that these changes, or acquired characteristics, are then passed to subsequent generations. Here, adaptation defines a particular

relationship between organisms and their environment; one where the environment actively shapes organisms. However, Lamarck's idea that acquired characteristics could be passed on to offspring was a confusion of the process of biological adaptation and evolution.

Nevertheless, Lamarck influenced Darwin's idea that those organisms that were better able than others to survive in a particular environment would succeed in passing down their own genes. Malthus' pessimistic ideas on human population also contributed to Darwin's idea that more individuals are born than survive to adulthood, integrating competition into the equation. This ideological procession was furthered by Spencer who took the concept of biological evolution and superimposed it onto a scheme of cultural evolution (Peet 1985, McGee and Warms 1996).

In biology, adaptation refers to "an evolutionary process by which an organism becomes adjusted to its environment; a feature fitted through natural selection for some special activity" (Jones et al. 1992). Burton (2009) writes that by definition, the word 'adapt' applies to both social and biological processes and this multiple usage might have contributed to the way adaptation fell out of favor among anthropologists, as it seemed equated with, or carried the 'intellectual baggage' of social evolution or social Darwinism, as discussed above. As a concept to explain the relationship between humans and their environment, adaptation was seen as overly deterministic. Nevertheless, the important part of the definition that I will return to following this review is noted by Smit et al. (2009) where *adapt* means to 'make more suitable (or to fit some purpose) … by altering (or modifying)." Through adaptation, humans do not only

respond to changes in their environment, but also actively modify their biophysical environment.

Adaptation in Social Sciences

The concept of adaptation has a long and contentious history in ecological anthropology. Since adaptation was first introduced into anthropology by Julian Steward and Leslie White, the concept has been criticized for representing the environment as a stable backdrop (Winterhalder 1980) or a closed system of energy flows (Orlove 1980). Outside of anthropology, it was criticized primarily as overly environmentally deterministic (Peet 1985).

In Steward's cultural ecology, culture *adapts* to the environment through "similar patterns of adaptation of technology and certain social forms to the environment" (Steward 1955:123). Although fundamentally functionalist and materialist in its explanations, Steward's emphasis "is to seek causes of cultural change" that arise from different environments, noting that adaptation is a "creative process" (1955:5). When cultural ecology is criticized as overly environmentally deterministic, a misunderstanding of cultural ecology may be to blame (McGee and Warms 1996). Steward emphasized how humans employ technology and labor to exploit their environment, and carefully noted that cooperation, rather than competition, is often employed as a human adaptation to environmental problems.

Adaptation has also been interpreted, and criticized, through the frameworks of cultural evolution (Sahlins 1977, White 1959) and cultural materialism, which depended on functionalist explanations of human behavior (Harris 1966, Rappaport 1968). For example, Rappaport's *Pigs for the Ancestors* (1968) was criticized for its portrayal of a closed, finite system that sees cultural behaviors as regulating institutions of resource

use in order to “maintain homeostasis in and among themselves.” Thus, warfare serves as a Malthusian form of population control within a system that self-corrects toward equilibrium. The study also received criticism for neglecting to examine the broader context in which cultural traditions existed and for ignoring how humans’ adaptations to an environment actively transformed that environment.

Optimal foraging theory, still a dominant explanatory framework used in archaeology, also presents adaptation in an evolutionary ecological sense (Ingold 1996). This represents a fundamental contradiction between cultural anthropology and archaeology (Crumley 1994). In the absence of material evidence of cultural data that might reveal preferences or other social norms of behavior, archaeology relies on an assumption that early humans were economic maximizers of the resources in their environment. This explanation has the benefit of parsimony, yet relies on the view that all early human decision-making focused on work-for-food calculations. Human ecology still applies such a model in its analyses of human behavior although most other current cultural anthropological approaches reject this staunch formalist approach to human-environment relations. The human ecology approach, however, does offer a framework with which to examine behaviors at the scale of the individual and I will return to this approach in Chapter 5.

Largely as a result of the heavy criticism against the preceding approaches’ interpretation of cultural traditions as adaptations to a finite environment, the term adaptation fell out of favor. Approaches that incorporate the broader system, either by utilizing the ecosystem concept or a multi-scalar political ecology approach (see below), replaced long-held notions of environmental equilibrium. These new approaches more

successfully integrate change in the analysis of human-environment interactions, reflecting how both humans and their environment influence one another (Ingold 2000). With the literature on resiliency and climate change, the concept of adaptation has since seen a resurgence.

Adaptation in Resilience Theory

The concept of adaptation is frequently used in the literature on resilience which originates with ecologists and aims to integrate social processes in the examination of socio-ecological systems of change. *Resilience* is a conceptual tool used to analyze and interpret observed patterns in socio-ecological systems (Carpenter et al. 2001) in order to address "adaptive change" (Holling et al. 2002:21). The concept of resilience incorporates the inherent unpredictability of the numerous factors in complex systems by assuming that unexpected change is a part of all socio-ecological systems (Holling 1973) and views humans and their constructed and natural environment as inextricably connected (Westley et al. 2002). A system that experiences social, political, or environmental disturbances while maintaining its identifiable features is defined as *resilient* (Walker et al. 2006). Adaptive capacity is then defined by Holling (2001) as "the resilience of the system."

The adaptive cycle is another concept used in the resilience literature, a model represented as a variation on the infinity symbol. Representing a theory of change, the cycle has four stages: exploitation, conservation, release, and finally, reorganization (Holling 2001). This model is used to explain change in both social and ecological systems, does not include an evolutionary component, and views systems as chaotic and unpredictable as opposed to stable and equilibrium-seeking.

When a system fails to maintain its identifiable features, it may *flip*. In the event of such a flip, or *regime change* (Gunderson and Holling 2002), the designation of who is resilient may change as well. The most resilient (individuals) in the previous system, i.e., those who managed to adapt to preserve a state of continuity the longest, may become the most vulnerable and even marginalized group within the new socio-political structure; while those seen as less resilient within the previous system and who adapted new livelihood strategies before the flip, are actually better positioned in the new regime. Thus the paradox arises of how to define coping strategies as adaptive or mal-adaptive, in a constantly changing system.

Adaptation and Climate Change

The recent explosion of literature on climate change has coincided with a renewed usage of the adaptation concept, but with varied definitions. Within much of the climate change literature, the unit of analysis is often a nation, region, or a broader, global effort of responding to climate change. The concept of adaptation is presented as a deliberate, concerted human effort alongside mitigation of climate change impacts. Some of these definitions of adaptation include:

- a planned and organized response, such as in the preparation of National Adaptation Programs of Action (NAPAs) (Smith et al. 1996);
- ‘‘adjustments in ecological–socio-economic systems in response to actual or expected’’ effects and impacts of particular stimuli (Smit et al. 2000 and 2009);
- that which “will help to minimize adverse impacts, and maximize benefits,” noting two types of adaptation: autonomous and planned (Pittock and Jones 2009), differentiated by whether impacts are anticipated or not, and whether the human response is deliberately made to protect “desirable” features. (The authors put the word *desirable* in quotes, deliberately leaving the definition of what and by whom, unanswered.)

As employed by these authors, these definitions share a conscious, deliberate attempt to predict the impacts and thresholds (i.e., assess risks) in a changing climate. Those predictions will enable the proposed human behavior modification.

Another feature of this reworking of the adaptation concept is its frequent use in contrast with vulnerability (Amadore et al. 1996, Kelly and Adger 2000). Thomas and Twyman (2005) cite a high level of vulnerability and a low level of adaptability as correlating with “a high reliance on natural resources” and “a limited ability to adapt financially and institutionally.” Adaptive strategies are attempts to reduce vulnerability (Acosta-Michlik and Espaldon 2008), a statement contradicted by Kelly and Adger (2000) who emphasize that “adaptation is facilitated by reducing vulnerability,” not “adaptation reduces vulnerability.” These studies do not reference previous theoretical work on adaptability and vulnerability, but rather define them in relation to one another and assign values where adaptability is desirable and vulnerability is undesirable. This conflicts with Bennett’s work, discussed below, regarding the care scientists must take to avoid assigning value to adaptation. Linking the two concepts together in such a way also obscures the more complex processes that may create conditions of vulnerability and adaptability that are not related to one another in such an inverse relationship.

A more useful conceptualization of vulnerability and resilience is to define the concepts as occupying a dialectic relationship with one another (Aguirre 2007). In this approach, adaptability and vulnerability are not restricted to opposite sides on a scale of resilience, where increasing adaptability is equated with improved resilience and a decrease in vulnerability. Rather, they are processes that operate within complex social systems consisting of “systemic interdependences and inter-effects” (Aguirre 2007:41).

Adaptability is not equal to resilience. Adaptations that may reduce vulnerability to one threat may create vulnerability to another, or such adaptations could raise the vulnerability of another population. As noted by Bennett (1976a), care must be taken not to assign value to the process of adaptation. Vulnerability, on the other hand, is a condition with a defined value attached to it: it is an undesirable condition where people are susceptible to some form of harm.

Community Studies of Adaptation

While the above citations are representative of the common use of adaptation in the climate change literature, some other recent work examines short-term climatic change events and instances of resource scarcity. These events are used as proxies for global environmental change. The authors describe their research subjects, principally rural agricultural peoples, as resourceful in their responses and adaptations to external disturbances and change, provided that there is the capacity to adapt (Thomas and Twyman 2005).

A 2008 issue of *Global Environmental Change* explored the adaptive strategies of rural farming communities. In one of the papers, Carr writes that for farmers in Ghana,

> "adaptation is not a change in a single behavior, but a suite of beliefs and practices related to risk and its management that takes shape under locally specific conditions of uncertainty. In a setting where individuals experience ongoing challenges to their well- being as a result of ever-changing economic and environmental conditions, these beliefs and practices become integral parts of everyday decision-making about life and livelihoods, making adaptation and livelihoods inseparable" (2008:693).

Social, economic, geographical, historical and institutional factors are noted for the part they play in defining a community's ability to adapt to change, and reflect why communities facing similar environmental stress may respond differently (Acosta-Michlik et al. 2008). Although not labeling their analyses as political ecology, the integration of

these complex factors reflects the usefulness of using a political ecology framework to address how people adapt to resource scarcity. Numerous factors both create the problem and circumscribe the options available (and desirable) with which to respond.

Not all adaptive options are viable in every community. For example, historical processes of land marginalization have left farmers with plots too small to make strategies such as reduction of water use (Liu et al. 2008) or irrigation (Kelkar et al. 2008) practical. Geographical distance and lack of market information can limit adaptive diversification of crops due to inability to exploit new markets (Saldaña-Zorrilla 2008).

Kelkar et al. (2008) found that socio-culturally based adaptive strategies may entail impacts that increase, rather than reduce, vulnerability. These include strategies such as taking loans or seeking wage labor outside of the community. Among agricultural households, a common last resort solution to water scarcity is migration (Acosta-Michlik et al. 2008), which includes both internal and external migration, principally in countries like Mexico due to their proximity to the US (Saldaña-Zorrilla 2008).

Other adaptive strategies identified among these studies include planting less water-intensive crops, irrigating fields, selling land, valuables, or livestock, looking for other jobs (largest percentage), and finally, emigration (Kelkar et al's study in India). Liu et al (2008) note specialization as an adaptive strategy, pointing out the need for local innovators to promote the production of specialty crops. Finally, Acosta-Michlik and Espaldon (2008) identify 19 adaptive strategies of farmers, including migration, and rank them in order according to preference among farmers. The undertaking of spiritual practices, i.e., to pray, ranked highest as a strategy with other strategies such as

diversification of crops and livelihood strategies, seeking help and borrowing money, ranking lower.

Carr (2008) writes that these studies employ empirical research to examine adaptive decisions in specific places and not as arising from general theories. They therefore recognize that the specific “knowledge and experience” of the people is given weight over external theories, i.e., “expert knowledge.” Also, “they highlight the fact that particular adaptation and coping decisions are not only the result of complex interplays between consumption and production decisions, but [are] also shaped by complex and locally specific social considerations.” And “approaching adaptation decision- making through an examination of the persistence of particular adaptations does not overlook the role of individual agency in shaping outcomes, but makes clear that individual decisions take place in a social context that is beyond the control of the individual decision-maker, and must be answered to if a particular decision is to become a socially sustainable adaptation” (2008:690). This reflects the ideas of both Bennett and Giddens, discussed above.

Thus, the above group of studies uses empirical observations of communities experiencing change in the developing world to identify adaptive strategies of natural resource users. The authors measure the frequency or preference with which some of the strategies are employed, but do not offer an explanatory model for the process of adaptation. Only one such model is suggested, diversification versus intensification, to which I will return to below.

Adaptation According to Bennett and Giddens

The work of two additional social scientists deserves mention here as I draw on their precise use of adaptation in developing the approach I take in this study: Bennett

and Giddens. Bennett defines adaptation as, “the patterns and rules of social adjustment and change in behavior by individuals and groups in the course of realizing goals or simply maintaining the status quo” (1976a:269). He notes that the adaptive process is an etic concept; adaptations are recognized by an observer and those engaged in the system under study may or may not recognize their adaptive behaviors consciously. This is important to remember: adaptations are human behaviors in response to change and the concept of adaptation, as also noted, should “never be used by the scientist in an unconscious valuational sense… Adaptation is not inherently good or bad; it is … simply coping, and coping can contribute to desirable or undesirable consequences” (1976a:252). As such, strategies that are adaptive for an individual may be maladaptive for the group (Bennett 1993).

One of the current issues within discussion on resilience, vulnerability, and adaptation concerns the valuation of these concepts. Resilience and adaptability are conceived of as desirable and vulnerability is undesirable. By defining values to processes, political decisions are made as to their outcomes, which cannot be predicted. While we can discuss desired outcomes of adaptations, only the results may be observed and analyzed, then interpreted as “good” or “bad.” Thus, researchers must avoid the assignment of values before behaviors have been identified. To give Gunderson and Holling’s (2002) example, a dictator may control a resilient regime that is difficult to overthrow. Because of a political perspective, the ruler is defined as a dictator and the regime is seen as undesirable.

Bennett also noted that adaptation includes coping which is evidenced by accepting the status quo and reducing one’s consumption. As opposed to adaptive

strategies, coping involves adjustments people make in order to integrate change into their lives. Bennett further points out that adaptive strategies may occur at multiple time scales, from immediate, short-term decisions, to long-term plans with “sustained effects” (1976a).

Giddens also emphasizes the ambiguous nature of the adaptation concept but allows for a social science definition seen as “the gamut of processes whereby human beings respond to and modify features of their physical environments” (1984:233), where processes are defined as responses to specific features or changes in the environment. Giddens stresses that if adaptation is used in this narrow way to refer to a response to a specific change, then the concept cannot be broadened at the same time and used “as a general mechanism for social change” (1984:234). Such an extrapolation of the concept is a common and spurious occurrence within social thought. When adaptation is broadened to such a degree, it becomes “so vague that it is useless as a means of explaining anything at all” (1984:235). Finally, he notes that when adaptation is used as a specific response to a specific change, care must also be taken against using simple functionalist explanations.

Adaptation and Technology

The preceding discussion treated the concept of adaptation as a process of response to change. This study involves a different type of adaptation through the use of technology that allows the fishermen to breathe underwater. The innovation of diving on compressed air was introduced to the fishermen in the 1970s and enabled them to (1) remain submerged for longer time periods and (2) target deeper waters. These two factors, diving for longer and deeper also offered more time for them to observe the marine environment first hand. The technology of diving, then, entails the development

of a new type of fishing knowledge, one based on direct first-hand observation as opposed to surface-based fishing.

Common Property Theory

Marine resources are common property resources, a class of resources that has an extensive history of study in the social sciences (McCay and Acheson 1987, Baden and Noonan 1998, Dolsak and Ostrom 2003). Early common property theory focused considerably on disproving the assumptions within Hardin's 1968 essay, "The Tragedy of the Commons" (McCay and Acheson 1987, Feeny et al. 1990, Berkes et al. 1991). In this section, I will review the early work on common property before addressing the two directions in which common property theory is currently engaged: adaptive governance of the commons and the examination of how internal community variation impacts the success or failure of resource management.

Fundamentally about property rights, an early body of work on common property theory emphasizes that many small-scale communities of resource users engage in systems of local management, successfully employing two features to avoid the Tragedy: the exclusion of outsiders and the regulation of use by those who are permitted access (Ostrom and Schlager 1996). In Hardin's scenario of an open access resource populated by self-interested, rational resource users, the Tragedy *is* inevitable. But, what the commons literature has demonstrated is that there are few examples that common property resources exist in a truly open access context devoid of social rules, formal or informal, which serve to mediate individualistic interests.

Common property resource research shows that human groups are able to cooperate and manage their resources by setting rules for community members' use and by excluding outsiders from gaining access. These rules may consist of informal

practices and norms of behavior such as the practice of Maine lobstermen excluding outsiders through the institution of harbor gangs (Acheson 1988), maintaining secrecy of fishing spots in Brazil (Forman 1967), and the use of marine tenure systems in Mexico (Cochran 1997) and Lake Titicaca (Levieil and Orlove 1990). Berkes has also published prolifically on this idea that informal rules of behavior can be understood as forms of local management (Berkes 1977, Berkes and Feeny 1990, Berkes et al. 1991).

Nevertheless, the resilience of a community's local management is vulnerable to external pressures on the community, and have led many of these communally managed resource systems to break down (Berkes et al. 1991). Small-scale fisheries face further pressures in the form of competition from industrial fishing, inconsistent government regulations, and the availability of new markets that both undermines local usage and increases pressure on local resources by opportunistic outsiders. The analysis of how such external factors impact community management of natural resources benefits from a political ecology framework, an approach that examines socio-cultural, political, ecological, and historical factors across multiple scales (see next section).

Common property rights systems are about how human groups negotiate their access to and use of things of value found in nature. McCay notes this, pointing out that property *rights* should not be confused with the resources to which rights are granted, because "property derives not from nature but from culture" (1996:112). Thus, the core issue behind common property theory concerns management and governance. Acheson (2006) points out the weaknesses with the various forms of property rights, where independently, each fails due to self-interest. Even in contexts of successful

communal property rights, it is difficult to enforce the rules and exclude outsiders without support from government enforcement. Acheson presents two factors he feels are responsible for recent failures in managing the commons: (1) problems with science and (2) problems with top-down management. The former is responsible for faulty designs of “sustainable” resource use, especially in fisheries, and the latter for “regulatory uniformity.” This refers to the tendency of centralized governments to use one set of rules for a large area, thereby ignoring local variations and changes in a resource’s ecology (Holling and Meffe 1996). Acheson ultimately argues for a form of polycentric governance made up of a hierarchy of government units and requires that the relationship between local users who regulate themselves and top-down policymakers who offer enforcement of authority, needs to be flexible (*adaptive*) to changes in the local ecology. Such a framework of adaptive governance of the commons (Folke et al. 2005) includes the polycentric institutions noted by Acheson and aids in building trust and leadership, features of successful governance mirrored in Lebel et al. (2006).

This recent work on adaptive governance of the commons, often labeled community-based natural resource management (Leach et al. 1999), acknowledges the unpredictability of natural systems and the tendency to reduce resilience with the loss of natural levels of variation (Holling and Meffe 1996). Thus, the commons literature now recognizes the more dynamic processes that frame natural resources. The second recent direction of common property theory stems from the preoccupation in earlier work on identifying the type of property regime that exists in a community. That is, researchers examined a set of behaviors in practice and theorized how those behaviors

served to regulate access to a resource. In this sense, common property theory has mostly been deductive. A recent direction in the commons literature is evidenced in the examination of internal variation among users of a common resource, and how such variation reflects the success or failure of regulating the resource.

Ruttan (2006) conducted a meta-analysis of cases from the Common-pool Resource Database and looked at factors that influence trust building and cooperation/compliance. The paper attempts to answer whether heterogeneity among a community of resource users can exist alongside successful resource management. He notes the problems with defining “success” in terms of a group of resource users, acknowledging that success may relate to goals of conservation but not social equity. By examining features *within* each common property community, Ruttan presents a comparative analysis that shows how variation among members within a community affects successful management of the community’s resource. He found that “social and cultural differences have negative effects, largely through their effects on levels of trust” (2006:849). (Trust was also discussed as one of the factors of successful governance emphasized above.)

My study integrates these current directions in common property theory research: studies of community-based natural resource management and analyses of internal community variation for the development of more successful management. The research community for this study reflects the cultural heterogeneity described in Ruttan’s research. Furthermore, I expressly examine the heterogeneity of the social networks of the group of fishermen to test if the differentiation in these relationships can predict the adoption of different behaviors in response to resource scarcity.

Defining community: An integral component of common property resources involves the concept of a community. In the context of this dissertation, I discuss two communities: San Felipe and the fishing cooperative *Los Pescadores Unidos*. Each fits the "conventional" definition of community (Agrawal and Gibson 1999) as a small space and/or having a homogenous structure or culture among its members. San Felipe is a settlement geographically bounded by mangroves and the community is made up of all human inhabitants within this area. The fishing cooperative is a sub-population of working men within San Felipe and the community is defined according to membership in the cooperative. I focused my data collection on the member fishermen of the cooperative. The individual members serve as the units of analysis and the cooperative defines the population parameters.

Agrawal and Gibson's paper (1999) criticizes the way community has been defined "conventionally," and points out how narrow definitions of community are problematic in community-based natural resource management. The authors focus on the complexity of identifying communities and their use as analytical units. Although my study largely bypasses these issues as the communities I describe fall into the conventional parameters quite neatly, my analysis on the community in Chapter 6 addresses the heterogeneity of interests among actors in any community.

Political Ecology

Another erroneous assumption within the Tragedy of the Commons literature is that it ignores impacts from the broader socio-political system: what external government is regulating the users? Under what economic model do the herders act? Are they producing for subsistence, local, domestic production, or a global export demand? Many common property resource studies focus on how local users manage

use of resources among members and note that outsiders must be excluded. The relationship between the community and broader political and economic system is largely neglected.

A political ecology framework can be used to examine multi-scalar factors that contribute to resource scarcity as well as the range of responses which are available to users within the local system (Stonich 1993). Political ecology as an approach, integrates local-level social relations with broader level political-economic factors (Stonich 1993) by viewing multi-scalar political influences as forces within a socio-ecological system. Environmental change is tied to socio-cultural processes (Scoones 1999) where nature is seen as “culturally constructed and socially produced” (Escobar 1999:2).

When the word adaptation declined in usage in analyses to explain the human-environment connection, it was largely replaced, as mentioned previously, by the concept of the ecosystem and political ecology. These two frameworks share a perspective of a more fluid, dynamic analysis that incorporates change as an integral element in addressing human-environment interactions (Moran 1990). In examining what adaptability means within a socio-ecological system, Escobar (1999) calls for looking at the discourse between actors and their environment, broadly defined to include historical, ecological, social, cultural, and political structures. Adaptation is analyzed in political ecology by examining how decision-making is influenced and even circumscribed by multi-scalar actors and interests with power, where decision-making is shaped by one’s social position.

I choose to situate adaptations within a political ecology framework in order to examine how the range of adaptive choices available may be affected by factors in the broader socio-political system. Robbins wrote that political ecology “recognizes human/non-human relationships to be linked through dynamics that may yield unpredictable consequences” (2004:207); impacts from adaptive responses may have unexpected results. Stonich (1993) uses a political ecology framework to reveal the vulnerable position of Honduran farmers to environmental destruction. A superficial analysis would see the farmers causing their own destruction by farming on hillsides, but by examining the broader historical and political system, she demonstrates how the history of land expropriation on the part of foreign interests has pushed people to farm the marginalized hillsides. The farmers adapted to (or coped with) their loss of land by farming the easily eroded hillsides as a short-term decision which altered and adapted the environment in such a way as to increase vulnerability to landsides. The resulting damage from Hurricane Mitch in 1998 was in one way, an “unpredictable consequence” and at the same time, the vulnerability of the farmers was clearly predicted by Stonich through her analysis.

While political ecology focuses on the factors that influence the context of a problem, I end this section by noting the care that must be taken to avoid viewing human actors as victims without their own agency. Practice theory offers a useful framework for considering adaptation as it focuses on the individual as an agent of change and decision-making within preexisting social relationships. Individual actors are neither wholly passive nor wholly liberated from the structure that influences their range of actions (Giddens 1984). Human agency plays an active role in decision making

(Rubenstein 2004), but adaptations are inevitably political. An “ecology of practice” (Nyerges 1997), then, renders as political the distinctions in social status and access to the means of production among members of a group.

Developing a Working Model of Adaptation

Drawing from the literature above, I employ the concept of adaptation to describe the human-environment interaction as a dialectical process where humans both respond to change and affect change in their environment. Adaptation refers to human behaviors made in response to a perceived environmental change, in this case, to resource scarcity. These responses are manifested as changes in individual behaviors, a process that will, in turn, have new effects on the total environment: social and physical. Adaptations ultimately lead to the shaping and construction of the environment, and are both responses and actions as part of a dialectic relationship with vulnerability (Aguirre 2007). The range of adaptive behaviors is defined by ecological, cultural, legal, institutional, and personal preferences (see Chapter 4).

Human adaptation is not a biological function of economically efficient responses (Cancian 1972), but may instead be driven by intensification of resource use to satisfy wants and desires (Bennett 1976b) as well as needs. Adaptive strategies are not explained by models of rational behavior, exemplified in Orlove et al.’s (2004) observation that fishermen targeted a decreasing stock until the species was nearly exhausted before altering technology or location. Although employed here as decision-making, the assumption is not made that informants weigh the probabilities of each decision before it is made (Quinn 1975). Rather, decisions and behavior are influenced by a variety of factors, one of which (social relationships) will be tested in this study.

Here, I operationalize the concept of adaptation to represent the interaction between humans and the environment and the environment under study is the context of a common property resource experiencing change. Adopting a political ecology framework for the broader discussion puts the adaptations into a cultural perspective, allowing for a more holistic analysis that considers the impact of factors external to the local setting. Such factors will influence people's choices and capacity to respond to change.

In the remainder of this section, I review models in the literature that examine adaptations to environmental change and scarcity of common property resources. First, I discuss two adaptive strategy models identified in fishing communities, one of which (intensification-diversification) is also used in studies of farming communities experiencing environmental change. These studies are reviewed in the section that follows. Finally, I examine the model of adaptation across temporal scales. Bennett notes three processes of adaptive strategies, defining each according to the temporal effects: (1) strategies with immediate effects or returns, (2) strategies with delayed effects, and (3) strategies with sustained effects (1976a:284). He further notes that risk is a variable in each strategy. In Chapter 5, I compare the intensification-diversification model, and Bennett's conceptualization of adaptive process.

Adaptive Strategies within Common Property Marine Resource Contexts

Small-scale fishing entails numerous uncertainties (McGoodwin 1990) to which fishermen must adapt. Anthropologists have noted that fishers adapt to resource scarcity in different ways. Here, I review two models of strategies identified in the coastal anthropology literature: Acheson (1981) and McCay (1978).

Acheson (1981) presented a model of four strategies fishers use to compete: acquisition of skills, occupational switching, capital management, and innovation. Acquisition of skills involves experience and knowledge, as well as what may be defined by other fishermen as ‘luck’; it concerns what makes a good fisherman ‘good.’ Occupational switching refers to a multiple livelihood strategy; engaging in both fishing and terrestrial livelihood activities or switching to other fishing strategies that involve different fishing gear and target species. Capital management refers to how fishers manage their money from an unpredictable industry. For example, money must be saved to survive through bad weather and closed fishing seasons. Some fishers are better able to manage their money than others. Finally, Acheson’s innovation reflects an adoption of more ‘effective’ fishing gear or technology, or otherwise novel fishing technique. He adds that fishermen are known to be conservative in their adoption of risk, and are often reluctant to accept certain innovations. One or more of these strategies may be found in any community.

McCay (1978) classifies adaptive strategies as either diversification or intensification, and specifies that strategies are aggregated individual and household decisions that respond to resource decline. Intensification involves an “increased commitment to an investment;” diversification entails “spreading the risk,” or “the expansion of alternatives.” McCay further suggests a chronology to the strategies where diversified strategies are adopted first (McCay 1978), and move into intensification strategies as resources become more scarce. Under McCay’s model, diversification refers not only to the adoption of non-fishing (terrestrial) labor activities, but also adopting new fishing gear in order to target different fish species (Acheson’s

‘innovation’). Intensification under McCay’s model also refers to “increased reliance on welfare assistance; increased commitment to wage labor, which replaced fishing as the core of pluralist strategies; increased temporary and permanent out-migration; and investment in longliner fishing technology.”

With the exception of the investment in longliner technology, McCay’s intensification strategies involve *less* pressure on marine resources—less fishing is involved. Intensification, as used by McCay, refers to the intensified use and reliance on whatever strategy of diversification was employed; given this definition, it is a tautology that strategies of diversification would be employed first. What is most useful in the discussion is the concept of *spreading the risk*. In my study, I use the adoption or rejection of risk to differentiate strategies of diversification and intensification. A livelihood dependent on fishing is risky; catches, weather, crewmates, prices, all are unpredictable. When marine resources are in decline, fishing becomes more risky; will the crew be able to catch enough fish on a trip to cover expenses?

Using McCay’s categories of intensification and diversification of adaptive strategies, I redefine what constitutes each type of decision based around the concept of accepting or rejecting greater risk in lobster fishing. Diversification involves ‘spreading the risk’; adopting other livelihood strategies outside of fishing. Intensification involves adopting greater risk, continuing to fish and intensifying effort by fishing in deeper waters and diving for longer times. Those components of McCay’s intensification such as an increased commitment to wage labor and reliance on welfare are classified in my model as diversification.

Diversification and Intensification

Apart from the work cited above, there are limited examples of the modeling of adaptive strategies in response to resource scarcity. In 2001, Berkes and Jolly pointed to the lack of studies on adaptation to climate change despite the frequency with which the word is used in the titles of publications. Indeed, while I find that many more recent studies identify adaptive strategies employed in response to environmental change, these studies offer a limited analysis of how the strategies are employed. The case studies describe the adaptive strategies employed in a particular context of environmental change, but do not suggest a model that can be tested in other contexts of change. With the number of these studies increasing, however, what is now needed is a model which can be used to examine cases of adaptation cross-culturally. I review the literature for examples of diversification and intensification here, before turning to propose the model that is tested in this study.

Many of these empirical studies of agricultural communities identify diversification as an adaptive strategy. Ellis (1998) provides an overview of diversification as a livelihood strategy, noting in a review of the literature that not all researchers classify diversification in the same way; diversification is defined according to the categories of income in a particular context. Ellis defines “livelihood diversification” as “the process by which rural families construct a diverse portfolio of activities and social support capabilities in their struggle for survival and in order to improve their standards of living.” His paper summarizes the conflicting results among different case studies; diversification is shown in one study to further development goals then to hinder those goals in another study. Furthermore, a livelihood strategy is broader than an adaptive

response to a particular stress and broader than expanding income options; diversification is a mechanism to mitigate risk.

Carr (2008) addresses the “diversified livelihoods strategy” of agricultural adaptation within households in Ghana, focusing on the gender inequalities that result with the employment of the strategy. Carr’s paper addresses how adaptations, especially once in practice for a period of time, become normalized despite the negative outcomes that may result for some parties. To diversify refers to when the husband focuses on crops for market sale and the wife focuses on crops for domestic subsistence; the inverse occurs when both the husband and wife focus on market production in their respective farming plots and maintain separate control of their earnings. Thus, the diversified strategy occurs when each gender is engaged in isolated spheres of production, and thus dependent on one another for cash or domestic comforts, respectively.

Saldaña-Zorrilla (2008) compares the preference for crop diversification and emigration as potential adaptive strategies among three communities in Mexico. He found that the poorest of the communities had more farmers who would change crops (77%) rather than choose to emigrate (38%); compared to the least poor community where 44% would diversify crops and 58% would likely emigrate. Migration was therefore interpreted to reflect “expectations of future income” rather than a reflection of economic stress. Then, in an open ended question asking how young farmers would recover from a future natural disaster, he categorized their answers, in order of frequency of response: governmental support, working/producing more, no idea (this included seeking God’s help), credit and prevention (tied), and to seek community help,

crop diversification, and reliance on insurance (tied). Saldaña-Zorrilla notes that adaptive strategies occur at varied temporal scales that include both immediate responses and structural, long-term strategies, but does not suggest how this temporal scale might relate to the list of adaptive strategies.

Acosta-Michlik and Espaldon (2008) identify 19 adaptive strategies within three villages in the Philippines, and rank the employment of these strategies among four typologies of farmers, determined by cluster analysis: traditional, subsistence, diversified, and commercial. This addresses the diversity among individuals in a community as to differences in investment, education, and how such factors may correspond with the election of different strategies within the same community. The adaptive strategies are ordered by user preference, where diversification of crops ranks prior to diversification of livelihood strategies away from farming. The remaining strategies involve seeking help and borrowing money, before ultimately, migrating.

Recalling McCay's (1978) classification of adaptive strategies as diversification and intensification, Thomas and Twyman (2005) address this model specifically. They describe evidence showing that rural livelihoods in Africa more commonly diversify rather than intensify natural resource production. Here, diversification can include other agricultural activities just as McCay included switching fishing activities as diversification. To summarize the above, many studies discuss diversification as an adaptive strategy, but the concept is used different in each study. Also, only Thomas and Twyman (2005) address intensification, although it is defined differently from McCay's (1978) usage.

Temporal Models of Adaptive Strategies

The process of adaptation involves behaviors producing short-term, immediate results to the problem as well as long term, planned returns (Bennett 1976a). In addition to Saldaña-Zorrilla (2008) discussed above, Berkes and Jolly (2001) note that a temporal scale differentiates adaptive strategies. They identify short-term adaptive responses as “coping mechanisms” and long-term adaptive strategies of cultural and ecological adaptations of the group, seen as “culturally ingrained mechanisms.” They consciously distinguish between coping mechanisms and adaptive strategies, citing McCay’s 1978 paper discussed above as representative of the distinction used in anthropology. Yet McCay does not in fact, make such a distinction between coping mechanisms and adaptive strategies across time scales. Rather, she notes that there are two kinds of adaptive strategy: diversification and intensification, and differentiates these where, over time, diversified strategies are intensified as stress continues.

Noting that people engage in both immediate emergency responses and slowly changing cultural behaviors in response to resource insecurity is an important contribution from Berkes and Jolly (2001). Also important to this study is the authors address that these two scalar responses may overlap in time and occupy parts of a continuum, rather than isolated phases. Nevertheless, both are conceptualized as adaptations, per McCay, in this study.

Testing a Model of Adaptation to Resource Scarcity

Spiny lobster, the principle resource for the fishermen of San Felipe, Mexico, is becoming scarce, making a fishing livelihood increasingly difficult, but providing an opportune context for studying the adaptive strategies of the fishermen. Understanding how fishermen adapt to scarcity is important for improved resource management.

Drawing on the conceptualizations of adaptation cited above, I use models of adaptation by McCay (1976) and Acheson (1981), and the following literature where adaptive strategies are identified as diversification (Ellis 1998, Carr 2008) and intensification (Thomas and Twyman 2005), and are noted to occur at different temporal scales (Bennett 1976a, Berkes and Jolly 2001, Saldaña-Zorrilla 2008).

After identifying the adaptive strategies of San Felipe's fishermen through participant observation and conversations with the fishermen, I categorize the strategies according to McCay's (1978) operationalized definitions where intensification refers to an "increased commitment to an investment" and diversification refers to "the expansion of alternatives." I then consider how these strategies are employed across the different temporal scales of the two studies. McCay's study examines adaptive processes over the course of 14 years, compared with the shorter time frame covered in this dissertation. I make an interpretation of diversification and intensification based on effort invested in the lobster fishery, as that is the scarce resource. Following analysis of these models, I suggest a framework for testing adaptation in other communities based on the evidence present in the present case study.

Conclusion

One of the objectives of this study is to contribute to the development of a theory of human adaptation to resource scarcity. A better understanding of human behavior in response to scarcity can move policy in a more equitable direction (Thomas and Twyman 2005) that reconciles the tension between human use of resources and the conservation of these resources. This objective connects two broader questions that guide this study: the theoretical issue of the adaptive interaction between humans and the marine environment and the policy-driven issue of how resource management can

both conserve resource stocks and protect the livelihoods of resource users. At the intersection of humans and their marine resources, adaptation occurs when humans experience resource scarcity. Community-based resource management attempts to reconcile this tension between human needs and resource conservation. Through a better understanding of how resource users adapt to resource scarcity, better policy (operating at both the local and regional level) can help mediate the socio-economic needs of small-scale producers with the goals of resource conservation.

Until recently, fisheries managers have created policy to govern *fisheries*, overlooking the social, economic, and political factors of fishermen and their communities (Ward and Weeks 1994, Callon 1986). Rather, policy has been designed based on the (limited) knowledge of the biological target species, only. This study contributes to the need for the development of measures with which to examine the social resources of fishermen in order to develop successful fisheries policy. An example where understanding adaptive processes can aid in the design of policy is offered by Thomas and Twyman (2005) who use the word *resourceful* to describe rural people's ability to adapt when faced with environmental change. Given this resourcefulness, the authors note that policy made in response to climate change should incorporate "head room" to facilitate people's engagement in diversification strategies and to allow for flexibility.

This chapter situated the two problems of the study within ecological anthropology and broader interdisciplinary studies of human adaptation to environmental change. It focused on a review of the relevant literature on adaptation, common property theory,

and political ecology. Next, I discuss the *place* of the study in its socio-cultural and ecological setting.

CHAPTER 3
PLACE

The concept of *place* denotes meaning is attached to space (Cresswell 2004). In this chapter, I use this idea of place to illustrate aspects of San Felipe that are meaningful for my study of adaptation. The place of this study, San Felipe, is one of several small-scale fishing communities on the northern coast of the state of Yucatán, Mexico (Figure 3-1). I first discuss the cross-cultural study of coastal communities and provide a literature review for the sub-field of an anthropology of fishing, in order to describe how San Felipe fits into, and differs from, other coastal fishing communities. Here, I include a framework with which to compare San Felipe as a small-scale fishing community according to the concept of the means of production. Next, I describe the location, or landscape, of the study site, including its physical and climatic features at both the regional and local scale. I include a discussion of the nationalized oil industry in this section because of how the fishermen perceive this industry as a part of their changing landscape, and a threat to their livelihood.

The most important social and political institution in the community is the fishing cooperative. I trace two historical threads from Yucatecan and Mexican history, the national political parties and Felipe Carrillo Puerto's involvement with cooperative formation, from the Mexican Revolution to present events in San Felipe. These threads connect the past with particular community features in the present that help explain the socio-political context in which the fishermen adapt to resource scarcity.

Next, I describe San Felipe through an ethnographic portrait of the community itself. Beginning with the spatial planning of the community, I narrate the pre-Hispanic and 20th century history of the community, which leads directly into the current process

of gentrification which is driving local residences inland from the coast. I then provide a brief overview of those elements typical in an ethnographic account, including the economy, demography, education, and infrastructure of San Felipe.

Fishing Communities as Places of Study

An early movement in anthropology saw the identification and study of *culture areas*. Under Kirchhoff's application of the culture area concept (1943), human groups occupying a similar environment shared behavioral characteristics that had risen locally. This way of addressing human culture, which sees shared cultural features arising within a shared regional environment, was heavily criticized for focusing on the ideological drivers of culture, and ignoring the effects of environment and cultural diffusion (Blanton and Feinman 1984).

Barth (1956) notes that the use of the culture areas concept was, in fact, frequently applied in demonstration of ecological factors working as a driver of cultural change. In Kroeber's (1939) use of the concept, he recognizes the influence of cultural factors of technology as a driver of change within an environment that, he claims, is qualitatively the same throughout a particular region. In a later paper, Kroeber (1947) critiques another scholar's use of "culture areas," for being overly ideologically driven, at the expense of examining environmental factors and cultural diffusion. Based on his work in the Swat region of Pakistan, Kroeber points out how ecological factors shape cultural features among different groups of people who occupy the same area, yet differ culturally (pastoralists and agriculturalists).

Steward (1955) sees the use of the "culture area" concept as a way to classify the abundance of ethnographic data in the early history of anthropology, which equates anthropology with a natural history collection where similar things are "grouped in

common sense categories based on the daily experience of people." Steward sees such a collection as a necessary precursor to scientific inquiry, but ultimately lacking in analytical merit. Nevertheless, the trend of studying regions continues in universities, based on the idea of the utility of grouping human populations based on geographical proximity. Indeed, academic centers are based around these culture areas, as evidenced by Latin American, African, and Asian study centers. While the idea of Kirchhoff's culture areas as having unique identifying characteristics has largely been rejected, these area study departments succeed in organizing interdisciplinary research, such as between the natural and social sciences (Lewis and Wigen 1999).

Within these currently recognized geographical area studies, research in coastal areas is, literally, marginal, despite the 1.2 billion people that live within 100 km of the coast (Adger et al. 2005). Lewis and Wigen (1999) call for the reframing of the world's continentally-based area studies (e.g. Latin American or African Studies), in favor of area studies that address common socio-ecological problems. The study at hand focuses on a particular human-environment interaction that occupies such a specific geographical setting: coastal zones. I do not mean to revive the concept of culture areas in the sense of environments limiting or circumscribing human culture and adaptations, but rather, to call attention to the fact that contemporary human populations in this similar ecological setting face similar problems which are comparable cross-culturally.

Rural peoples living in coastal areas share common problems, including processes of gentrification taking place in the Mid-Atlantic coast of the U.S. (Griffith 1999) and West coast of Florida (Smith and Jepson 1993), marine environment degradation in Sonora, Mexico (Meltzer and Chang 2006), Indonesia (Osseweijer

2000), Peru and Chile (Aguilar Ibarra et al. 2000), and middlemen pressuring small-scale producers into destructive fishing practices in India (Chacko 1998) and Tanzania (Guard and Masaiganah 1997). Pollution from industrial shrimp aquaculture increases nutrient levels in nearby waters, leads to algal blooms, and renders locally harvested shellfish poisonous (Paez-Osuna et al. 1998). Cruise ship accidents damage coral reefs (Mair 1998), affecting local fishing or the tourist industry to which fishermen turn to supplement their fishing income. New access to capital and changes in technology, such as the use of GPS devices, may increase local production in the short-term but ultimately impact the fecundity of the resource in the long-term (Chacko 1998). Studying the processes that lead to these problems is more appropriate to do with other coastal communities, rather than examining them in contrast with local or regional agrarian problems.

In addition to sharing problems, fishing communities occupying a shared coastal setting share other characteristics. For example, a fishing livelihood is full of risk and uncertainty (Bernard 1967, McGoodwin 1990, Sabella and Bort 1991) where success requires extremely independent minded individuals (Price 1966, McGoodwin 1990, Jentoft and Davis 1993). Nevertheless, McGoodwin (1979) has found individualism replaced with cooperative behavior as risk and uncertainty increased in more dangerous fishing activities. Fishing also provides a high degree of job satisfaction and usually forms its members' core identity (Acheson 1988, Griffith 1999). McGoodwin also describes some core features of fisherfolk, saying that they "derive their livelihood primarily from the sea; their view of the world is essentially local; and … their social, political, and economic clout is relatively minor" (1990:23). According to McGoodwin,

then, fisherfolk are rural, socio-politically marginal people who make a living from marine resources. These problems all share a dependence on common property marine resources, a type of problem that is notoriously difficult to solve.

As a collective body of research, these studies are often grouped under the sub-category labels of Maritime, Fishing, or Coastal Anthropology. While Gatewood and McCay (1988) distinguished between maritime anthropology and an anthropology of fishing, regarding the former as the study of fishing peoples and the latter focusing on the fishing activity itself, Acheson's 1981 review article and an earlier paper by McCay (1978) use the two terms interchangeably. The multiple labels reflects the fact that this body of research is not yet recognized as an area of study in its own right, despite the common problems and issues that surface when addressing rural populations exploiting resources in the marine environment.

Multiple Scales of Fishing Communities

Fisherfolk are broadly classified as industrial (large-scale), artisanal (small-scale), or subsistence (even smaller scale) based on the level of capital invested, the degree of involvement (or lack thereof) in market production, and whether the catch is for personal or local market consumption. Artisanal fisheries, also referred to as petty commodity producers reflecting the kin relations within crews (Poggie and Pollnac 1991), are defined as utilizing simple technology (both for fishing equipment and transportation) requiring low capital investment to catch species for local or regional consumption. (Firth (1966) defines the artisanal fishers of Malaysia as peasants, a category that is not appropriate to the more market-integrated and dependent subjects of Poggie and Pollnac's study.) These fisheries have a greater reliance on human labor than mechanized power (Poggie and Pollnac 1991). Also, the capital is owned by those

directly engaged in the production process. Artisanal fisheries may thus be described as independent, where captains own the means of production (boat, motor, etc.) (Robben1989). Despite ownership, captains are also often deeply in debt to moneylenders and middlemen.

In contrast to the artisanal fisheries, industrial fleets have far higher capital investments (Sabella 1980). In industrial fisheries, the owner of capital (means of production) is not likely engaged in the fishing activity. Captains and crews are wage laborers with wages usually determined by the size of the catch. On the opposite end of the spectrum, subsistence fishermen have the least amount of capital investments and rely almost solely on human labor as opposed to mechanical technology. Subsistence fishermen engage in domestic production rather than market production. Few communities have even fewer subsistence fishermen, a fact reflected in the dearth of current studies on fishers who principally engage in fishing for domestic consumption.

The distinction between these categories is better described as a continuum rather than distinct groups and the defining features of each have blurred. Artisanal fisheries are increasingly integrated into producing for the global market, although still on a small-scale. New technologies such as motorization and GPS are becoming more accessible to rural fishing communities. An important distinction then, lies with whether the owners of capital are engaged in the production process (artisanal) or not (industrial).

Yet even this distinction has exceptions. An example is evidenced by Petterson's (1979) description of a Mexican fishing cooperative where cooperative members jointly own an industrial size tuna fleet. The capital investment required for an off-shore tuna

fleet exceeds what rural, individual fishers' could obtain. The individual members of the cooperative both jointly own and jointly work the means of production.

Artisanal Mode of Production

Most anthropological work on fishing has focused on artisanal fishing communities. The classification of types of fishermen reveals the most fundamental differentiation among fisherfolk: their interaction with the market system. This system of classification reifies fishermen as economic beings. This also corresponds with my view that coastal anthropology is not an independent sub-field of theory building; rather, coastal anthropology is a geo-ecological focus that attempts to answer similar questions asked by those interested in terrestrial communities' use of natural resources, climate change, and impacts of globalization. Coastal anthropology focuses on the same issues as a broader ecological or economic anthropology, but with a study area focus that is transnational, encompassing a linear spatiality.

Fishing communities have been compared with both hunter-gatherers and farmers. Despite the frequency that the word "harvest" is used to describe production, most fisherfolk employ hunting and gathering techniques to exploit marine resources. The resources of hunters-gatherers and fisherfolk are wild, not domesticated, and highly mobile. Yet, the qualitatively different environment of an aquatic habitat, with the unique properties of light and sound within it, fundamentally sets fishing apart from terrestrial hunting and gathering activities (Hewes 1948).

McCay (1981), however, argues that fishing communities have more in common with agrarian groups than with hunter-gatherers. McCay argues that this commonality has to do with a similar organization in the production of commodities. Production is a process that arises out of the connection between humans and nature (Cook 1973), and

small-scale agrarian and fishing communities may both be regarded as petty commodity producers. Adapting Marx's model of the mode of production, I will compare the important features of an artisanal, or small-scale, fishing mode of production with an industrial capitalist one.

An analysis of artisanal small-scale fisheries as a variation of the capitalist mode of production reveals features that many artisanal fisheries have in common. Using my research community, San Felipe, as a model, I want to emphasize that similar contexts are identified among fishing communities elsewhere in the world. Capital investment is usually limited to the technology required for production (McCay 1981). Small-scale boat captains both own the means of production and are actively engaged in the production process. This contrasts with a capitalist fishing mode of production, where the means of production are owned by an absentee capitalist. Palsson (2000) also notes a pattern where small-scale fishery producers will continue investing in the means of production even when profit margins fall, whereas capitalist fishing owners do not. This pattern is supported by Durrenberger (1997), who also notes fisher folk's tendency to remain in a fishery long after it has ceased being profitable to do so. In further comparing artisanal and capitalist production, Palsson notes that small-scale captains are more likely to respond to perceived environmental problems that may lower future catches, through collective behavior with other captains. Capitalist fishery owners may instead pursue profit regardless of decreasing stocks and leave the fishery when economically rational measures reveal no further profit.

In a small-scale fishing mode of production, the means of production also include what the fishermen know about their resource and the skills they have to successfully

harvest the resource (Cordell 1974). Knowledge composes part of the means of production because it is invested in with time and also represents an interface between humans and their environment (Cook 1973). Knowledge may include social memory of a past resource crash, as occurred among the lobster fishers in Maine (Acheson 2003). Such knowledge influences the use of the resource, even if few active fishers lived through the past event. Small-scale fishers are also regarded as more flexible in their adaptive strategies than are capital-intensive fishermen (McGoodwin 1992). That is, they are able to switch target species or technology easier than capital-intensive fisheries.

The relations of production differ within the two modes as well. In areas where a successful cooperative works, artisanal fishers share in the ownership of the capital-intensive infrastructure necessary for the production of their highly perishable catches. Cooperative institutions, then, enable artisanal fishers to produce for the regional or global market. In areas without cooperative institutions, middlemen buyers are often the owners of such infrastructure. A better system of categorizing fishing communities for the sake of comparison would consider both the means and relations of production together, used as an analytical model for a mode of production. The three approximate categories of fishermen, industrial, artisanal, and subsistence, are engaged in such differentiated modes of production, owing to differences in both the means and relations of production.

The Landscape

This study is centered on the fishing community of San Felipe, which is in the state of Yucatan, roughly halfway between the capital, Merida, and the tourist hub, Cancun, in the state of Quintana Roo. The state of Yucatan's coastline is roughly 355 kilometers

long. The Yucatan peninsula is made up of the states of Campeche, Quintana Roo, and Yucatan. Throughout this dissertation, I use ‘Yucatan’ to refer to the state and append ‘peninsula’ when speaking of the Yucatan region, generally.

The waters of the eastern Caribbean coast of the Yucatan are constantly moved northward toward the east coast of Florida by the Gulf Stream current, creating conditions of clear water and abundant coral growth. The waters off the Gulf coast of the Yucatan, on the other hand, lack this current. Here, the water is more turbid than the Caribbean and the water moves in circular eddies, much like a stewing pot (Figure 3-2). The Gulf remains a warmer body of water than the Atlantic and this warmth works as fuel for hurricanes that enter the Gulf of Mexico, causing an increase in strength. The Campeche bank borders the north and west coasts of the peninsula and consists of a shallow, calcium substrate, pocked with holes that provide shelter and hiding places for marine life. Here, the Gulf waters deepen gradually so that fishermen must go far from shore to reach greater depths. In the port city of Progreso, for example, a 6.5 kilometer long pier was recently built, in addition to a seven kilometer long channel dredged to a depth of 12 meters, to allow for the docking of container and cruise ships.

Important fisheries on the north Yucatan coast include spiny lobster (*Panulirus argus*), octopus (*Octoups maya* and *O. vulgaris*), and various species of shallow water grouper, the most abundant of which is red grouper (*Epinephelus morio*). This means that these species are available in commercial quantities and that a market exists for which the fishermen can produce. There are, of course, many other species in the Gulf, but if there is not a known and accessible market, the species have no exchange value and will not be harvested. Yellowtail snapper, Spanish and king mackerels are also

caught seasonally or in smaller quantities. Federal law prohibits the harvest of Queen conch and sea cucumbers from the coast. This federal law prohibits these species from being harvested, despite the fact that there is a high exchange value for these species. Many species have a local use value and are harvested for local consumption.

San Felipe is located roughly halfway between the state's capital, Mérida, and the tourist hub of Cancún, in the state of Quintana Roo (Figure 3-3). This stretch of coastline is dotted with several small coastal communities and sheltered by a barrier island which begins in San Felipe and extends eastward, almost to the border of Quintana Roo. The government pays to have channels in the barrier island dredged regularly, allowing resident fishermen of the communities access to the Gulf of Mexico on the other side of the protected estuary.

This estuary or lagoon formed between the barrier island and the mainland is approximately 80 kilometers long and is a growing tourist attraction to both domestic and international visitors owing to its abundant biodiversity. Within it resides the largest colony of flamingos in the Americas, crocodiles, and hundreds of species of birds. Boat trips to observe the wildlife are heavily promoted out of Rio Lagartos, another fishing community 12 kilometers east of San Felipe, and to a much lesser degree, from San Felipe itself. The estuary is also used for catching the bait used in the octopus fishery. Several species of gastropods (small conches and whelks) are also collected for local consumption from the estuary during the low-season for fishing. These marine snails are a common ingredient in the local delicacy, *ceviche*.

On the outside of this barrier island is a narrow, white sand beach. These beaches, at present, remain undeveloped and are dramatically different than the over-

developed beaches of Cancún and the Maya Riviera. Further east along this beach from San Felipe, centered on the beaches closest to the community Las Coloradas, is a major turtle nesting zone. A state run research center stationed there works to educate the local population about turtle conservation as well as aiding in the protection of turtle nests, aiming to promote a higher survival rate of turtle hatchlings.

Environmental Events

The fishermen recognize three seasons: the dry season occurs from March to May, followed by the rainy season from June to October, and the season of the *nortes*, lasting from November to February. *Nortes* are cold fronts or winter storms that come from the north and are usually accompanied by strong winds and cold air. Most fishing activity ceases when a *norte* blows in due to rough seas and turbid waters which make fishing for lobster and octopus difficult. Those fishermen that fish during a *norte* restrict themselves to net fishing in shallow waters.

The hurricane season, with its winds generally coming from the east, begins in the rainy season and overlaps into the season of the *nortes*. Hurricanes are a major threat to the community. Built on reclaimed land from drained mangrove marsh, San Felipe is at sea level and flooding is common. Two major hurricanes are still remembered by community members for the damage they caused to homes and boats: Hurricane Gilbert in 1988 and Hurricane Isidore in 2002. Several fishermen are volunteer members of the Civil Patrol which assists in organizing evacuations of the city's residents prior to a major storm event. The state government sends city buses to assist residents in evacuating the community. The people of San Felipe take refuge in Panaba or Tizimin, either staying with friends and family, or renting small houses. The Civil

Patrol volunteers remain in the community, riding out the storm; they monitor damages and prevent theft or looting.

Hurricanes not only cause economic damage to property, they can alter the marine environment. Hurricane Isidore in 2002 effectively ended the region's exploitation of sea cucumbers and conch as commercial quantities of each resource essentially disappeared after the storm. Federal legislation is now in place that prohibits the harvest of either sea cucumbers or conch, although export fisheries existed for these species prior to 2002. They were likely increasing in scarcity prior to the storm, but the hurricane seems to have impacted the remaining population of these species in some still unexplained way, perhaps reminiscent of the 'flip' or regime change in Holling's (2001) Panarchy model.

Another ecological hazard to the community concerns the health of the marine ecosystem, and so, the fishermen's resources. A recent study of 42 coastal cities in Mexico by Ortiz-Lozano et al. (2005) found fecal contamination in all areas surveyed. The study also identified problems with the development of coastal tourism without regard for its ecological impacts as well as the growing threat of the petrochemical industry, especially in the Gulf of Mexico (see below). Increasing occurrences of algal blooms known as red tides impact fishermen's catches and livelihoods. The mere rumor of a red tide makes the regional news (Briceno Perez 2005, Tzec Valle and Briceno Perez 2005, Ucan Salazar 2005) and generates much speculation. This is due in part to a lack of knowledge and understanding, both at the local and scientific levels, of the causes and impacts of each new algal outbreak. San Felipe's fishermen, for example, reported that sometimes a red tide left them unable to fish for weeks and caused

respiratory problems among people in the community. Others reported that the fish killed as a result of the red tides polluted the beaches or decreased the populations of commercial species, such as grouper.

In interviews I conducted during 2005, fisherman most often claimed that *aguas malas*, or bad waters, wash in from elsewhere. During interviews in 2008, 64% of those interviewed stated that red tides are caused by decomposing marine algae and 9% claimed they are caused by contamination. One fisherman told me that red tides are caused by “some organism,” but he could not explain how it happens, and two fishermen told me they are caused by excessive marine algae. Finally, one fisherman told me red tides are caused by underwater volcanoes, adding that he saw a documentary about it on the Discovery channel. (The mechanism as to what triggers a red tide is still under study, but it is generally accepted that a red tide is an algal bloom caused by excessive nutrients in the water on which the algae feed.)

While there is no evidence at present that the pollution cited by Ortiz-Lozano et al. (2005) is currently impacting the harvest of spiny lobsters in Mexico, the slow circular movements of the Gulf waters, its relative isolation, and the known migration patterns of many commercially important fish species should lead us to suspect transnational connections in regards to Gulf activities and contamination.[6] This means that resource management of a locally important species requires regional coordination and participation.

[6] The conventional idea of spiny lobster dispersal has held that the larvae spends many months in the planktonic water column where it can be transported far from the spawning site to ultimately settle and mature elsewhere. This idea, discussed further in Lasseter 2006, leads to the idea that it is in the interest of all spiny lobster fisheries to cooperate in their management as the disparate populations were likely linked by the movements of ocean currents. This idea has begun to be challenged and new studies are showing that recruitment of spiny lobster populations may more commonly be local (Dr. Behringer, personal communication).

Petróleos Mexicanos **and Oil Drilling**

Petróleos Mexicanos (PEMEX) is Mexico's state-owned petroleum company founded in 1938 under president Lázaro Cárdenas, following a workers' strike against the foreign petroleum companies in 1937. At that time, the president expropriated the foreign-owned companies and nationalized the industry, creating PEMEX. In 2006, PEMEX is the largest enterprise in Mexico and the third largest oil producer world-wide. In 1971, a fisherman in the neighboring state of Campeche noticed oil welling up from the ocean floor, beginning one of the largest offshore oil productions in Mexico. This site, the Cantarell oil field (located 80 kilometers offshore in the Bay of Campeche, was followed in 1979 by the Ku-Maloob-Zaap oil field, also offshore in the Bay of Campeche, to the northwest of the Cantarell fields.

The fishermen of San Felipe are well aware of the offshore drilling in Campeche. They tell stories of how the drilling has destroyed the fishing in Campeche and also in the state of Vera Cruz, although none of them have first-hand knowledge of those fisheries. Many fishermen have expressed their fear to me that PEMEX is coming to their coast to drill and that the fishing in San Felipe, too, will be destroyed. They have told me that there is nothing they or the cooperative can do. Some have gone on to claim that deals are made among those with money, the politicians, and the fishermen have no way to fight such power.

Towards the end of my field stay, PEMEX television commercials began to appear during the nightly *novelas*, faithfully watched by everyone I knew. These commercials depicted a warm image of the PEMEX and the oil industry, touting the development of jobs and their protection of the environment. Spliced among the images of smiling, happy people wearing indigenous dress were images of offshore rigs. I interpret these

advertisements as an attempt to warm people up to the idea of PEMEX exploration in their area, by telling viewers that they were a company that was to be seen as their friend.

Although PEMEX is a nationalized company, gas stations are privately owned as franchises. Gas prices are regulated at the national level and are kept the same across the country.[7] Despite being a nationalized industry, they still award contracts to foreign companies. For example, a Houston based company announced on February 5, 2009, that it had been awarded a contract by PEMEX to build drilling platforms in the Bay of Campeche (Offshore Shipping Online 2009a). Also, in March 2009, PEMEX awarded a contract to Cal Dive International to install almost 14 kilometers of undersea pipeline offshore of Tabasco. Construction was expected to begin in May of 2009 (Offshore Shipping Online 2009b).

As I work on editing this section, the BP oil spill from the Deepwater Horizon rig in the Gulf has just happened. Media reports are citing the fears of fishermen that their livelihoods have ended. The federal government made an emergency opening for shrimp fishermen to scoop up what they can before the oil moves through their shrimping grounds. When I visit San Felipe shortly after the leak has been stopped, nearly every fisherman I talk to asks me about the livelihoods of the Gulf coast fishermen in the U.S. and whether or not they will be able to continue fishing.

[7]In San Felipe, the cooperative bought and built the PEMEX station that is on the outskirts of town both as a capital investment and to provide fishermen with readily accessible fuel. After the cooperative split into two, conflicts arose over management of the station. Neither cooperative was willing to sell their shares to the other and ultimately, the station was sold to an outside investor.

Socio-Political Place

In San Felipe, the fishing economy and local politics are interconnected. While this study focuses on the members of a single fishing cooperative, the cooperative is but a large sub-group of the entire fishing community in San Felipe. There is another cooperative in the community as well as independent fishermen who sell their catch to local fish houses. Here, I describe these different sectors and discuss the politics and social interactions between the sectors, as well as how they overlap or interact. My aim is to situate the cooperative within that broader community and discuss the social relationships between member fishermen and other fishermen in the community.

The fishermen of San Felipe are can be most broadly divided into the categories of *socios* and *libres*. *Socios* are cooperative members and *libres* are independent fishermen. This study focuses on the members of the Pescadores Unidos de San Felipe, one of two fishing cooperatives in the community. Here, I describe the cooperative as an organization, discuss the other sectors of the fishing community, and compare and contrast their relations to one another and with their resources.

Cooperatives

The institution of the cooperative has a long history in Mexico dating back to the 1870s. The first cooperative in Mexico was recognized in 1873 (Petterson 1979) and the first in Yucatan, in 1918. Common in many towns throughout Yucatan, there is a statue in the central park of San Felipe of Felipe Carrillo Puerto (Figure 3-4), remembered as a supporter of the poor and an “agrarian socialist” (Joseph 1982). Carrillo started a cooperative store in Motul, a town southwest of San Felipe (Figure 3-3), in 1918 in order to provide poor workers access to goods without the price gouging of merchant middlemen. Initially successful, the cooperative eventually failed due to pressure from

wealthy merchants who fought against Carrillo's socialist ideology. These merchants from both Motul and Mérida, pressured political elites to end the cooperative and preserve their profits. Carrillo also struggled to convince US businesses, backed by the US Food Administration, to sell to the cooperative rather than the private merchants with whom they preferred to do business (Joseph 194:1982).

In the 1930s, President Cárdenas passed the cooperative laws of 1936 and cooperative formation again increased as a mechanism for rural development (Petterson 1979). Cooperatives were organized to be independent institutions, but could organize into federations for the purpose of promoting political interests. Cárdenas is also famously responsible for the implementation of *ejidos*, a land redistribution program that created communal agricultural lands for rural small-scale producers. In the Yucatan, Cárdenas reorganized the henequen plantations into 272 collective *ejidos*, however, the land was redrawn in such haste that the boundaries were incompatible with the necessary production structure of the henequen commodity.

A noted difference between Carrillo's cooperative stores and Cardenas' agrarian reforms is that Carrillo's reforms came from within Yucatecan society and Cardenas' came from outside. Carrillo, who was from Motul, understood first-hand the needs of Yucatan's *campesinos* and developed the cooperative institution with their specific needs in mind. Cardenas, coming from Mexico City, appreciated the need for land redistribution but his ignorance of the local production process led to the arbitrary drawing of *ejido* boundaries that obstructed efficient henequen production (Joseph 1982).

From the 1930s to the 1970s, fishing developed on both the east and west coasts of Mexico. As fisheries developed, fishing cooperatives began to be formed due to the passage of federal laws that restricted fishing rights to cooperative members (Petterson 1979). Also, another wave of agrarian reforms that were implemented in Mexico promoted the formation of fishing cooperatives in coastal areas in the 1960s and 1970s (Fox 1993). From this time, fishing cooperatives served both a social organizational role for growing fisheries and a supervisory role from the government's perspective.

According to an annual statistics publication produced by Mexico's CONAPESCA (Comisión Nacional de Acuacultura y Pesca), a fishing cooperative is defined as a "social organization whose members associate with the objective of working in common for the market production or public service, relative to fishing and its resources" (Ojeda Paullada et al. 1984). The success or failure of fishing cooperatives is dependent on numerous factors. Independence is regarded as a primary characteristic of a successful fisherman (Kottak 2006 [1983], Pollnac 1977). Poggie (1980) defines independence as "the propensity to think and behave free of the influence of others" and he regards independence as an adaptive characteristic. He points out that organizing independent personalities into a group that makes collective decisions can only be successful under particular conditions, principally where a sense of egalitarianism exists among the members.

In San Felipe, the bi-annual election of new cooperative leaders helps to prohibit the development of a rigid, internal political hierarchy, as each group of leaders returns to fishing upon completion of their term of service. Thus, the leaders of the cooperative are fishermen both before and after their service. Despite this check on political power,

as detailed below, the cooperative split in two following several years of a small group of members who managed to acquire political and economic control over the cooperative.

McGoodwin (1980) found that inshore Mexican cooperatives' failure was related to their founding and relationship to the government; the cooperatives were not autonomous. Once the government turned its favor to larger-scale fishing ventures, the small-scale fishing cooperatives were unable to compete. But government involvement can provide benefits, as well. Petterson (1980) gives an example of how cooperative formation in Mexico allowed independent fishermen opportunities to expand their capital investment on a larger scale. The organized fishermen were able to invest collectively in larger vessels, capable of larger landings and thus greater returns. In San Felipe, cooperative membership does not result in pooled fishing capital, but members are able to procure interest-free loans for personal boats and fishing equipment.

Private Fish Houses

By federal law, permits for the production of lobster are only valid within a legally sanctioned fishing cooperative. By extension, the harvest of lobster is restricted to member fishermen of the cooperative in possession of the permits. All other species for which harvest is legal do not require that fishermen be members of a cooperative; these species may be caught by independent fishermen and bought and sold by private fish houses. In San Felipe, there are four such privately owned operations that buy octopus and grouper (as already mentioned, lobster cannot be sold outside of the cooperative), as well as recruit and employ fishermen to whom they rent boats and equipment. The private fish houses recruit men from several inland communities to fish the four month long octopus season as *libres* (non-cooperative fishermen). The fish house owners find houses for the fishermen to rent and share. Of the four independent fish houses, two

are owned and managed by former members of the cooperative; one of which was expelled under accusations of fraud and the other quit in order to pursue opening his fish house. Each of these individuals had served as an elected official in the cooperative while still a member. That they have become wealthy after leaving the cooperative angers many remaining member fishermen. Many fishermen feel that these men used the benefits of their position as cooperative leaders to enable their private business interests, rather than the cooperative improvement for all member fishermen.

Recently, immediately following the end of his term serving as an elected official in the cooperative, the official charged with enforcing regulations quit the cooperative to start his own octopus buying fish house. The other members of the cooperative were furious. Although individual members view the cooperative as a way to realize personal benefits, to serve as an elected official requires a member to campaign and declare his commitment to improving the cooperative. It is also recognized that during their term, elected officials have the ability to become very wealthy. When this member quit so suddenly following service in the cooperative, the members felt that he must have stolen a lot of money and was now able to open up his own fish house.

The fisherman's defense was that after 17 years of membership, he was ready to start something different. Ultimately, his fish house failed and he petitioned to reenter the cooperative in 2010. Put to a vote among the members, his readmission was denied. Unable to dive for lobsters from his own boat, he now works as a *libre* diver on the boat of a sympathetic cooperative fisherman.

Los Pescadores Unidos de San Felipe

In the fishing community of San Felipe, processes at the national and international scale influence the local socio-political structure within the fishermen's cooperative. The

fishermen do not represent a homogenous community and they will adapt to change in different ways. While many social norms are shared, the fishermen differ in livelihood strategy and fishing intensity. Variation also exists in how the cooperative is viewed as serving individual member's needs; for some, the cooperative is the means through which they sell their catch, others recognize it as an institution that works for their benefit at a wider scale and allows them to access state-level benefits such as health and social security benefits.

The cooperative, *Los Pescadores Unidos de San Felipe*, was formed in 1969 with 24 members. Year after year, the number of members grew until spiny lobster harvests eventually began to decline. With the decline, federal regulations were implemented in 1996 to restrict access to the resource. No further lobster concessions were granted and the cooperative eventually capped the number of members at 225; new members could only be admitted upon departure of existing members.

The cooperative serves as an intermediary between individual fishers and the regional buyer-exporter. The relationship between the cooperative and exporter, which was initially mutually beneficial, quickly became exploitative. The exporter owned the ice factory as well as the cooperative's production facilities. The exporter also makes loans to individual cooperative members for boat repairs and new equipment, which can result in large debts given the capital-intensive investments required for lobster diving. Because he owns the local infrastructure required for production and because of the debts owed to him by individual fishermen, the cooperative is contractually required to sell all of its lobster production to this exporter. In return, this exporter controls the price paid for lobster, paying less than the cooperative could sell the lobster elsewhere.

The *Unidos* and *Legitimos*

The Pescadores Unidos remained the only fishing cooperative in San Felipe until 2005 when a brewing internal conflict led approximately 100 members to quit and form a new cooperative. Naming themselves the *Pescadores Legitimos de San Felipe*, they defended their legitimacy to form a new cooperative. The conflict concerned how the control of power was maintained both within the cooperative and in community politics. According to the remaining Unidos members, the conflict began over complaints that one family with many brothers, cousins, and nephews, maintained their control of the cooperative and mayor's (*alcalde*) office. The data does not support the existence of such a rigid oligarchy as was described to me. Nevertheless, there was a history of several members of one family holding office, and it was likely that this family held influence over the selection of candidates for office. This occurred for the positions of both the *alcalde* and president of the fishing cooperative.

A turning point in 2001 signaled a change in politics in San Felipe and is relevant to broader social change in the community: the election of Joaquin Diaz Mena, now a Federal *Diputado*. Huacho, as he is known locally, was the first PAN (Partido Acción Nacional) party candidate for *alcalde* in San Felipe. In fact, the election in which he won was the first time residents had ever had a choice of candidates on the ballot. Previously, only a single PRI (Partido Revolucionario Institucional) party candidate was on the ballot, guaranteeing a win. By extension, with only one party represented, the local party office essentially controlled who would be the next *alcalde*. A similar electoral situation dominated the leadership of the *Pescadores Unidos*, as well.

Huacho became *alcalde* the year after the first PAN candidate, Vicente Fox, won the national election. Since the Mexican Revolution until 2000, the PRI party had

maintained control of the federal government. At the local level, the electoral system of a single political party finally broke down when Huacho, returned to San Felipe after obtaining his law degree. Wanting to run for office, he approached the local PRI party office and was told that he could be vice-president, also called *secretario*. Not content with the option, Huacho contacted the regional PAN party office who assisted him in forming a local office in San Felipe. Running against the PRI selected candidate, Huacho campaigned to the people for change and won. I heard this story from several PAN supporters in San Felipe, who narrate as if describing a legend.

Along the same lines, a division began that mirrored politics in the broader community. *Unidos* members told me that one brother after another became president, never allowing other members to run for the office. Everyone expresses frustration at the perceived corruption of each new group of elected officials. These frustrations led to two members deciding to change things. They began a campaign within the cooperative, seeking support for their nominations. They built up enough support to open up the electoral process of the cooperative in the same way as the broader community: by providing members with a choice between two candidates. The other side began to rally its own troops from among the still united membership. Ultimately, tensions became so rigid between the two camps that the smaller faction, having lost control of the president's office, formed their own cooperative.

By law, when the *Legitimos* broke away from the *Unidos*, they could not keep any lobster permits, nor could they be transferred to another cooperative. Although relations were extremely volatile, the two factions were able to come to an agreement prior to the

split regarding issues of accounting. One point of agreement was that the *Legitimos* would work with the *Unidos* bookkeepers to conduct all required legal paperwork.

The conflict is superimposed along national political party lines, where the fishermen of the *Pescadores Unidos* cooperative (with whom I principally work[8]) are PAN supporters and those of the *Pescadores Legitimos* cooperative are PRI supporters. Nevertheless, the conflict has little to do with contrasting PAN and PRI political ideologies. Rather, the split overlies the preexisting social conflict among families in the community. Interestingly, ReCruz (1996) notes a similar political division superimposed on a local conflict in Chan Kom, also in the Yucatan.

Being a *Socio*

Being a cooperative member entails both responsibilities and benefits. Members receive the economic benefits of state-funded health care (*seguro social*) and loans from the cooperative for personal emergency expenses or for equipment purchases or repairs. The health insurance, for which the members pay a monthly premium,[9] covers the high costs of decompression treatments in the hyperbaric chamber. Although diving has inherent physical risks, these are largely downplayed. As members, the physical risk of diving is not matched by economic risk. Should the cost of hyperbaric chamber treatments be unavailable or financially prohibitive, perhaps diver behavior would be affected.

The cooperatives pay a different per kilogram price to *socios* than *libres* where *socios* receive less per kilogram than do *libres*. The price paid to the *socio* includes a

[8] When I first began research in San Felipe in 2005, the cooperative had recently split and it was not possible to work in-depth with both cooperatives due to issues of mistrust.

[9] The cost of the premium varies according to factors such as number of years as a member. The premium is roughly between $38US and $60 per month.

small percentage paid into a type of savings fund (*remanente*) that is returned to the *socio* in a lump sum at the end of each month. Independent *libres* do not receive the fund, but do get paid a bit more per kilogram at the time of the catch. The different prices reflect payment into different funds for administrative and production expenses.

One of the responsibilities of cooperative membership is mandatory attendance at cooperative assemblies that are full day affairs several times a year. During assemblies, new officials are elected every two years to run the cooperative; new members are voted in or problem members may be voted out. I often heard the fishermen grumble about having to attend the assemblies, and there is always a name-taker assigned to guard the exit to the venue and keep track of those members that sneak out to purchase something to drink and fail to return. Members also vote on the penalty given to those members who do not attend the assembly; it is usually a fine of 500 pesos, or roughly $50. When the issue comes up on the agenda of the assembly, the members in the audience begin chanting, "*multa*, *multa*", or "fine [them], fine [them]", by way of vocalizing their support for fining those not in attendance. Although these meetings can often appear quite chaotic, the members are genuinely engaged in the process of participating. I have been surprised the see a member who had been gazing for some time at the centerfold model in a magazine, suddenly stand up with something to add to the argument that had been going on around him.

Place: *Unidos* and *Legitimos*

There is some spatial differentiation between the two cooperatives, however it is not a rigid distinction. The production facilities for the two cooperatives are side-by-side on the street facing the water. The main dock intersects with the main street into town and is closest to the production plants. On this dock, mostly the boats of Unidos

members are moored. The next dock to the east, perhaps 100 meters away, is where mostly members of the *Legitimos* and *libre* fishermen moor their boats. This eastern dock is directly in front of one of the independent fish houses that buys octopus and grouper. The difference in social groups between the two docks is obvious; when I walk down either one in the morning or afternoon, nearly all of the fishermen are members of the respective cooperative. Nevertheless, I never heard anyone refer to any dock as "ours" or "theirs."

The different areas where boats are moored further overlap some social cliques within the community. There are an additional two areas to the west of the main dock where fishermen moor their boats; the first is dominated by the *libres* that fish for another independent fish house, and on the west end of the community there is a mix of *Unidos* members and independent fishermen who fish for the third largest independent fish house. Recalling the adaptive strategy of pirating, discussed in Chapter 4, there is a socio-spatial correlation between where someone moors their boat and their pirating activity. The cooperative officials know this. There is an ongoing problem with a few members who moor at the either end dock, each of which is in front of an independent fish house. The official in charge of enforcing cooperative members frequently complains of the difficulty in preventing members from occasionally selling their catches to these fish houses.

Another slightly more overt spatial difference in social spaces between the cooperatives' members is in the community's cantinas. Again, this is not a rigid distinction, but I was often told that a particular cantina was frequented mostly by members of the *Legitimos*. Only one *Unidos*, known for his social drinking, frequents the

bar. As mentioned in the last chapter, Caguama will drink with anyone and maintains good relationships with everyone, regardless of cooperative membership or political affiliation.

Working with the *Unidos*

This study focuses on the fishing cooperative *Los Pescadores Unidos de San Felipe*. There are other fishing sectors in the community, including the independent fishermen and the members of *Legitimos*. There are also nearby fishing communities who fish the waters in front of San Felipe. Many are members of cooperatives in their own communities. I chose to work most closely with the fishermen of this cooperative for several reasons.

First, I was specifically interested in the practice of lobster diving and the high incidence of decompression sickness that is an accepted risk of the job. Diving entails a different encounter with the fishing environment than does fishing from the surface. Spiny lobster is also regarded as the most important resource to the community, having cultural significance as well. Thus, it was partly out of research curiosity that I decided to focus on lobster divers. In San Felipe, only within a cooperative is lobster fishing permitted, hence my focus on the cooperative.

My first contacts in the community were also with members of this cooperative and they readily agreed to participate. I was able to build rapport easily with the cooperative officials I first met with. I was never able to build similar relationships with members of the *Legitimos*, although by the end of my field stay, this was beginning to change. I will note that I participated on fishing trips with members of both cooperatives and had the chance to observe fishing practices among fishermen from all sectors.

Finally, for pragmatic reasons I could only work with one cooperative. I spent nearly every afternoon in the production facility and evenings in the *Unidos* office. I could not have participated this fully in two places at the same time. Nor would it have been possible to gain the level of confidence I developed with the *Unidos*, with the *Legitimos* due to lingering issues of mistrust on both sides. At the time I began fieldwork in 2005, the cooperative had just recently split and tensions were high.

I want to temper the above by noting that there are good social relationships between members of the different cooperatives, just as there are bad relationships among some members within the same cooperative. For example, one of the *Legitimos* is very social with the *Unidos*, sharing information with them. On the way out to sea for the day's fishing, the men idle their boats across the lagoon and through the channel cutting through the barrier island leading out to sea. Meanwhile, the captain and second diver are often talking about where they will fish that day. This is the time to consider weather conditions and the most recent information from other fishermen about fishing conditions. The captain is configuring the GPS units and consulting with their logbook for coordinates to enter for the day's trip. Pairs of boats often idle side by side as they make this crossing to the open sea. I have been on multiple fishing trips when, as we are idling, the *Legitimos* member will approach the boats of his *Unidos* friends and chats with them about the plan for the day. The *Unidos* appear to be just as forthcoming with information with him, as they are with other *Unidos* members.

The Place of San Felipe

City Planning

A common feature in Latin American city planning follows the colonial model in which a plaza (*parque central*) occupies the city center and all buildings radiate outward

from this central point. Conventionally, the most important community buildings face the four sides of this central park: the Catholic church on the east side (facing west), with the government administration offices (the town hall, or *Palacio Municipal*) directly across. The residences of important officials and the commercial district occupy the south and north sides. This pattern forms a cross, a significant symbol in the dominant Catholic tradition. The city planning of Mérida, the state capital of Yucatán, exemplifies this model (Figure 3-5).

One of the first things I noticed upon arrival in San Felipe is the modification of this urban planning model to reflect the importance of the sea. Whereas the central park is the center for community activity in inland communities, the Gulf of Mexico is of central importance to San Felipe and the community radiates from a waterfront park. This central park is still framed by the Catholic church on the east side and local government offices to the west. A central pier extends into the estuary from the north side of the park and the main street out of town (*calle principal*) begins here heading south. Larger shops and pharmacies occupy this street, close to the central park.

The central park has two monuments and cypress trees framed by concrete that serves as a bench. Extending east and west, the waterfront borders a breakwater with a pedestrian walkway, known in Spanish as a *malecón*. The park monuments include a concrete-enclosed well, labeled with the original name of the community, “Actan Chuleb.” The other monument is a bust of the assassinated Yucatecan governor, Felipe Carrillo Puerto.

The central park is an important social space for the fishermen. Most of the cooperative members’ boats are moored to this central pier or along the breakwater

nearby. From here, they depart and return from their daily fishing trips. This is also the main late afternoon place for to socialize under the cypress trees in the afternoons after fishing or during days of bad weather when they were unable to leave port.

Pre-Hispanic Settlement

Although San Felipe today is a mestizo community, the area was first settled by Maya people prior to Spanish contact. Offshore five kilometers to the west from San Felipe's breakwater is Isla Cerritos, a round island that was inhabited from roughly 100B.C. to 1200 A.D. Material evidence from the island supports the idea that Isla Cerritos was the main trading port for the late-Classic Maya period, contemporary with the height of Chichén Itza. The earliest material artifacts found, circa 100B.C. to 400A.D., suggest that the island was a fishing village (Andrews et al. 1988).

According to Maya legend, Ceban Chan, a Prince from Ek' Balam,[10] was exiled from the city for having incurable leprosy. It was believed that the prince had acquired the disease as punishment for his sins and it was ordered that anyone who aided the prince by giving him food, water, or shelter, would be punished. Banished, Ceban Chan headed north, traveling only at night as was the custom in the Yucatan because of the heat of the day, but also because the sun worsened his lesions. He passed through the pueblos of Tizimin and Panaba, already in existence by then. When he arrived at the coast, with its nearly impenentrable mud and mangroves, he bathed in the shallow waters between the mainland and the small offshore island. This is the area he would

[10] Ek' Balam, meaning 'black jaguar,' was inhabited from around 100 B.C., with a rise to prominence around 500 A.D. (Classic Period), a cultural peak sometime around 700-1000 A.D., a decline during the Post-Classic around 1200 A.D., and was still inhabited at the time of Spanish conquest.

call *Poh Ceban*, now known as El Paso del Cerro, referring to the waters between the mainland and Isla Cerritos.

Bathing in the waters cured his ulcers and once he was healed, he decided to return to Ek' Balam to tell of his recovery and to recruit people to help found a new settlement there. At first, when he tried to return to Ek' Balam, the people refused him until they saw that he was, in fact, cured of his ulcers. He then told the people of the place with the healing waters which he called, *Poh Ceban* meaning 'washed from sin,' or 'to clean the soul.'

Ceban Chan brought people to Poh Ceban and they make a settlement on the small island, naming it *Satah-Zipil,* or the pardon of the sins. The people were said to have been aided in building the island's structures by the *aluxes*, (small mythical creatures). Satah-Zipil came to be known as a sacred place that Maya elites would visit to bathe and cleanse their sins and to commune with the Maya gods (*Kues*) but the people of the Ek' Balam prince are regarded as the first settlers of this area (Contreras Marrufo 2003).

Then, from 900 to 1200 A.D., Satah-Zipil was an important Post-Classic commercial trade port connecting the interior commercial centers, principally Chichén Itza (which was the most important city in the peninsula during the 10th-12th centuries), with other maritime ports both east and west around the Yucatan peninsula. Eventually, the place was destroyed and only the ruins of the carved stones and monuments remain, now grown over by vegetation and appearing as small mounds. These mounds are for what *Isla Cerritos* was named for (Island of the Little Hills), and are actually the unexcavated ruins of Satah-Zipil. Populated only with a staggering quantity of frigate

birds, Satah-Zipil is currently being excavated by a joint team of Harvard and UNAM archaeologists. That the island has Maya ruins is common knowledge among the fishermen, as is the rule that access to the island is completely forbidden except for the archaeologists. This rule appears to be respected, unanimously, in the community. When people tell me about the island, they make it clear that no one can go there. While I have accompanied several fishermen on fishing trips there, they have taken me around the perimeter of the island by boat only and always point out that no one is allowed to go on the island.

Although Actan Chuleb is known to be the pre-hispanicized name of San Felipe, some locals say that Actan Chuleb was actually located a little west of where San Felipe is now. The story is unclear as to the origins of the mainland settlement, where San Felipe is now. Perhaps it began alongside the growing island settlement of Satah-Zipil, which lies five kilometers to the west of the contemporary settlement of San Felipe. Or, perhaps the mainland settlement began after the island settlement was destroyed. What is known is that a pueblo was established on the mainland at the site of a freshwater spring and was named *Actan Chuleb*, meaning, place where the *chuleb*[11] bird drinks. A well was built over the place where the *chuleb* bird drinks and is now encased in concrete, marking the center of San Felipe's central plaza (Figure 3-6), a focal point of the community. Here, fishermen gather in the shade of the park's concrete-encased cypress trees to talk. Principally a place for men during the day, the park becomes a place for couples and families on weekend evenings, where a pirated music seller sets

[11] *Chuleb* is the Maya name of a species of parrot, a bird with white feathers (although the coat of arms depicts it as having red feathers). I was told another time that *Actan Chuleb* translated as 'bird with white feathers.' Another reference states that the *Chuleb* is similar to the blackbird.

up his stand, a concrete kiosk opens up to serve *tortas* and *hamburguesas*, and children play in a fenced-in playground.

The people of San Felipe today identify as mestizos and only the elderly speak Maya. Families with a multi-generational history in the community are phenotypically European, being tall and fair-skinned. The majority of the population, however, is first or second generation residents; their parents or grandparents having moved to San Felipe from either Panaba or Tizimin (Figure 3-3).

Twentieth Century to the Present

On July 12, 1935, San Felipe became an independent municipality, breaking away from the municipality of Panaba, to the south. Panaba and San Felipe have had a long relationship with many people moving between the two. Panaba remains a center for ranching commerce about 32 kilometers to the south.

Prior to the development of the lobster fishery, San Felipe was a port for transporting cattle from the ranches around Panaba to the city of Progreso, to the west. A 92-year-old resident of San Felipe remembers how ranchers would bring their cows and bulls to San Felipe and load the animals onto waiting ships by driving the animals across the rocky waterfront on wood planks. Back then, before the breakwater was built in 1975, the water was deep enough for larger vessels to dock. One such ship is still remembered locally, the sailboat *Los Tres Reyes* (Figure 3-7). Its owner, Alejandro Marrufo, used the boat to take salted fish and cattle to Progreso, Isla Mujeres, and Cozumel. His store is still run by his granddaughter, now in her 50s, and a neighboring store by his son. His son told me of how they would load the cattle onto the ships, using a pulley system to lift each animal and lower it into the hold of the ship. The ship could hold 12 bulls, 12 passengers, and salted fish. The boat would return with merchandise

to sell in Alejandro Marrufo's store. Don Alex sold the boat when a dirt road was built connecting San Felipe with Tizimin. From there, a paved road the remainder of the way to Merida. In its place, he bought a truck and continued transporting cattle and fish.

Without ice available until the 1970s, there were no facilities for preserving and storing highly perishable marine resource products. Fishing was important, but if fish were not consumed fresh locally, they must be salted and dried. In addition to the Los Tres Reyes boat exporting preserved fish, fish buyers occasionally arrived from as far away as Vera Cruz and Mexico City to buy fish. Grouper and shark were the primary targeted fisheries. Green turtle (*Chelonian mydas*) was also an important local fishery on the Yucatan coast through at least the 1960s (Carranza 1962).

In the early 1970s, two changes ultimately transformed the small communities along this coast into fishing communities: cooperative organization and the introduction of lobster diving. At this time, the Mexican government was engaged in new agrarian reforms including cooperative formation extending to fishing communities (Fox 1993). While many of these cooperatives have since failed (McGoodwin 1980), those of the Yucatan peninsula continue to function. The second event was the introduction of producing lobster for the export market. Older fishermen remember the arrival first of a group from Oaxaca and then of a small group from Isla Mujeres, in what is now the state of Quintana Roo, who came to San Felipe and introduced the fishermen to the fishery. Both state-subsidized and private capital infrastructure development, including road improvement and an ice factory, quickly followed the new market production. The paved road directly to Panaba was completed 15 years ago; prior to that time, the only paved road from San Felipe passed first east to Rio Lagartos, before turning south

through the community of Loché and on to Tizimin. During these early years, the abundance of lobster and a lofty market value led to a high rate of migration to the community, principally from the nearby ranching communities to the south.

One of the original cooperative members told me that during the early years of the lobster fishery, catches were good and fishermen would dive *al pulmon*, holding their breath and free diving, to depths of no more than 15 feet to find lobsters. He himself could dive to seven *brazas*[12] (fathoms) and in that one breath, kill three lobsters before surfacing. The lobsters were so big and plentiful, he said, that a single tail might weigh 1.5 kilograms. The water back then was also so clear that he could see the lobsters on the ocean bottom from the surface, and when he dove down to the bottom, the lobster was actually huge. In those years, he boasted, he would catch *un tonelada* of lobster a day, *puro al pulmon*, only by holding his breath. The lobsters would fill the bottom of the open hulled boats in a much shorter period of time than the fishers now spend out at sea, another old fisherman added.

The old man went on to explain that they began using air compressors to dive in 1980-82. A couple of Germans came, brought the equipment and showed some of the local fishers how to use it. The first compressors used locally were automotive air conditioning compressors. Lobsters were still plentiful, but there were more divers and they had to go farther from shore. The new technology enabled the fishermen to reach greater depths from before.

[12] A *braza* or fathom is a nautical measure of six feet. The masculine form, *brazo,* means arm, and the fishermen measure *brazas* as the distance between the fingertips when the arms are extended perpendicular from the body.

Today, the lobster fishermen use more sophisticated technology that involves both an increase in capital investment and personal risk. Yet, many days, not a single lobster is caught. With the increase in the importance of export production, the national government began to regulate the fisheries and the first federal fishing laws passed in 1996. Although enacted, enforcement, and in turn, compliance, are not complete.

Land, Homes, and Gentrification

Generally, households consist of nuclear families. Until recently, land has been available for marrying children to build their own homes near but independent from their parents' homes. In recent years, however, a process of gentrification has begun where wealthy people from outside the community have bought waterfront houses which are used only during vacations. When this process began, land was readily available and houses were cheap by the standards of city residents. Quickly, local home owners realized the willingness and ability of these buyers to pay large sums for waterfront property and houses. Because so many of these houses have now been sold, most waterfront houses remain unoccupied for most of the year, their owners visiting from other parts of Mexico only during the summer vacation and *Semana Santa* each year.

As more outsiders have purchased homes closest to the waterfront, the younger generation has had to build their houses further inland. An added problem is that the coastal community is built on reclaimed, filled land. The edge of town is ringed by houses that butt up against a wet mangrove habitat. Flooding is a frequent problem that occurs during heavy rains and winter storms (*nortes*).

San Felipe's mayor explained that outsiders buying houses is a big problem for the community and has a big impact on local young people trying to find housing. But, he feels unable to enact rules restricting land ownership (personal communication). He has

helped put in place laws that stipulate that an owner forfeits ownership of a parcel of land if it remains without a structure for so much time. Thus, some outsiders who have bought land with the intent of selling it for a profit or building a home on it at a later date, stand to lose this property.

The state government has also given money to build a *fraccionamiento* at the edge of town. Land was cleared, drained, and filled to provide homes for 30 families.[13] Each family is provided with the plot, the price of which was heavily subsidized by the government. Materials for construction were also provided. These houses stand in sharp contrast to the houses in the main part of town. While the houses in the *fraccionamiento* are rectangular, single room concrete block structures with a concrete block roof, the waterfront houses are built of wood with large windows that face the Gulf waters. Most were originally constructed with one large, open room; over time, the occupants have built partitions to create bedrooms and different living spaces. These wood front houses are painted bright colors and most are repainted each year. The waterfront and main central street are lined with these homes, giving the community an atmosphere of a small fishing community that attracts foreign vacation home buyers.

The community regularly faces the threat of hurricanes. San Felipe lies on filled mangrove marsh built right at sea level. Two or three times per year on average, the entire community evacuates inland, fleeing the path of a hurricane. The household practice of tying bed frames to the roof reveals the biggest perceived threat: flooding. That the streets and houses will flood is a certainty during even minor storms. On the other hand, it remains only a possibility that roofs will blow off, destroying the bed

[13] A subsequent program has begun to clear land for an additional 30 houses which in 2010, are nearing completion.

frames and mattresses tied just below their beams. The government's response to this seasonal yearly hazard has been to provide residents with the materials to construct single room concrete block buildings behind their wooden homes, intended for use as secure storage during hurricane evacuations. The concrete rooms are built approximately one meter higher than the surrounding ground, a height that has remained dry during recent storms. Due to another recent trend toward gentrification, however, San Felipe's residents are experiencing a housing shortage resulting in most of these emergency buildings being used as primary residences for the younger generation. Wealthy people from nearby cities, especially Tizimin, have bought most of the picturesque wooden homes along the waterfront of the community for use as vacation homes. This has led to a housing shortage for the younger generation as they mature and marry. As a result, many young couples are moving into one-room concrete structures attached to their parents' home. These structures were provided by the government after Hurricane Isidore for use as storage during hurricane evacuations. With only one small window and a concrete roof, these rooms are like ovens in the hot humid climate. In contrast, the wood houses with their large windows are more comfortable and appropriate to the climate.

Social Organization

The prominent placement of a lobster on either side of the San Felipe's adopted crest (Figure 1-1) reflects the cultural and economic importance of lobster to the community.[14] On the bottom of the center panel, San Felipe's other two economic mainstays are represented. These include a beach with palm trees to represent tourism

[14] Although they look more like crawfish, people recognize these as lobsters.

and the beauty of the community, and a bull to reflect ranching, the community's second most important industry.

Apart from fishing and work on nearby ranches, there are few economic opportunities for local men. Some families have opened small stores in the front of their homes, but these are largely run and tended by women. Throughout the community, local people know which houses sell various goods ranging from small foodstuffs, fresh butchered meat, prepared meals, and even oil and basic boat supplies.

According to the World Bank (2009a), in 2004, 47% of Mexico's population was living at or below the poverty line. Furthermore, while only 25% of the total population resides in rural areas, over 60% of those living in extreme poverty live there (World Bank 2009b). This means that generally, Mexico's poorest people live in rural areas. Employing Kottak's term (2006), the community of San Felipe lives in paradise and enjoys a relative affluence. Of the households I surveyed, all had indoor plumbing including shower and toilet, electricity, electric fans, refrigerator and stove, and a television and stereo. Beyond this, there was a great diversity in the ownership of consumer goods. Most have microwaves and DVD players. Motorbikes are common and cars are becoming more common. Local men drink bottled beer; I know of no one who distills their own alcohol. Meat is consumed daily at the mid-day meal, the main meal of the day.

People commonly expressed pride in the community, alternately pointing out how clean, safe, and beautiful it is. I was frequently reminded of the slow, stress-free lifestyle that everyone there prefers to the noise and heat of the capital city. On the other hand, fishing provides an unstable income due to volatile prices and climatic conditions. Most

families must engage in a multiple livelihood strategy. In the early months of the fishing season, July to September, there is much more money moving around than during the months of March to June, when there is little fishing and thus, a drastically reduced opportunity for income. Small businesses, such as those engaged in by women, also suffer from the lack of money entering the local economy from fishing. In the last few years, local fishermen have benefitted from government programs that subsidize fishermen when they are unable to fish due to extended bad weather (*nortes*) or during government closed fishing seasons (*vedas*). In exchange for a small salary and domestic goods, the fishermen engage in community improvement projects.

According to records kept by the municipal office, the population in 1990 consisted of 1,452 inhabitants. In the year 2000, this had increased to 1,838 people. A new census completed by the community health center put the population at 2,414 inhabitants (Table 3-1). According to the Secretary of the Mayor's office, the growth in population is principally due to immigration. At the beginning of the octopus season each year, many people arrive from rural communities around the state to work. This fishery can be lucrative and is an attractive short-term opportunity. While most of these part-time fishers return to their communities after the height of the season, each year, some decide to stay.

There is a primary, secondary, and a special education school in San Felipe, but students who wish to go on to high school must travel elsewhere. Most commute to Panaba, the ranching community that is a 30 minute bus ride to the south. Many families have family there with whom children can spend the week while attending high

school, or the children commute daily. While it is more common for children to complete high school now than in past, many do not study past secondary school.

According to the statistics of 2000 (kept by the local municipal office), 44% of the population is functionally literate with 21% having finished primary school and 12% finished secondary school. Only 3.92% studied beyond secondary school (the equivalent of the 8th grade in the U.S.). Most families are able to send their children to high school, and some go on to college or university. While school fees are expensive by local standards, the larger issue is whether or not the child wants to pursue their schooling. Many local children drop out of school before finishing secondary school and there is little resistance from parents. The parents of those children who want to attend college seem able to find a way to send their children.

There is a public health clinic in San Felipe for basic care, but most people go to Tizimin, an hour to the south, for medical treatment including births, accidents requiring x-rays, etc. The closest hyperbaric chamber is also located in Tizimin, so all divers are rushed there upon returning to shore after an accident. Many people prefer to go to Merida for medical treatment, especially to consult with specialists, as they regard the quality of care as superior.

There is no post office and not all of the houses have recognized addresses. There is a public library at the primary school. A woman who works there accepts and delivers the mail in the community. There are no banks or ATMs in the community, and most people do not have bank accounts outside of town. There are now three hotels, none of which are owned by locals. I frequently heard women complain about the owners of one of the hotels for subsisting on tourists' money but not spending any of it

in the community. Rather, this owner frequents large supermarkets in nearby cities to make all of her purchases, even drinking water.

Spanish is spoken by everyone in San Felipe. The people identify themselves as 'mestizo' and recognize a Maya heritage. Many older people speak Yucatec Maya, but most, and their children as well, claim that they learned the language on the ranches as children from Maya speakers—they themselves were not Maya.

Religion, Fiestas, and *Gremios*

Catholicism is by far the dominant religion in San Felipe. As in nearly all Latin American communities, the Catholic Church occupies a dominant position on the main square. Attendance at mass is frequented by far more women than men, although there are a few fishermen who are always in attendance with their wives. There is also a small evangelical presence in the community. Two members of the fishing cooperative are members of different evangelical churches, as are a handful of other community households. For the most part, conversion seems to accompany a trend for social separation from the remaining Catholic population of the community.

As is common throughout Latin America, fiestas are important markers of time; there seems to be some big event roughly every month. The two most important fiestas take place in February and August, marking the days of San Felipe's two saints: San Felipe on February 5 and Santo Domingo de Guzman on August 8. Additionally, there are two important fiestas for fishermen: *El Día de la Marina* (The Day of the Mariner, June 1) and *El Gremio de los Pescadores* (The Guild of the Fishermen, early February).

Gender Roles

For the most part, women do not fish. The wives of the fishermen, however, are often quite vocal and knowledgeable about their husbands' livelihoods. When I

conducted interviews in a fisherman's home, many times, his wife would join us. During these interviews, these women were often more vocal then their husband about the problems in fishing. The wives called for more enforcement of the rules and penalties for breaking the rules such as harvesting in the closed seasons. They also complained about outsiders coming to San Felipe just to fish. Not all fishermen's wives engaged in the conversation about fishing; sometimes I was politely offered something to drink before she would excuse herself.

The one fishery in which women not only participate, but is widely regarded as the women's arena, is fishing for *maxkil*, the crab used as bait for octopus fishing. A group of these women have organized themselves into a cooperative with 13 members. All of these women's husbands are fishermen except for one who has been widowed more than once; each of her deceased husbands was a fisherman.

When I first asked many of the fishermen if their wives worked, the answer was 'no'; the women stayed at home with the children. After observing that many women engaged in some type of entrepreneurial type of small business, I rephrased the question to ask if their wives did anything to earn money. The answer was now mostly, 'yes.' In addition to women running the small stores out of many of the homes, they are engaged in cash-earning activities such as selling shoes from catalogues, running *mutualistas* (a type of savings program popular in Latin American communities), and selling various desserts made at home. There are numerous women who cook meals for public sale each day. Some have small chalkboards outside their home which they update for each day's menu, at others; you must stop in and ask the cook what she is preparing that day. These meals are sold according to how much one wants to

purchase and usually come with portions of beans and rice. Other women sell evening food, usually a lighter meal, making *panuchos* and *salbutes*,[15] per order, to go.

The wage labor jobs for women in the community are limited to secretarial positions in the schools and public administration offices. Since the administration of the first PAN party mayor in 2001, a community program pays groups of women in 15 day turns to sweep the streets and pick up litter. The mayor of this administration, Joaquin Diaz Mena is responsible for many of the economic programs still in place in the community and is now a federal *diputado*.

Gender also defines some social spaces in San Felipe. After the men return from fishing, or on days of bad weather, there are two places of significance as social settings. Groups of fishermen gather on one of the central corners outside a small store, more often in the evenings. The second place, more popular during the daytime when the sun is directly overhead, is the central plaza, referred to by the fishermen as "*el ciprés*," the cypress tree. This park has several cypress trees, the trunks of which are bordered in concrete block forming benches for use as seating space under the trees. With the shade of the trees and the Gulf breeze, this is one of the most comfortable places in town on a hot afternoon. A man pushes a cart along the *malecón* (breakwater), calling out the *saborines* he is selling. He arrives on the early bus from Tizimin to sell his fruit slushies and ice creams. Lining the park are the fishermen's rusty bicycles and motorbikes. Every so often, a motorbike pulls up driven by the wife of one of the fishermen, usually with a young child holding onto her waist. Her husband gets up

[15] Yucatecan dinner fare of fried tortillas, with and without beans, respectively. The tortillas are topped with shredded chicken or turkey, pickled onions, lettuce, tomato, avocado, and/or a slice of hard boiled egg.

and oh-so-slowly walks to where she is waiting for her message. I never see the wives acknowledge the other men standing around despite that at least one of those present is likely her father, brother, or other close social relation.

For the most part, the women stay in their homes. They visit one another, and their mothers' homes, walk to do the shopping, travel out of town to visit family or to see a medical specialist in Tizimin. Sometimes, they may spend some time while picking up food at one of the homes where the woman cooks and sells food. In all the interviews on socio-economic status, I asked the men if their wife worked, what was done with the money; it was unanimous that the money she earns belongs to her. While there is a lack of public space for women to socialize as there is for men, the women, for the most part, have freedom of movement and to their personal finances. I was aware of a couple of households where domestic abuse existed and other households where a jealous spouse curtailed the movements of their partner.

Gaviotas

The transference of fishing activity from one generation to the next can be observed along the waterfront as the fishermen return home each day. Young boys called *gaviotas* (sea gulls), wait along the breakwater and docks for the boats to return, clambering aboard and competing to help the returning crew. The boys will help to gut and clean fish, sort the day's catch into plastic tubs to be weighed, and clean the boat. In exchange, the captain, who may be father, uncle, or *compadre*, will give the boy a fish or two. The boys, not restricted to sell their catch to the cooperative, always know where he can trade his fish for the most pesos. The fishermen say this money is "*para los chicles*" (for their chewing gum), but I know one father who makes his son save his *pesos* to purchase his own school supplies, like new shoes and a book bag. His young

gaviota is one of the most successful young boys and is allowed to spend some of his earnings on playing video games at the small store, too.

Figure 3-1. Map of Mexico showing the political boundaries of the states of Yucatán, Campeche, and Quintana Roo within the broader geographical area of the Yucatán peninsula. Map by Edward W. Tennant.

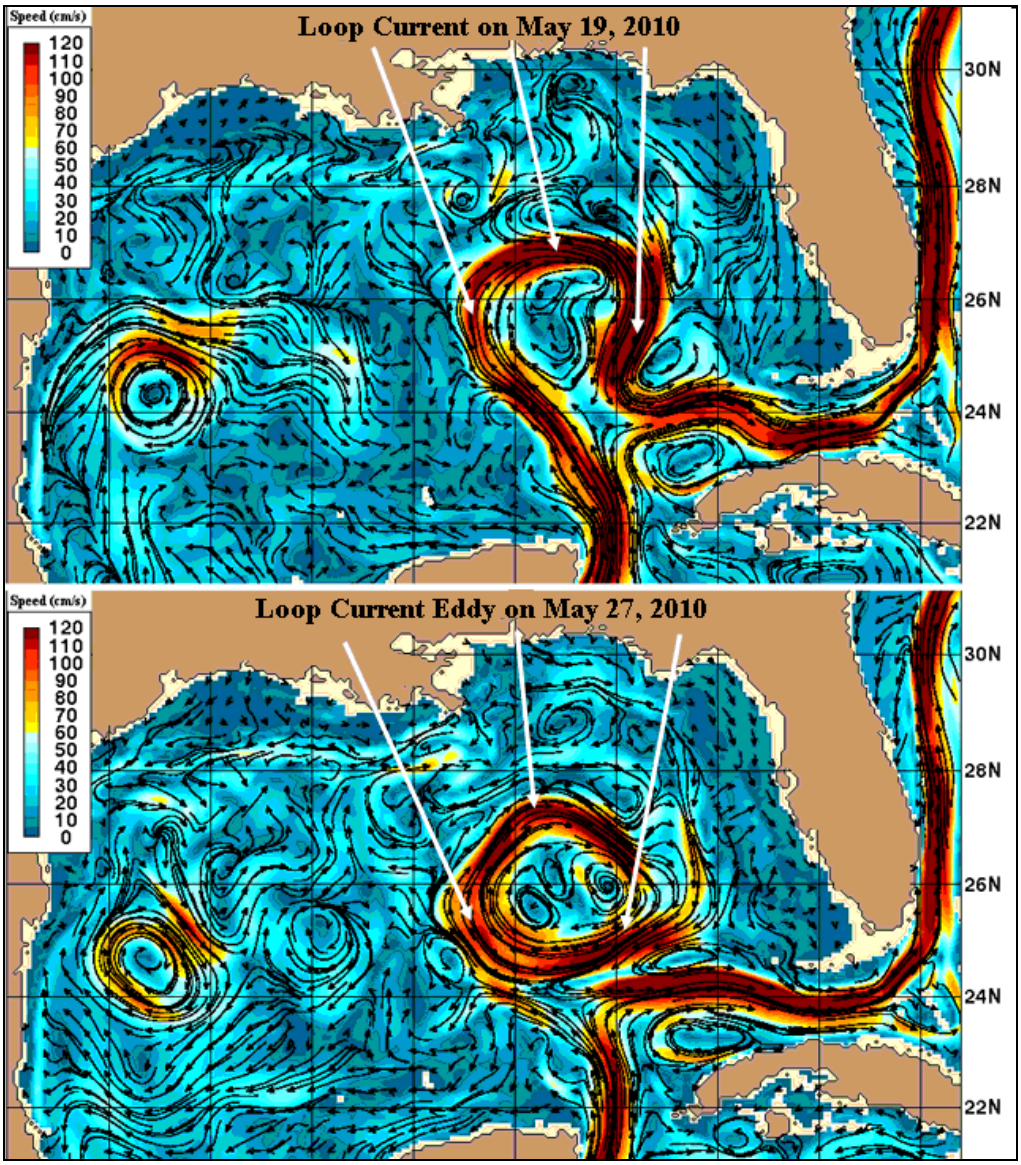
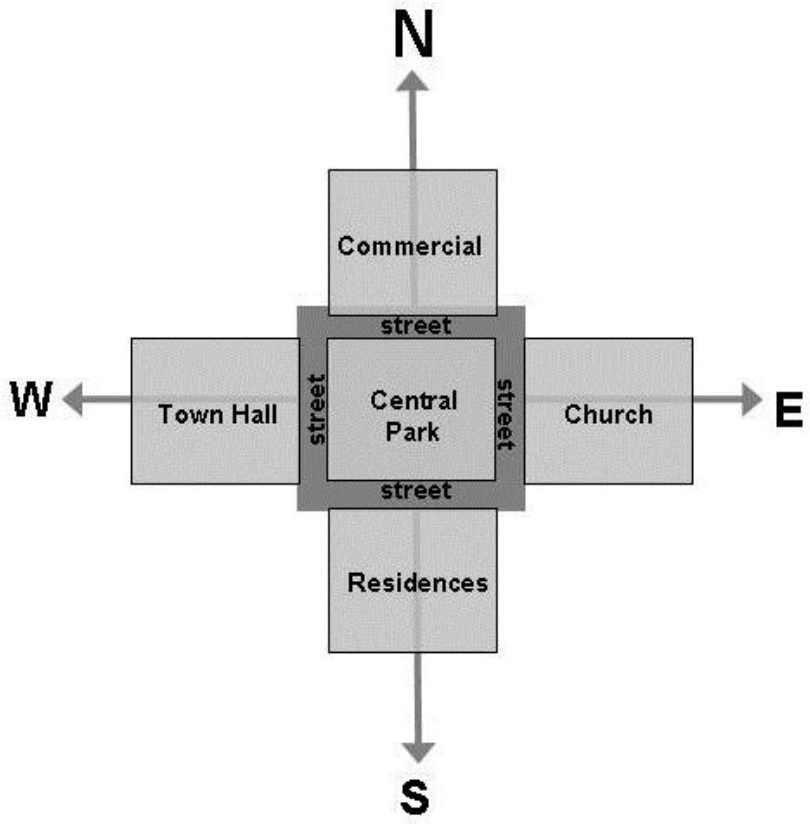


Figure 3-2. Map of Gulf of Mexico showing current vectors. The two images depict changes in the loop current on different dates following the BP Deep Horizon oil spill. The two maps visualize that the generally circular, but varied, loop current with resulting current eddies. Map by Dr. Jeff Masters, accessed June 2, 2010 http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=1494

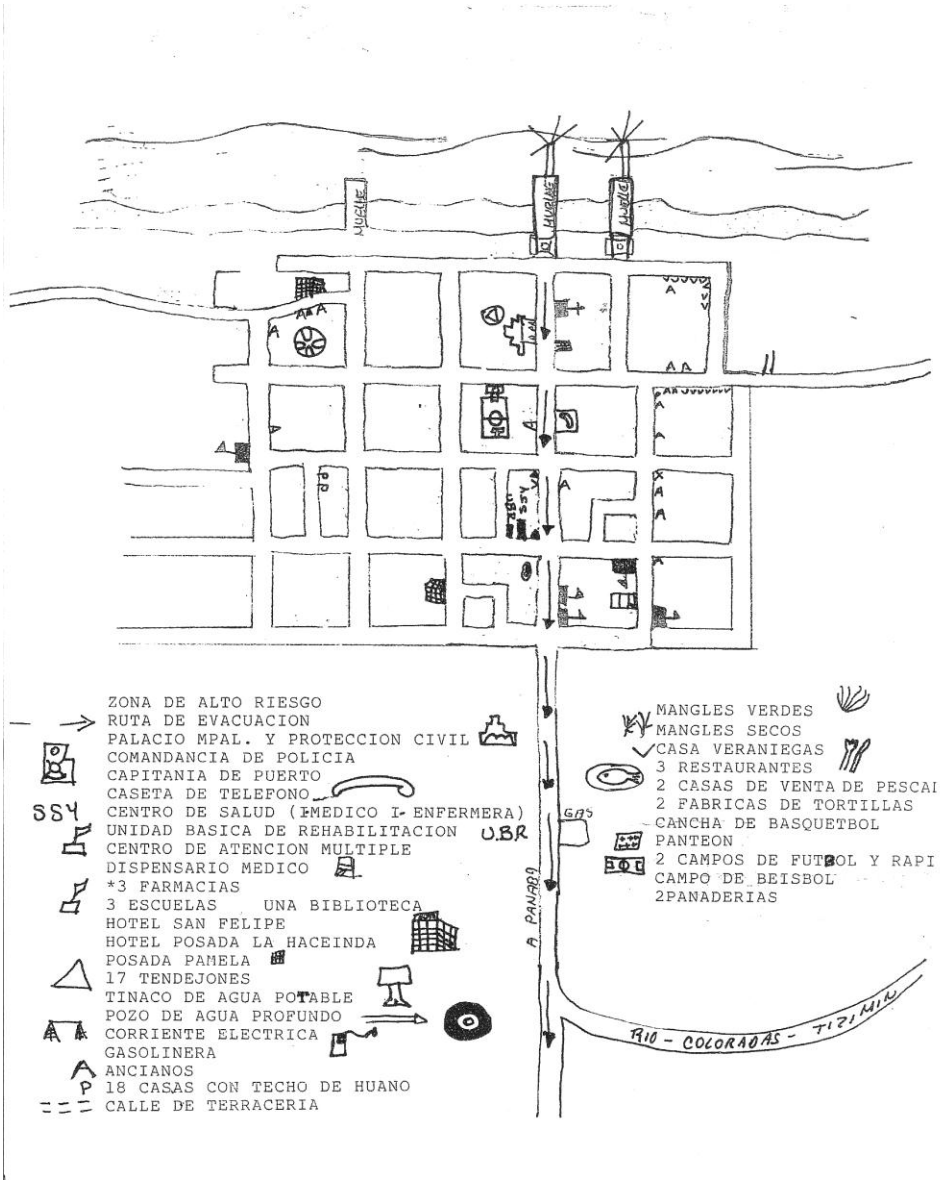
Figure 3-3. Map identifying the locations of San Felipe, Mérida (the state capital of Yucatán), the tourist hub of Cancun, and other places mentioned in the text. The cooperatives in the three fishing communities of San Felipe, Rio Lagartos, and El Cuyo are organized into a Federation of Cooperatives for the eastern half of the state's coast. The cooperative of Dzilam Bravo is a member of a Federation of Cooperatives for the western half of the state's coast.

Figure 3-4. Monuments to Felipe Carrillo Puerto such as this one, located in the central waterfront plaza of San Felipe, are common in communities throughout the Yucatan peninsula. The quote says, “Don’t abandon my Indians [Indigenous].”



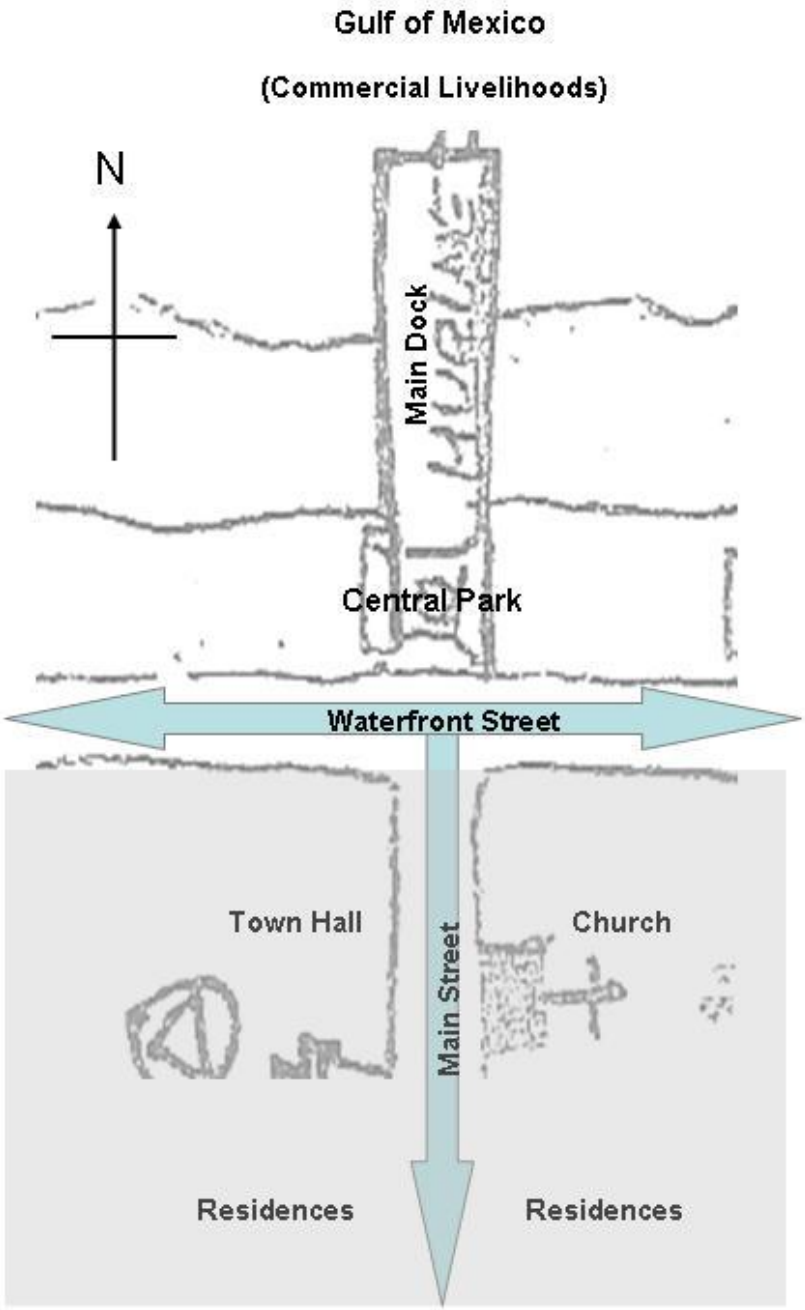
A

Figure 3-5. Throughout Latin America, the colonial Spanish used a city planning pattern based on the shape of a cross. A) A central park occupies the intersection of the arms of the cross and also represents the geographical and cultural center of the city. On the four sides of the park, corresponding with the four appendages of the cross, are located the important civic structures of the city, always in the same orientation. The church faces west and the town hall buildings are directly across, facing east. Commercial offices and residences occupy the other sides, respectively. B) Map of San Felipe provided by the city offices of San Felipe. C) Overlay of typical Latin American city planning model onto San Felipe's city center.



B

Figure 3-5. Continued



C

Figure 3-5. Continued

Figure 3-6. The Actan Chuleb well is located in the central plaza of San Felipe, shown here on June 1, 2008, the Day of the Mariner. On this day, a service is held at sea and the wreath is thrown into the sea in memory of those lost.

Figure 3-7. The sailboat, *Los Tres Reyes*, or The Three Kings, was owned by Alejandro Marrufo who used it to carry salted fish and bulls to the port of Progreso. He returned with merchandise to sell to the people of San Felipe.

Table 3-1. Breakdown of San Felipe's population by age group and gender.

Population of San Felipe in 2008		
Children	Boys & Girls	489
Adults	Men	886
	Women	867*
Age 60+	Men	94
	Women	78

Note: Data provided by the community health center in San Felipe.
*Approximately 23 adult women were pregnant at the time.

CHAPTER 4
FISHING

This chapter describes fishing, fishing behavior, and my observations of adaptive behavior to resource scarcity in San Felipe. Over the course of 13 months of fieldwork, I approached the identification of adaptive strategies in multiple ways: I talked with fishermen daily about fishing and the changes they experienced; I participated on fishing trips and observed catches at the docks when the fishermen returned to shore; I conducted an interview with a sample of the cooperative members that asked about adaptive strategies; and I collected daily production data for all cooperative fishermen which reveals changes in fishing gear and crewmates.

I begin with an overview of fishing in San Felipe, so that the reader has an idea of what fishing is like. I adhere to what is generally true for most fishermen; there are always variations on “typical”’ fishing behavior and many variations are responses to perceived scarcity. I next frame the problem of resource scarcity as an example of environmental change, according to the fishermen’s responses to questions about their perceptions of the environment and environmental problems. In response to resource scarcity, the fishermen adapt. They engage in individual behaviors that are responses to scarcity, but they are also members of a cooperative, a social institution, and as members of this cooperative, the fishermen engage in adaptive behaviors, collectively. I follow this with ethnographic accounts of how different fishermen adapt, as a way to survey specific cases of the adaptive strategies I identified. The collective actions of the cooperative are described in Chapter 6. I end this chapter with a discussion of the factors that influence the availability and desirability of these options to the fishermen, including socio-cultural, ecological, and economic factors.

Fishing in San Felipe

In order to understand the adaptive strategies, I first describe conventional fishing methods must in order to demonstrate how coping strategies deviate from conventional practice. Yet, I acknowledge that in describing *typical* fishing behavior, I am presenting a static reality which ignores the fact that fishing in San Felipe is always changing. Still, I want to paint a picture of what fishing is like in order to examine the behaviors that deviate from this norm and are a response to the increasing resource scarcity. It should also be noted that when asking the fishermen about fishing, individual responses sometimes deviated from generalized norms of behavior described by the fishermen as a group. When an individual fisherman deviated from general norms he may describe them as “the way things are done.”

Overview of Fishing Cycle

Since the 1970s, the fishermen of San Felipe have engaged in catching spiny lobster (*Panulirus argus)* for export production. Lobster is the primary commercial species for the community and has the highest economic value followed by octopus (*Octopus maya*) and red grouper (*Epinephelus morio*), in descending order of value. *P. argus* is the same species of lobster caught throughout the Caribbean and coast of Florida. Two species of octopus are present in commercial quantities, *O. maya* and *O. vulgaris*, but *O. maya* is more abundant in the shallower waters where the technique of fishing with bamboo poles (*jimba)* is used. The larger species, *O. vulgaris*, is typically found in deeper waters and occasionally caught alongside the smaller *O. maya*. Although several species of shallow water grouper are fished, red grouper (*E. morio*) is by far the most abundant. Other targeted marine species will be detailed within the corresponding sections of the technology used to catch them.

The legal harvest of each species requires different fishing technology and thus, separate capital investments. Lobster is caught by diving on compressed air. Octopus is principally caught using bamboo poles rigged as fishing lines, called *jimba*. Grouper is principally caught by long lining. Nets are also used at certain times of the year for catching grouper and other species of finfish.

It is rare for a fisherman to own and operate all four sets of equipment. Generally, it is the responsibility of the boat owner to purchase and maintain the fishing equipment that will be used. Therefore, it is rare for non-boat owners to own fishing gear. For his investment, the boat owner receives one share of the catch, in addition to his share as a diver or fisher. Just under half of the cooperative's members own a boat, which is a significant economic investment. Most members who do not own a boat are relatively young and are likely to invest in a boat in the future. A new fiberglass boat costs approximately $4,500US, while a new outboard motor can cost up to $6,200US. (Some fishermen purchase used boats or motors, when available.) Fishermen usually borrow the money for this initial capital investment from either the cooperative or the regional exporter, who also sells boats and motors. Although interest-free, these loans carried a cost to the cooperative through an obligation to sell all lobster to this exporter at the price he sets.

After a boat is purchased, most owners next invest in the equipment needed for diving including an air compressor and tank, hose, and regulator (approximately $1,300US). Few boat owners do not own dive equipment and those fishermen who do not own a boat generally do not own any dive equipment except for their own mask, fins, and thermal protection, if needed. This is true even for boat owners who do not

dive themselves. The *jimba* poles used for octopus fishing are relatively inexpensive and replaced at the beginning of each season, if a captain plans to begin catching octopus. The biggest gear variation among captains pertains to whether they own nets or longline equipment. Nets require the larger initial investment and more maintenance than the longline.

I categorize the community's fishing as 'small-scale' based on three characteristics: (1) the boat owner is both the owner of the means of production and also the captain, engaging directly in the fishing activity. (2) crew size is never more than 3 men, and (3) the technological investment depends on manual power rather than mechanized power. Nets and lines are pulled in by hand, and while divers use fuel powered air compressors, the hose is fed out and managed by the labor of a deck hand. Furthermore, the fishermen stay near shore, fishing in 24' fiberglass open hull boats, most with an outboard 60hp motor (Figure 4-1). Fishing activity is limited to day trips; only during the slow fishing season will some fishermen stay out to sea overnight in order to minimize fuel expenditures. Even on these fishing trips, however, captains remain close to shore, spending the night in hammocks onshore.

Two factors regulate the yearly fishing seasons: (1) closed seasons for managed species and (2) climatic events. There are federally mandated closed seasons for the three principal species: spiny lobster, octopus, and grouper. Lobster season opens on July 1 each year and closes on February 15. Octopus has the shortest season, open only from August 1 – December 15 each year. The closed season for grouper lasts from March 15 to April 15 each year, recognized as the spawning season.

Climatic factors render ocean conditions unsuitable for each type of fishing at various times of the year. The cold fronts (*nortes*) begin to arrive from the north beginning in late October, bringing strong winds that make conditions too rough to leave port in the small boats used by the fishermen. For several days after the winds have calmed, the water remains too turbid for the fishermen to find lobsters while diving. This is an opportune time for net fishing and some fishermen switch gear from compressor to nets at this time of the year. When the moon is full and the waters clear, however, net fishermen say that fish can see their nets, rendering net fishing unproductive under these conditions. Fishing for octopus with *jimba* relies on the movement of the waves rocking the boat, which moves the lines hung in the water, to attract octopus to the bait. For the first month after the octopus season opens, the water is usually too calm for good octopus fishing. Thus, although the season opens on August 1, it is not until September that the season becomes busy with octopus fishermen, due to improved conditions for this style of fishing.

From conversations with researchers working in other parts of the region, I became aware of some features of the local fishing that seem specific to San Felipe. The following are worth noting as they reflect local practices and thus consideration of available adaptive strategies. Unlike other small-scale fisheries in the broader region of the Gulf of Mexico and Caribbean Sea, San Felipe's fishermen do not carry multiple fishing gear on a single day. That is, if they leave port equipped for diving, they do not carry aboard a long line, nets, or the poles for octopus fishing. Nor do the crews change fishing gear from one day to the next and back again. Once a crew is using one type of gear, they will use that equipment for a period of time, usually at least a month, before

switching gear. The shortest period of time I witnessed a crew fishing with a particular gear, was switching between diving and nets. When the cold fronts (*nortes*) begin in October and November, the fishermen are often unable to dive for a couple weeks at a time and some may switch to using nets during this time. Those who own nets, will take their compressors off their boats, replacing it with their nets. Many of these crews, once the switch to nets has been made, will not return to dive before the end of the season. So, short-term decisions on changing fishing gear or species is not an adaptation that is made during a fishing trip, while at sea.

Diving (*Buceo*)

The opening of the lobster season on July 1 each year is the symbolic beginning of the yearly fishing cycle. Leading up to this day, the least amount of fishing production of the entire year occurs in the month of June. Fishermen are busy preparing for the new season: air compressors are serviced and repainted; new fins and masks are ordered if needed. But fishing activity ceases not only to begin preparations for the new season. By this time of year, the bait for long line fishing is scarce and the price of grouper has dropped. Even if fishermen want to fish, the lack of bait often prohibits their ability to do so. The lack of fishing activity impacts the economy of the entire community. Without money coming in from fishing, there is little money moving around town, being spent in local stores and cantinas. As July 1 approaches, there is a buzz in the air; the fishermen talk only about what the season will bring. Will the diving be good?

Only the boats of cooperative members are permitted to dive for lobsters. Thus, the permits are linked to the boats. On the night before the opening of the lobster season, June 30, 2008, I walked the entire breakwater and counted 108 boats that were

prepared to fish for lobsters in the morning. Of these, 71 are boats owned by members of the Pescadores Unidos and the remaining are owned by members of the Pescadores Legitimos, the faction of members that broke away from the Unidos cooperative (Chapter 3).

On the morning of July 1, just as the day begins to get light, the docks are busier than they have been in months. Men are coming and going, pushing their dollies loaded with fishing gear to their boats. A local restaurant has set up a kiosk to serve breakfast and make prepared lunches. A group of fishermen's wives have also set up a small eatery; they fry *empanadas* and pack *tortas* wrapped in napkins into plastic bags for the men's lunch at sea. By 8:00 in the morning, the dock is empty of all boats. One of the women jokes that on this day each year, there is not a man left in town and the women could do whatever they want.

Although some fishermen left in the pre-dawn hours to stake out their favorite lobster spot, they are unable to dive until first light. The divers do not use underwater lights and rely on daylight to find lobsters hiding in the crevices of the substrate. On a typical lobster diving trip, the crew of three men departs the dock just past 7:00 a.m. and will return between 3 p.m. and 6 p.m. The crew consists of the captain, who is also the boat owner and primary diver; a second diver; and a helper, called a *manguerero*. Diving for lobster is the most capital intensive of the fishing techniques. The diving is surface supply diving, which uses an air compressor and hose to supply air to the diver in a hookah-type system. A regulator, mask, and fins are also required. Some divers use thermal protection (wetsuit) including a neoprene hood, while many dive wearing only underpants. All dive boats now use GPS units to mark successful fishing locations

and to return to those locations. The cost of this initial investment varies greatly as many divers begin with used equipment. As a member of the cooperative, a fisherman can purchase needed equipment on credit through the cooperative, which does not charge interest, and payments are deducted from the fisherman's daily production over time.

As the crew departs the dock, the boat first passes through a dredged channel in the barrier island. For this part of the journey, the captain motors the boat at idle speed while engaged in dialogue with the second diver about where they will fish that day. They review the captain's book of marked coordinates of successful lobster habitat or talk about searching for new fishing spots. While it is ultimately the captain's decision where to fish, the decision-making process is based on mutual input. Sometimes, another boat will pull up alongside them in the channel and this decision will be examined among two boats.

After passing through the channel, the boat reaches the open waters of the Gulf of Mexico and they increase speed. The GPS unit is now programmed to direct them to their first selected fishing spot of the day. The use of GPS units has impacted how the fishermen communicate about the marine space. Previous systems of marine navigation of triangulation using landmarks on shore have been replaced with a vocabulary that describes the marine space in terms of *cuadras*, or squares of longitude and latitude, often coupled with a compass reading in degrees. For example, a captain may tell another he fished in "45x00." Both recognize this lexicon as meaning they went east to Las Coloradas and fished in approximately seven (14 meters) *brazas* depth. Compass readings are used in degrees. Because this part of the coast runs fairly

straight east to west, north of San Felipe is 360 degrees, east is 90 degrees, and west is 270 degrees. Fishermen are often heard saying that they are going to 330, which means North Northwest, or 30 degrees west of due north.

There are two techniques of diving for lobster: *revisando* (revising) and *arrastrando* (dragging). Revising refers to when the crew returns to previously recorded GPS coordinates where lobsters have been found on previous fishing trips. These coordinates are kept in a log book, carefully guarded by each captain. Dragging is the technique for finding new caves and ledges (*cordilleras*) in which lobsters may be found. On a given fishing day, divers may both revise known coordinates and drag, looking for new coordinates to mark. Finding new coordinates can take time given the general homogeneous blanket of algae that covers much of the substrate.

A brief note about Gulf of Mexico ecology is relevant to add here. Much of the calcareous rock substrate of the Campeche Bank off of San Felipe is covered with a layer of swaying algae and echinoderms such as sea biscuits are common. Expansive areas of this monotonous substrate are randomly broken up where holes in the hard bottom become cracks that create a ledge. The fishermen call these cracks *cuevas* (caves) or *huecos* (holes) and longer ledges *cordilleras*. These cracks and holes offer shelter and attract marine life such as reef fishes and spiny lobsters. The lobsters hide underneath the cracks during the day with only their antenna waving outside of their dens, and leave their refuges to roam at night, foraging for food (Figure 4-2 shows examples of the substrate and bottom types).

When a diver is revising coordinates, the captain positions the boat so that the cave is directly below while the diver prepares his equipment and moves to the side of

the boat from which he will enter the water. When the exact location has been reached, the captain gives the go ahead and the diver enters the water, usually just after crossing himself with a Hail Mary. The helper who is in charge of the compressor and air supply line (*manguerero*), feeds the hose out to the diver taking care that the hose does not kink, which would shut off the diver's air supply. He also monitors the air supply in the compressor's tank, turning it on and off appropriately. The diver searches for the cave below and ideally finds lobster as well. He may take the time to look for fish to spear (Figure 4-3), then he either surfaces and the boat moves to the next coordinate, or the diver searches the nearby area for other caves and ledges.

Dragging usually begins after a coordinate has been searched for lobster, or revised. From there, the captain begins to move the boat in a given direction. The diver remains underwater, holding onto the hose through which his air is supplied, and is literally dragged along the bottom. While being dragged, he looks for particular species of fish such as porkfish and angelfish which congregate near the caves in which lobsters are hiding. These fish signal the presence of nearby habitat where lobster may be found. The diver signals the captain to stop the boat by tugging hard on his air supply hose, and then searches the nearby substrate for caves containing lobster. Another hard tug to his air hose signals the captain to resume dragging. Two hard tugs in succession signal the captain to mark the spot where the diver is on the GPS device. Unless he surfaces with a good catch (Figure 4-4), a diver will usually signal again to resume being dragged underwater.

As is common among fishermen everywhere, the exact location of successful fishing spots are a closely guarded secret (Durrenberger and Palsson 1987, Forman

1967). The fishermen of San Felipe share where they fished with one another, but limit their answers to the longitudinal square where they fished. A captain may tell other fishers that they fished in 37x15 that day. The other fishermen understand that those coordinates correspond to three *brazas* (six meters) deep and north of the inlet. Within that broad area, the specifics of their fishing location is still kept secret.

Decompression sickness. In addition to the added investment in gear, divers breathing compressed air are at increased risk of problems due to the physiological effects on their bodies from pressure underwater. Decompression sickness (DCS), also known as “the bends”, is the most common dive injury to inflict San Felipe’s divers. The increase in pressure on a diver’s body (think about how your ears hurt in a swimming pool) while breathing at depth corresponds with physiological changes in the human body. The partial pressures of nitrogen and oxygen, from air breathed under pressure increases and through respiration, are absorbed into the bloodstream in greater quantities. As a diver ascends, pressure on the diver’s body decreases and air expands. The diver should ascend slowly to allow time for his body to compress the gas particles and through respiration, eliminate the excess gas. If he ascends too rapidly, the excess nitrogen can form bubbles which can become lodged in his joints, lungs, or brain. The result is decompression sickness (Vann 1992, Flemming and Max 1990, Miller 1979).

Other dive related injuries that have occurred to divers during my stay in San Felipe include carbon monoxide poisoning, middle ear barotrauma, and gas embolism. This last injury led to the death of a cooperative member and is detailed below. Yet, despite the severity of these injuries, many fishermen accept DCS as a risk of the job. In fact, many divers in San Felipe have never developed symptoms of decompression

sickness and have never been treated in the hyperbaric chamber. These divers cite their conservative dive profiles as the reason they avoid decompression sickness. This is important to note: lack of education as to the risk factors of DCS is not responsible for the high rate of DCS. When I ask a diver about why he got decompression sickness, they are always able to answer that (a) they were diving too long, (b) they were diving too deep, or (c) they were exerting too much force while spearfishing. The divers know how to avoid DCS, yet many engage in risky dive behavior anyway.

Lobster divers along this coast of the Yucatan develop decompression sickness with alarming frequency. In 2005, 25% of the cooperative members were treated in the hyperbaric chamber at least one time (Lasseter 2006). Each year, the first incident of decompression sickness occurs earlier in the season (Table 4-1). Developing decompression sickness is not an adaptation, of course, but rather an impact from a behavioral pattern engaged in as a response to scarcity. Each year, the fishermen say they must move to deeper waters earlier in the season to find lobsters. Following this trend, the first dive accident of the season is occurring closer to the beginning of the season. As discussed in Chapter 7, the availability of good lobster catches at the beginning of the 2010 season probably contributed to the delay of the first dive accident of the season until August 2.

Pole Fishing (*Jimba*)

Octopus season extends from the beginning of August through the end of December. This type of fishing uses the least capital investment, requiring only a pair of bamboo poles, spools of a thin nylon rope (*hilo*), and bait. The bamboo for the poles are grown in fields outside of Merida and cost 40 pesos each (approximately $4US). New

poles are bought each year. The poles are affixed to the boat so that one extends out the bow and the second from the stern of the boat.

With the poles attached to the boat, a series of lines are rigged to each pole; three lines for the bow and three for the stern. The lines are rigged so that the fisher can pull in the lines while remaining stationary in the center of the boat, checking all the other lines. An additional three lines are rigged to one side of the boat and the lines will be thrown to the side from which the current comes. When we arrive at the fishing grounds, the captain throws a blue tarp, attached to the side of the boat with weights on the bottom, overboard. This will create drag and keep the boat from moving too fast with the wind. The fisherman then ties lobster heads to the end of the thin rope lines along with three 200 gram lead weights. Lobster heads are the preferred bait. (A kind of crab called *maxkil,* Figure 4-5, or horseshoe crabs are also popular bait.)

Once the lines are baited and in the water, the boat's rocking with the waves attracts the octopus to the bait. When the fisherman feels a tug on the line, he pulls in the line. Sometimes, the octopus lets go as the line is pulled in, but usually, the line ends with an octopus wrapped around the bait. Grasping the octopus around the animal's head, the fisherman pries the animal from the bait, its tentacles reaching up his arm. With his other hand, the fisherman uses a sharp tool to stab the octopus in its mouth, where the tentacles meet. The fisherman is careful to do this while leaning overboard; as he does this, killing the octopus, the animal releases its ink as a last defense. Once dead, the fisherman inverts the head of the octopus and rips out the animals organs, before throwing the rest of the animal into the cooler on the bed of ice.

If the bait is still intact, he returns the line to the water. Sometimes, new bait must be tied to the line.

In addition to setting the lines for octopus, the fisherman keeps a monofilament line in the water to fish for grouper. The line is wrapped around a plastic spool or a rectangular piece of wood with wide notches cut in the end, on which to wind the line. Either of these is called a *cordel* and is used instead of fishing rods. He will cut off the end of a tentacle of a caught octopus to use as bait on the hook.

Jimba fishing requires only one crew member. A captain, who will also fish, usually recruits one or two other octopus fishers to accompany him. While the captain will fish in his own larger 24' boat with the motor, he loads one or two smaller boats, called *alijos* or *chalanas*, one for each additional fisher. These smaller boats are also rigged with the bamboo poles, but no motor. The crew departs port with the smaller boats loaded aboard the mother boat and heads to the day's fishing grounds. When they arrive, the crew pushes one of the *alijos* off the boat and one of the fishers will board. Moving away some distance, the second *alijo* will also be set adrift, with its fisherman. With no motors, the boats drift with the waves, the motion moving the bait to entice octopus (Figure 4-6). Nearly all fishermen also keep a baited handline apart from the *jimba* lines, used to catch small groupers. This catch is kept for home consumption by the fisherman and is the only example of multi-gear use on fishing trips. The captain fishes from the main boat (*lancha*), drifting without the motor while keeping an eye on the two smaller boats. He will pick up each fisherman and his *alijo* at the end of the day and all three return to shore together.

This system saves fuel expenses by carrying three fishing boats but using the fuel of only one boat. The accompanying fishers give the boat captain a third of their catch, in a cash transaction after the octopus has been sold. This means that the fisher is free to sell his catch to whatever buyer offers the best price; usually one of the private fish houses. Cooperative members must sell all their catch to the cooperative or risk being fined.[16] The side catch of grouper is not shared with the captain of the mother ship; it is understood that this catch is removed from debt.

Longlining *(Palangre)*

Grouper may be caught year round except for a one month closed season from March 15 to April 15 each year. The principal method for catching grouper is with a long line (*palangre*). The long line used by San Felipe's fisherman relies entirely on manual labor, as opposed to those that use a mechanical winch to retract the line. Also, the line is a monofilament fishing line, not wire. A hook is tied to the line at every three meters and stored on a *piano*, a wood board with slats for each hook (Figure 4-7). The piano facilitates baiting the hooks and prevents entanglement of the line.

Longlining requires two crew members. The fishermen leave port at roughly 4:30 a.m. and return around 4 p.m. The fishing grounds for long line are the farthest from shore, compared to diving, *jimba*, and net fishing. When the fishermen arrive at the fishing grounds, they begin to prepare the line by cutting up bait and baiting the hooks. Ballyhoo (*pico rojo*) is the preferred bait and costs five pesos per kilogram; each fish is cut into five pieces. When the entire length of line is baited, they begin to throw the line

[16] From time to time, debate arises as to whether cooperative members should allow the catch of their non-member *alijo* fishers to be sold independently. The argument pertains to the monies lost by the cooperative when members do not sell all the catch landed by their boat, to the cooperative.

out. Each end of the line is attached to a pole and buoy that is marked so that the fishermen can recognize their own line; weights are also attached. Some are painted and others are marked with torn rags. As one fisherman steers the boat, the other first throws the pole and buoy into the water, then each of the baited hooks, the steering captain keeping an eye on the GPS unit in order to steer the boat in a straight line. The last hook is followed by the end pole and buoy. The fishermen move to a new location and throw in a second long line. Once this long line is set, they return to the first line and begin to pull in the catch.

Again, one fisherman pulls in the line while the other steers the boat. First, the pole and buoy are pulled in, followed by each hook which is placed in the next available slot on the piano. The bait is missing from most of the hooks; the amount of fish caught varies widely; sometimes not a single fish surfaces on a line of 100 hooks; other times, the catch is good and many fish are caught. The most common species caught on the line is red grouper, followed by other species of grouper, snappers, and fish species such as small perch and grunts. These are often used as bait for setting the line again.

One problem with the use of the long line is the reliance on bait, which becomes a greater problem as the season progresses (Figure 4-8). Ballyhoo (*pico rojo*) is the preferred bait and is caught using a small mesh net, but only a handful of fishermen in the community own these nets. It is formally illegal to catch ballyhoo in the state waters of Yucatan, as the government desires to protect the species from being exported to the bordering state of Quintana Roo where it has a high value for sport fishing bait.

Net Fishing (*Redes*)

Net fishing is practiced in the community for harvesting various fish species, but is generally practiced only when other fishing technologies are not viable. Nets are

expensive and require much time to maintain; fishermen are often seen repairing their nets in their doorways or public social spaces such as the central plaza (Figure 4-9). Many fishermen do not see nets as a worthy financial investment, some think they take too much time to maintain, and a handful of fishermen sold their nets recently after an accident.

Nets are most often used when the weather is poor both because they are used closer to shore and because turbid water increases catches, in contrast to other fishing gears. At the same time, net fishing in poor weather is risky. Choppy seas coupled with the unbalanced weight on one side of the boat while nets are pulled aboard makes capsizing a real risk. A few years ago, a net fishing boat from San Felipe capsized while at sea. The bodies of the two fishermen aboard were never found. This was not an isolated event; the local newspaper publishes articles of similar tragedies happening in other communities along the coast with enough frequency that many fishermen regard nets as a risk not worth taking.

The most common net fishing requires a three-member crew and uses a drift net. Like the long line, there is a pole and buoy that mark the end of the net. With the nets stretched out so the top of the net (with floats) is closest to the boat's bow and the bottom of the nets (with lead weights) towards the stern, a fisherman tends each of these ends. The captain remains at the motor, steering the moving boat to facilitate setting of the net in the water. As the boat moves, the fishermen lift and spread the net evenly over the side of the boat, helping the net to enter the water untangled (Figure 4-10). Several nets made up of *paños*, or sections of net, will be set adrift at a time. Unlike long line fishing, which returns to pull in the first line after all lines have been set out, the

nets are left at sea and the crew returns to shore. Nets are set out in the afternoon, from 3 p.m. to 5 p.m., and then checked in the morning. Some fishermen then reset the nets and leave them out during the day, while others bring them ashore and return in the afternoon to set them adrift for the night.

Other types of net are used in San Felipe including the nets used to catch the bait fish for longline fishing. Only four crews own these nets, which often results in great demand for their catch by numerous fishermen who wish to use long lines. A couple of longline fishermen have smaller versions of these bait nets and are able to catch their own bait on their way to long line fish.

Other Fishing Equipment

The previous four fishing gears are the most commonly used in San Felipe. Other fishing equipment is less commonly used. The nets described above are the most common type of net in use, but one fisherman owns a cast net that he uses during Lent. He makes casts in the brackish mouth of the estuary, close to port thereby not requiring much fuel for the boat. He sells his catch locally; often there are people waiting for his return at the dock.

Two other types of fishing involve the same equipment but different techniques and locations to catch different species. As mentioned above in the octopus fishing section, rods and reels are not used for line fishing; rather, a *cordel* is used. This refers to a monofilament fishing line that is hand wound on either a plastic spool or piece of notched wood (Figure 4-11). With this equipment, the fishermen will either troll (*simbrar*) for barracuda in the marine reserve, or fish at night for yellowtail snapper (the word *cordel* is used both for the gear and the type of fishing). Trolling is done by baiting and setting one or more lines and pulling them along the surface of the water, behind the

boat. This technique is used in the shallow waters of the marine reserve, directly east of San Felipe. Barracuda is the primary species targeted although a smaller quantity of grouper is caught as well. Using a *cordel* to catch yellowtail snapper involves leaving port around 5 p.m. and heading to the depths where the long lines are used. While long lining catches bottom dwelling groupers, yellowtail snapper are feeding at night in the water column, so the *cordel* lines are baited and set to hang mid-water. One or two fishermen will remain at sea throughout the night with several lines set at a time. This is the favorite type of fishing for one local fisherman. A quiet, reserved man who captains his own boat, he does not dive himself. Rather, he employs a diver to work for him during the initial month of the lobster season. He quickly exchanges his compressor for other gear types at the end of the first month of the season and is known for consistently good catches year round. He told me that he loves fishing at night with *cordel* because of the cool temperature and the quiet of the sea which allows him to think while fishing the entire night.

Perceptions

In approaching my research question of how fishermen adapt to resource scarcity, I knew it was important to investigate how and if they perceived scarcity. I approached this task formally, by asking the sampled fishermen a series of questions, and informally, by analyzing how their language reveals perceptions of their resources. This difference between formal and informal corresponds with an emic and etic analysis, respectively. First, I present, in the fishermen's own words, how they describe environmental problems. From my etic perspective, then, I examine the words they use to describe these resources for meaning.

Perceptions of the Environment

In the next chapter, I develop and code observed behaviors into adaptive strategies. The behaviors I am examining are responses to resource scarcity, or to be more accurate, the fishermen's perceptions of resource scarcity. This distinction is important: it is not my aim to identify the cause(s) for the decline nor to examine spiny lobster recruitment patterns. My focus is on the behavioral responses of resource users who feel an insecurity of access to their resource. Here, then, I discuss the fishermen's perspective of scarcity.

In interviews conducted in 2005 and 2008, I asked a sample of fishermen about their perceptions of the health of the fishery and experiences with environmental change. I also investigated their perceptions during numerous informal conversations. In each interview, I designed the series of questions to avoid suggesting to the informant that there is a problem with the resources, environment, or the fishery. Rather, I began by asking whether they have any concerns about the fisheries and note (below) when fishermen report normalcy, as compared with scarcity of resources.

In the summer of 2005, I documented perceptions of resource scarcity reported by the fishermen. I used a quote from an older fisherman in the title of my thesis: "Lobsters are Like Gold," because it captured the value and perceived scarcity of the resource this fisherman expressed. In an interview with a random sample of the cooperative's members at that time, all reported that the abundance of lobster was declining, although they had different ideas as to the cause of the decline. Some blamed off-shore fishers for harvesting all the large lobsters with traps before these giants can reach the community's near shore fishing grounds while others blamed pollution and contamination of the sea. Many complained about fishermen who take undersized

lobsters or catch lobsters out of season for sale on the black market. The one factor agreed upon by all, however, concerned an increase in the number of divers and boats as responsible for the decline. Each year there are fewer lobsters and more fishermen. They acknowledge their own role in their predicament, yet see no way to stop the decline. They expect the commercial quantity of lobsters to continue declining and predict that within 10 years, the resource will disappear entirely (Lasseter 2006).

The decline is also recognized at the regional export production plant in the state capital of Mérida where the cooperative delivers the fishermen's harvests. The manager of the reception facility at the plant, Agustin Peniche, told me that each year, he notices that the lobsters get smaller and the quantities from each of the fishing communities are decreasing (Agustin Peniche, *Atlantida Pesquero*, Mérida, personal communication). Thus, local production can have effects at the regional level, too.

Outside of local experiences, the newspaper is another source of information about the fishery that stimulates discussion. The regional newspaper, *Diario de Yucatán*, frequently publishes articles about the state's fisheries. For example, an article published on July 21, 2007 predicted a bad season for octopus harvests in the peninsula with the headline, "*Este Año Bajará la Captura de Pulpo*" ("this year, the octopus catch will be lower") (*Diario de Yucatán* 2007). Prior to the article's publication, the fishermen were talking about whether the octopus catch would be good. The fishermen recognize that octopus catches move in cycles; in some years, octopus are abundant and in others, they are scarce. The stocks of these primary resources fluctuate according to both fishing effort and natural pressures within their own trophic relationships. According to Arreguín-Sánchez (2000), the variation in annual yields of

octopus, as noted by the fishermen, coupled with the constant fishing effort at present suggests that the octopus stock is undergoing heavy pressure. Arreguín-Sánchez's analysis also found that the seasonal decreases in the octopus population correlated with an increase in lobster. Octopus is the main predator of lobster.

After publication of the article, everyone was talking about the prediction although most had not read the article themselves. When I informally asked fishermen about the article prior to the first day of octopus season, August 1, everyone would only say, "*dice*," or, "so they say," that the octopus season would not be good. They proposed theories as to why this year, the catches may be lower, and discussed the plight of their resources overall. It was interesting to hear them integrate different sources of information, their own and each others' observations plus this externally reported media article. The prediction turned out to be true when the season opened less than two weeks later; the year's octopus catch was low.

In 2008, I interviewed another random sample (n=44) of the fishermen about their perceptions of the environment and resource availability. I asked a series of open ended questions and describe the results for three of these questions below.

What types of changes have you seen in fishing? In the answers to this question, interviewees recognized a decrease in catches. Of the 44 fishermen interviewed, 35 either remarked that catches were less (*menos*), or that there used to be larger catches (*había más*). Seven more used the word "scarcity" (*escaso*) or overexploitation (*sobre explotación*) to describe the current state of fishing. Of the remaining two fishermen, one, a 47-year-old fisherman answered, "before, I would dive here in the shallows, up to six to eight meters. We dive now to as deep as 24, 26

meters." While he does not state that there are fewer lobsters, he notes an increase in dive depth in order to find lobster, indirectly noting that lobsters are less abundant in the shallower waters. Many other fishermen also noted in their responses, the need to go farther from shore in order to fish successfully (eight of 45, or 18%).

Only one fisherman's response did not note an overall decline in resource availability. A 30 year-old fisherman responded that "there are years of [good] harvests and years without harvests, [it] depends on the red tides (*mareas rojas*)" He went on to say, "this time they [red tides] were the strongest. I've seen [them] three times." (One other fisherman noted in his answer that during some years, the fishing is worse than others, but he added that overall, the fishing is declining.) Fishermen differ in their explanation of red tides, specifically whether or not they are of anthropogenic origin. In a different interview about knowledge of the marine environment, I asked the sample of fishermen (n=45) about the cause of red tides. Most (30 out of 45, or 67%), including the fisherman just mentioned, answered that red tides are caused by the decomposition of algae (locally called *yerba*, Figure 4-2), reporting a process that is not of anthropogenic origin. Three fishermen attributed red tides to contamination, and five fishermen said they did not know the cause. Only one attributed the phenomenon to a type of organism that was not algae, which would be the answer closest to the etic explanation.

What changes have you seen in the environment? I next asked about the changes, if any, they had observed in the environment. These answers did not share a common theme, as did answers to the previous question. Of the 44 respondents, the most common answers were an increase in the frequency of red tides (15 mentions, or

34%) and an increase in the frequency and intensity of hurricanes (11 mentions, or 25%). One mentioned that after hurricanes pass, the substrate changes. Another specifically cited changes since Hurricane Isidore hit San Felipe in 2002. Since then, some edible species of conchs found in the estuary have disappeared. There were seven mentions of changes in the severity of the cold fronts that occur beginning in October, and in increase in bad weather (*tiempos malos*) was mentioned eight times. Three fishermen mentioned contamination in the environment, one of which cited the fishermen's adoption of motorbikes for the bicycles they used to use. Three more cited global warming without citing specific local manifestations of its impacts. Finally, some fishermen had unique answers including an increase in warmer water, an increase in water turbidity, an increase in wind intensity, and a decrease in marine biodiversity (one respondent each). Finally, five fishermen (11%) answered that they have not observed any changes to the environment.

What is the biggest risk to the marine resources of San Felipe? I was not surprised to find great variation in answers to this question. Again, many cited environmental factors such as red tides (11 mentions) and weather phenomenon such as hurricanes and other storms (5 mentions) as major risks. Nevertheless, threats of anthropogenic origin were mentioned most frequently. These included over exploitation (7 mentions), marine contamination (2 mentions), too many boats (4 mentions), too many fishermen (8 mentions), and "other" fishermen (6 mentions). This final category of "other" fishermen included two groups. Fishermen cited local buyers who recruit people from surrounding communities to fish in San Felipe, as well as fishermen from other parts of the coast who fish in larger boats, farther from shore. Blaming the "other,"

however, was not always the case. Several fishermen noted that their own participation contributes to the problem (Table 4-2) by using the *we* form of verbs.

An additional six fishermen noted the imminent offshore drilling plans of PEMEX, the national oil industry, as the biggest threat to local fishing. Finally, one fisherman noted the increased technology they use, and another the fact that they fish farther from shore, as the biggest risks.[17]

Perceptions of the Resources

The results of the interview presented above speak to what the fishermen perceive from their emic perspective. I want to turn now to address an etic observation of linguistic usage that relates to how the fishermen perceive the environment. This pertains to how the use of language denotes meaning in examining the fishermen's relationship with their environment and resources.

In consideration of my own linguistic usage, a resource is something of value. Marine resources, then, refer to those parts of the marine environment which have value to a stakeholder. That value can be defined in multiple ways, but for fishers, it is most common to label as resources those species of the marine environment that are caught for their use or exchange value.

In the interview section containing the preceding open-ended questions, I consistently used the term *recursos* (resources) or *recursos marinos* (marine resources) in asking about change in the fishery. Yet, in their responses, the fishermen always used the term *el producto* (literally "product"), to refer to their own catches or available resources of the fishery. The cooperative officials use the word *producto* to refer to the

[17] Due to the format of the question as open-ended, I allowed fishermen to name more than a single risk. The sum of mentions, then, reflects the multiple risks cited by some of the 44 respondents.

catch they buy, weigh, and in turn, sell to their exporter, thereby reflecting a process of production. But individual fishermen also use *producto* to refer to their catch or possible catch. Returning to shore having caught very little, not even enough to cover the expenses of fuel and food, a fisherman gripes to me one day, "*no hay producto*," or, "there's no product." And in the interview responses, the consistently used word *producto* to refer to available marine resources (Table 4-3).

Cognitively, this reflects the fishermen's view of themselves in relation to their environment: they are producers, acutely aware of their engagement in the global process of production. The environment provides them with spiny lobster, a resource with a high exchange value. This does not mean that they are entirely individualistic, incapable of cooperation, and destined to fulfill the tragedy of the commons. They support the need for regulations and many argue that improved enforcement is the best protection for the future of their fishery. Rather, they see the interaction between themselves and the environment, as one where their removal of marine animals is an act of production and they are the producers. It is a primarily economic relationship; the sea is the provider for their livelihoods.

Perceptions and Production

Small-scale fishers cope with numerous uncertainties in their livelihood (McGoodwin 1990) including variation in catch availability and market prices. The fishermen of San Felipe recognize good and bad seasons of octopus fishing as normal; for lobster, however, everyone bemoans an overall decline. Despite these sentiments, for the six years that I have been collecting data on individual production, the catches appear fairly consistent according to the individual fisherman (Figure 4-12). When I first examined the results shown in the graph, I had to wonder to what degree the lobster

population was actually declining[18] and whether or not the fishermen's reported feelings of scarcity had more to do with insecure access, or perhaps local nostalgia for a now mythical fishing lore where lobsters were so abundant, divers could free dive without compressed air and fill their boats with large lobsters in a couple of hours.

Whether or not the lobster population is declining and to what extent overfishing is occurring is difficult to determine. The causes for a decline are equally difficult to ascertain. The leading theory about spiny lobster recruitment has held that fertilized lobster eggs join the plankton mass that drifts with the currents of the water column for up to 11 months, possibly coming to settle far from the location of fertilization (Cobb 1997). This meant that the spiny lobster population is a connected species throughout its range of the Caribbean, Gulf of Mexico, and east coast of Florida. This theory might also offer support to the observation that spiny lobster population off southern Florida benefits from its position alongside the Gulf Stream, which by moving north from the remaining range of *Panulirus argus*, might be benefiting from high recruitment compared with other populations of the animal from which the current passes. This theory of regional recruitment is now being questioned with evidence of local recruitment events (Dr. William J. Lindberg, personal communication); recruitment occurs locally when the larva from spawning lobsters contributes to future generations of the same species, in the same location.

Successful management requires an understanding of both the people who use resources, but also, the ecology of the species, singular and plural, that are under a

[18] As I edit this chapter, I have just heard from the President of the cooperative. In the first three days of the 2010 lobster season, the cooperative received 5,300 kilograms of lobster tails. This is a very large harvest and is causing me some discomfort every time I type the word *scarcity*.

plan of management. The case of spiny lobster recruitment theories demonstrates how management could differ depending on patterns of recruitment: in contexts of regional recruitment, successful management requires cooperation among the multiple communities that harvest from the same population pool; any one area is comparable to a single shepherd's subtractability in Hardin's theoretical commons. I will return to this discussion in Chapter 7.

The production of lobster for the entire Gulf of Mexico coast of the state of Yucatan is displayed in Figure 4-13. The most recent year's production shown, 2008, is at the same level as 1982. Between then and now, the production has fluctuated widely, but only rarely has it dipped below that of those early years of production. Another point to consider is the production of lobsters in comparison with the two other species of greatest commercial importance: octopus and grouper (Figure 4-14). Evidence showing an inverse relationship between the catches, and thus, populations of grouper and octopus off the Yucatan coast was found in a study by Arreguín (2000); the population abundances change in cycles that operate on different temporal scales. A general inverse relationship appears to be present in looking at the lobster and octopus catches, but a more in-depth analysis of this relationship is not relevant to this study.

The production shown in the preceding graphs are for all commercial boats for the entire coast of the state of Yucatan. On the other hand, the number of boats working along this coast has only increased since the fishery began (Figure 4-15). In 1980, there were 1,339 commercial fishing boats along the entire coast of Yucatan state. This number slowly increased during the 1980s, reaching 2,138 by 1989. At this time, the records begin to differentiate small and large scale fishing boats, which must be noted

in examining these totals. In 1989, there are an additional 1,760 boats indentified as *la escala menores*, or small-scale, and a total boat number of 2,138 boats. This suggests that while the catches have seen peaks and valleys, the number of fishers among which that catch is divided has only increased. A crude calculation of the numbers shows that in 1980, the average lobster catch per boat was 120.99 kilograms; in 1989 they caught 180.11 kilograms per boat, and in 2008, only 41.56 kilograms per boat. Prices for fuel and investments in technology have increased; the value of spiny lobsters has largely stayed the same, roughly 300 pesos per kilogram, lobster tail only.[19]

Despite highly variable catches, and thus variable resource populations from year to year, the number of fishermen and fishing boats has only increased. The technology for finding and catching lobsters has become more expensive and sophisticated, enabling greater access to lobsters but adding to the financial investment of the fishery. Many fishermen cite this increase in technology as responsible for the scarcity of lobsters; it makes fishing easier. Regardless of whether the lobster stock is overfished by bio-economic equations, making a living as a fisherman now requires more effort. That effort is invested in different ways, at different scales, and by different entities.

Adaptive Strategies

The following section is divided into three parts. Through both observations and conversations, I describe various behaviors in practice by some fishermen that I categorize as adaptive strategies. First, I describe ways that the cooperative (section I), as a social institution of fishermen, responds to scarcity. Next, I divide the practices of the fishermen into strategies that involve fishing (section II) and those that do not

[19] This is difficult to determine. The peso has crashed twice and always fluctuates dramatically in relation to the dollar.

(section III). Strategies are not mutually exclusive, they may be employed together, to different levels, and create a strategy in itself. Fishermen may also engage in multiple responses at both the short and long term scale.

In separating the strategies this way, I maintain focus on the human-environment issue of how a natural resource dependent community uses common property resources. Examining strategies that involve further use of the resources, an intensification of effort into fisheries, versus a diversification of livelihood strategies away from dependence on the natural resource is one way of defining the socio-ecological system: around the fisherman-marine resource relationship. In the following chapter, I compare this model with one where adaptive strategies are identified and categorized around a different relationship.

I. Cooperative Adaptation

I framed this study around the fishing cooperative, *Pescadores Unidos de San Felipe* and this section considers some of the actions taken by the cooperative that respond to perceptions of scarcity. These are examples of local management in that the fishermen as the resource users themselves engage in all stages of resource governance, such as its initiation, design, and implementation. The following initiatives are also discussed according to how they interact with actors and agencies at broader scales.

Marine Reserve

Marine Protected Areas, or MPAs, are becoming a popular approach in marine resource management. MPAs designate some space of the marine environment for protection, but specific restrictions vary widely. An MPA may be a designated area worthy of protection but include no prohibitions on human activity, it may be designated

as no-take zones for a particular species or gear type, or one may completely prohibit all human activities within the designated zone (Shipp 2003).

In contrast to the dominant model where MPAs are top-down management tools and local resource users usually resist (McClanahan et al. 2005, Christie 2004), the local marine reserve in San Felipe was initiated by members of the fishing cooperative and the local community. In 1995, officials of the cooperative and the local municipal office signed a document designating the MPA and establishing rules to protect the area as a fish nursery. In 1997, the MPA was given the previous Maya name of the community, the *Reserva Actam Chuleb* (Actam Chuleb Reserve).

The area, demarcated by natural geographical features, is recognized by local fishermen as a breeding and nursery ground for important species including groupers and snappers. For the first few years, funding was provided by both the fishermen's cooperative and the municipal office and the reserve was patrolled by fishermen. Funding has since dried up and since the cooperative's split into two, the organization among fishermen for patrolling the reserve was also impacted. It is important to note that the signed declaration is unofficial since only the federal government has the authority to designate such protected areas. The community-designated Actam Chuleb Marine Reserve lies within the larger state created Dzilam Reserve, designated in 1989.

Despite its local initiation and support, the reserve has limited significance to the local population of fishermen (Martins de Jesus 2007) who regularly fish within its boundaries. The only fishing permitted within the reserve is trolling (*simbrar*) for subsistence (i.e., household) consumption. Principally, barracuda is caught here, along with lower quantities of various groupers and snappers. This is also where some

fishermen fish for snook (*robálo*). For the most part, fishermen troll in the reserve when other types of fishing are unavailable to them, such as when bait is unavailable for grouper long line fishing. Also, because barracuda is the preferred fish for preparing *ceviche,* a local delicacy, much of the barracuda that is caught is sold for local consumption. Nevertheless, because fishing is permitted, much of what is caught is sold to any of the local fish houses, as well. It is not possible to determine how much fish is caught within the reserve and where this unknown quantity of fish ultimately is consumed. A further irony of the reserve is that is has become known as a fishing spot. When asked where a fisherman fished that day, he may answer, "*la Reserva*".

Cooperative Independence

The cooperative is obligated to sell all of the lobster caught by its members to a single fish house in Mérida. The exporter owns much of the property that the cooperative uses: the ice factory, waterfront production and storage facility, and the offices, housed in a separate building. He makes loans to the fishermen through the cooperative, which maintains the accounting for the debts; the exporter also sets the prices. The cooperative members resent the relationship and would prefer to have freedom to negotiate their own price with various buyers. Frustrated, the fishermen ultimately sought an alternative.

Since the PAN (Partido Acción Nacional) party's success in the 2000 national election and the split in the cooperative along political party lines (see Chapter 3), a new relationship has developed between San Felipe's local politics and broader politics. The cooperative now openly interacts with the broader political arena; there is awareness that the cooperative organization has power itself and the fishermen are interested in exploring available opportunities.

United in a regional federation with three other cooperatives from two neighboring coastal communities, the local cooperative negotiated an agreement to fund the construction of a federation-owned ice factory and production facilities. (The other federation members also sell their lobster to the exporter in Merida.) In time, this new infrastructure will enable the Pescadores Unidos to terminate their exploitative relationship with the regional exporter by producing their own ice and developing relationships with regional buyers. The acquired funds come from three sources: the federation, funded by the cooperatives, contributed one-third, a bank loan provided the second-third, and the remaining funds came from the state government and do not need to be repaid.

As the new production facility neared completion, a problem arose due to the alleged theft of 300,000 pesos (roughly $30,000) by the plant manager hired by the Federation. This is an example of corruption as it appears that the accused manager is using the complicated legal system and the assistance of the Federation lawyer, to avoid prosecution. There is a legal loophole where, once the money disappeared, it appears there is no legal way to hold the manager accountable for the disappearance. The cooperative continues to attempt to recoup the money, but for the present, the facility remains unfinished.

Fishing Development Projects

I address alternative fishery projects here, despite the fact that they do not represent cooperative-initiated adaptation. Rather, these have been development projects designed and managed by actors external to the community who introduce the projects with the intention of helping the fishermen or improving the fisheries. Nevertheless, these projects are a collective adaptive response to declining resource

availability and fishermen regularly tell me that they wish to see such projects brought to the community.

To date, these projects have failed, according to the fishermen. For example, a 46 year-old fisherman told me of an open-water aquaculture type project where a group of fishermen were recruited to tend structures called *criaderos* in which to raise mangrove snappers (*Lutjanus griseus,* locally known as *pargo mulato*). He said the project failed because only a small group of fishermen participated, rather than the whole community, and they were not able to protect the structures left out in common waters. Also, the project was short-term, designed as an experiment rather than a long-term investment.

Another project was in the planning stages when I first began fieldwork in 2005. This was a joint project between CINVESTAV (*Centro de Investigación y de Estudios Avanzados*) in Mérida, and the four fishing cooperatives that form the membership of the Federation. The marine biologists at CINVESTAV are aware of the decline in lobster catches along the Yucatan coast and this project was designed in response to that problem.

The project involved putting artificial habitats for lobsters, called *casitas cubanas*, on the seabed to improve available lobster habitat. Locally called *refugios* (refuges) or *casitas* (little houses), they can be made of wood and/or concrete; the ones used in this project were large, concrete slabs with a slight bend in the middle that forms the shape of a roof. After fabrication in Merida, they were brought to San Felipe then stacked along the breakwater to await submersion. A maximum of four *refugios* were to be loaded on a fisherman's boat. They should be put into the water attached with buoys that would slow the speed of their fall to the bottom, thereby limiting breakage and

making sure that the *refugios* land on the bottom correctly. (One *refugio* weighs 200 kilograms.) The *refugios* were not to be placed too close to the caves where lobsters were found; previous research had shown that lobsters would not use artificial structures when natural habitat is nearby (Figure 4-16).

The first phase of the project was completed shortly before the 2007 season began when the fishermen put 414 *refugios* in the shallow waters of their fishing grounds. Later during the 2007 season when the weather was poor for diving, the fishermen delivered another 624 *casitas*. Fishermen were reimbursed for their work and had the opportunity to be the only boat that knew the exact location of the *casitas* that they put down, thereby permitting them exclusive harvest from these *casitas*, until other fishermen should stumble on them and mark them on their own logbooks.

Some problems arose in the implementation of the project. During the first round of submerging the *casitas*, most fishermen either failed to record the coordinates where they dropped the *casitas*, or failed to give the coordinates to the local project coordinator. The scientists at CINVESTAV were thus unable to locate many *casitas* in order to document the presence or absence of lobsters, and thus success of the project. When the second batch of *casitas* were delivered, this problem was remedied by requiring that the captain give the coordinates of where he dropped his *casitas* prior to receiving payment. Although this problem was resolved, during the second phase of delivering the *casitas*, some fishermen began to informally compete with one another as to who could take more *casitas* on his boat and who could return to shore the fastest. Because the reimbursement was the same regardless of how many trips to sea were required, or how much time, these fishermen behaved as though they had won some

sort of competition. Unfortunately, in their haste, many of these fishermen neglected to use the buoys and merely pushed the *casitas* overboard from the boat, allowing them to fall to the bottom inverted or broken. Others dumped all of the *casitas* in the same place, piled on top of one another.

As mentioned, in order to increase efficacy, the *casitas* were to be placed in a designated area that had been determined to have good bottom for the *casitas*. Before each *casita* was put in the water, a fisherman was to dive down and survey the bottom to make sure that it is an appropriate location, meaning that there was not a natural cave in the vicinity. Although I went with several crews to drop the *casitas*, not a single diver surveyed the bottom before a *casita* was dropped; many did dive in afterward to verify that the *casita* was positioned properly and to retrieve the buoys.

Also, there is a question of the purpose of using *casitas cubanas*. The purpose of the project remains unclear. If the *casitas* were being used as artificial habitat to increase recruitment of the resource, or whether they are to be used as fishing gear is an important distinction to the management of the fishery (Dr. William J. Lindberg, personal communication). This issue requires greater discussion and is more germane to the discussion on management in Chapter 7.

A final problem, mirrored in some of the other community initiatives described above, is that the community no longer has a single cooperative entity. When the project began, there was only one cooperative. The lobster habitat project involves only those members who remained with the Pescadores Unidos cooperative; those members of the smaller break away cooperative are not able to participate. All fishermen in the community knew, however, that the fishermen were being paid to ferry

the *casitas* and drop them in the water. This adds to the conflict and resentment, especially since fishermen were paid for their participation during a time of bad weather, when money was needed by all fishermen.

I talked with many fishermen about their opinions of the *casita cubana* project. Nearly all told me that the *casitas* were too small; they felt that lobsters would not be able to enter, or that if they were bigger (taller), more lobsters would enter. There was consensus that the design of the *casitas* was flawed. When I took these concerns to the scientists at CINVESTAV, they explained that the *casitas* were designed to prevent large predators such as nurse sharks from entering the *casitas* and eating the lobsters. When I visited the *casitas* with these researchers, I observed lobsters using the *casitas*; they were in fact large enough to house many lobsters. This issue seems to reflect a disconnect between the scientists who designed the project and the fishermen who implemented the project on the ground. Better communication was needed between the project designers and the fishermen, in order to convey the importance of proper delivery of the *casitas* to the best available terrain. I write this not as a criticism of the CINVESTAV scientists nor the local project liaison. The fishermen have known the Merida scientists for many years and the project liaison is a local fisherman who has gone away to study marine biology. These are problems that seem to commonly plague such projects and I return to this issue in Chapter 6, when I address the social brokers of the cooperative.

Although the projects described above may not fulfill the intended objectives, there is interest in pursuing such fishery development projects in response to the perceived negative future of fishing in the community. The cooperative representative to the

Federation told me that he wants the fishermen to begin tilapia aquaculture once the fishery crashes. Another fisherman who is no longer a cooperative member told me he wants someone to bring shrimp aquaculture to them because they will earn a lot of money then, he claims. The difference between these two conversations was that the first sought to initiate the venture from within the community and the second saw the solution in having capital investment originate from outside the community; the local fishermen would earn a lot of money from this foreign investment, he felt. Regardless, some fishermen consider aquaculture to be an alternative to fishing once wild catches are no longer profitable.

Self-Imposed Season Closures

By the end of the lobster season, especially the month of January, fishermen say that only undersized lobsters remain in the fishing grounds. The fishermen of San Felipe complain about those in the neighboring community of Rio Lagartos, as the ones responsible for the harvest of these small lobsters. They say that they cut the meat from the tail, and sell it locally; by removing the meat from the tail, the actual size of the lobster is unknown to both buyer and consumer. Because San Felipe and Rio Lagartos are so close to one another, a mere 12 kilometers, the fishermen of these communities share their fishing grounds; from the western boundary with Dzilam Bravo to the eastern boundary with El Cuyo, the fishermen of both San Felipe and Rio Lagartos are free to search for lobsters wherever they please (Figure 3-3).

With an ever increasing pressure on the resource, it is highly unlikely that the lobster catches will improve for the fishermen without successful cooperative action to regulate access and use of the resource. Although federal laws are in place, these laws are largely unenforced. Recognizing their common problems, the four cooperatives of

the federation formed an agreement to close the lobster season one month early, prior to the federally mandated closure at the end of February. This is an example of co-management between the cooperative and regional government authorities who would provide assistance in enforcing the locally agreed upon rules.

This agreement is negotiated yearly and is strongly supported by the fishermen of the Pescadores Unidos of San Felipe. With the agreement of the four cooperatives, the 2005-2006 season ended at the end of January 2006, one month early. However, because the lobster harvests did not improve as much as many fishermen hoped at the beginning of the 2006-2007 season, the fishermen of Rio Lagartos' cooperatives would not agree to closing the season early the following year. Thus, the 2006-2007 season remained open until the end of February 2007. The following two years followed the same pattern; the lobster season was again closed early for the 2007-2008 season, ending at the end of January 2008, but the 2008-2009 season ended with the federal closed date of the end of February 2009.

The idea of ending the season early is to allow the small, undersized lobsters to grow to a legal size. When undersized lobsters are harvested, they may only be sold locally and because they are not legal, they bring a much lower price than export sized lobster tails. In San Felipe, the local price on the black market during the time of research was 150 pesos (roughly $15US) for 12 *colitas*, or small lobster tails. One fisherman griped to me that a local restaurant owner will then put only two of these small tails on a plate with some salsa and charge customers 150 pesos. Twelve lobster tails of the minimum legal size would weigh approximately two kilograms, resulting in an

increased value of approximately 420 pesos (roughly $42US).[20] The conundrum for the divers, however, is that he who finds the undersized lobsters is not likely to be the same fisherman who finds them full-grown in the following season.

Although the fishermen of these communities are not always in agreement about early season closures, I find this example of local management to be an important first step toward collective action. It demonstrates recognition among the fishermen themselves that delaying short-term profits can improve their yields in the long-term. It also shows that cooperation is possible. The fishermen recognize that enforcement, however, is desperately needed.

External Enforcement

The final tactic of the cooperative I want to address is the cooperative's solicitation for enforcement assistance of the federal regulations. Numerous fishermen have complained to me that when they do engage in illicit behaviors, it is due to the fact that if they do not take that small lobster, for example, the next fisherman will most certainly do so. These same fishermen tell me that if there was adequate enforcement and they did not feel that other fishermen would just come along behind them and fish out of season or take undersized lobsters, they would comply with the law.

The cooperative officials, fishermen themselves, recognize this and call on the enforcement agents of CONAPESCA (Comisión Nacional de Acuacultura y Pesca), the one agency charged with enforcement of the federal regulations, to patrol their waters. However, for the entire coast of the state of Yucatán, CONAPESCA has six agents and

[20] During the 2007-2008 season, cooperative members received 285 pesos per kilogram of lobster tail ($28.50US) on the day of their catch, followed by an additional 50 pesos per kilogram paid as a kind of savings program at the end of each month (*remanente*).

no boats available for patrols. The agents occasionally visit the community to check on the fisheries and must use the boats of local fishermen to make patrols. The cooperative knows in advance when CONAPESCA will arrive. The officials of the cooperative escort the agents around, allowing them to inspect the production facility and accompanying them on marine patrols. The group then ends at one of the local restaurants where the officials of the cooperative pick up the tab for the agents. One time, one agent told me on that particular visit, he was not there to patrol and give fines; he was to observe and report back on detected violations. On other trips, the agents may confiscate equipment that is used out of season, or confiscate illegally caught marine life. I know of no fines being given and it appears that the agents are not authorized to give fines.

Although these agents are being called on with greater frequency by the cooperative officials to enforce federal regulations, this is met by a certain hesitancy of the agents to castigate the fishermen. The state agents have told me that they are reluctant to punish the fishermen for violations if the illegal catch is for home or local consumption. They also develop personal relationships with the local fishermen, especially the officials, and these relationships lead them to be sympathetic to the fishermen's perspective.

For example, one day in September 2007, CONAPESCA agents were in town and they confronted a fisherman who had a *chacpel*, a large species of conch, the harvest of which is prohibited (but remains a local delicacy). The agents took down the registration numbers of the fisherman's boat and gave him a stern lecture about the penalties for violating the law (he could be taken immediately to the prison in Valladolid and fined up

to 50,000 pesos, or roughly $5,000) and the reasons for having the law in place, then let the man go home with his catch. In this instance, the *chacpel* was not even confiscated.

Many fishermen regard the problem as driven by those who buy illegal production, arguing that if there was nowhere to sell illegal harvests, the fishermen would not kill it. When I asked the agents why they did not search the plants of the regional exporters who buy from the cooperative and fishermen, they told me that the buyers are powerful, and power equates with money. These buyers have the ability to hire lawyers to get them out of any legal problems; the small scale fishermen do not, so enforcement continues to be levied at the scale of the fishermen only. From the agent's perspective, the exporters are untouchable and for them, it is easier to encourage compliance among the fishermen.

II. Adaptive (Fishing) Strategies of Fishermen

From the opening of the lobster season on July 1 each year, a fisherman's daily lobster harvest generally declines as the fishing season progresses and the fishermen adapt to decreasing returns in various ways. Variation in the adoption of adaptive strategies among the fishermen reflects the lack of homogeneity of the group as a whole as well as variation in access and investment in various social resources including knowledge, social networks, and fishing capital. Here, I describe the fishing behaviors of several fishermen who continue but modify their fishing activity in response to a scarcity of lobsters. In fisheries economics terms, this is labeled as increasing the Cost Per Unit Effort (CPUE). Fishers have to invest more time (longer fishing days), capital (bigger engine, technology), additional fuel, or personal effort, in order to achieve the desired catches.

As described above, lobsters were abundant in shallow waters during the early years of the fishery. Fishermen were able to dive to the bottom without the use of compressed air and find a plentiful supply of lobsters. Over time, lobsters have become increasingly scarce in these shallow waters and fishermen use compressed air to dive to deeper depths to find lobsters. The practice of diving in deeper waters, which corresponds with a greater distance from shore, is noted by all fishermen, although only a handful of crews are willing to accept the additional risks to target the deepest waters. Fishermen are aware that diving to greater depths incurs greater risks of decompression sickness and other dive accidents and each fisherman determines the maximum depth to which he will dive.

Figure 4-17 shows the depth to which fishermen report diving (x-axis) and the total kilograms of lobster they reported for the 2007-2008 season. This is the same data shown in Figure 4-16, but the individual fishermen are identified here by a three-digit code. Again, I selected the 26 diving boat captains from my sample of 44 cooperative fishermen for comparison, because they share the following features: (1) they receive two shares of the day's catch and (2) they have a shared level of capital investment through boat ownership. The narratives below describe some of the fishermen represented in this figure.

There appears to be a trend between the depth that a fisherman reports as his maximum depth, and his overall lobster production (Figure 4-17), but as shown in the R^2 values from Figure 4-16, this association is not strong ($R^2 = .048$). Increasing dive depth is weakly correlated with increased production for this sample of fishermen. Actually, this means that although the fishermen dive deeper, they are not guaranteed equivalent

catches. The scale of their catches does not move in integral increments according to greater depth. Other factors influence successful catches apart from depth including knowledge and experience.

Jaquetón and Muán

While all divers admit the need to dive deeper to find lobsters, Figure 4-17 shows that this strategy is not equally successful for all divers. Nevertheless, diving deeper proves successful for some divers. Jaquetón (#223) and his cousin Muán (#224) are among the handful of divers that target the deepest waters. In interviews, Muán reported that he dives to 21 *brazas*, or roughly 42 meters, while Jaquetón said he will dive to 18 *brazas* (36 meters).[21] In Figure 4-17, the two men are just below the top producers but are the deepest divers in the sample.

When fishing at these depths, Jaquetón and Muán opt to fish together, traveling to the fishing grounds and diving in proximity to one another. By traveling together, as opposed to the preferred technique of guarding one's exact fishing spots, they seek to reduce the risk of accidents that often occur at greater depths. Jaquetón and Muán know and accept greater risks in diving to such depths; fishing together provides assistance should equipment fail or a diver suffer a barometric accident.

On these deep diving trips, each man captains his own boat along with a second diver and a helper, the *manguerero*, making up the crew. In total then, they are a group of six. At these greater depths, they are able to spearfish large groupers in addition to searching for lobsters. However, the divers exert far more energy underwater when they spearfish, as opposed to hunting lobsters. The extra effort involved in spearfishing along

[21] This is an example of receiving an emic response that contradicts an etic observation. I accompanied Jaquetón on a fishing trip where he dove far deeper than he had previously reported.

with rapid ascents from greater depths compound the risks of lobster diving that divers already faced in shallow waters. So it was not surprising that, at the end of a fishing trip in early August 2007, both captains and the second diver on Muán' boat returned to shore with symptoms of decompression sickness; the three men were rushed to the hyperbaric chamber in Tizimin, together. The chamber in Tizimin can only accommodate two people at a time forcing the divers to take turns receiving treatment.

The two captains are regarded as successful fishermen, and have both served as elected cooperative officials. In their late 30s, they both are married with four and three children, respectively, and both recently became grandparents to their eldest daughters' children. As captains, they fit the image of calculating risk takers who know how to manage their money. Unlike other fishermen, Jaquetón has a dry shirt tucked into a pair of shorts by the time he reaches the dock after fishing; I have never seen him on shore without being so dressed. Muán is a bit more casual. Deceptively quiet at first, he is known as having a [tells the wittiest dirty jokes, kind of guy…]. Separately, both have told me that they do not invest in cattle and ranches because they have "bad luck" with such investments. Economically savvy, they invest instead in fishing, as pragmatic thinkers, measuring risk investments and potential yield in their heads.

Caguama

As described above, each captain keeps a log book containing the coordinates of successful fishing spots. Fishermen use longlines in greater depths than where they dive so the fishing grounds of these gear types do not overlap; thus by extension, the coordinates marked for longlines are not the waypoints marked for diving spots. Recently however, some fishermen have begun to dive at the recorded coordinates of a

successful longline pull. The recent depths to which Jaquetón and Muán travel and dive together are within the area they use for longlining.

Now 39 years old, Caguama (#128) has always fished with his father, Don Pancho, who recently turned 60. The two of them are well-known customers in San Felipe's cantinas. Their non-diving helper, also a cooperative fisherman, is both fishing and drinking buddy. Caguama is known for drinking a lot, and I have noticed that his socializing in the cantinas extends beyond membership in any of the local social cliques; Caguama can be found drinking with any group of men. In a small town, everyone knows each other but they do not necessarily socialize together. Generally, members of the *Pescadores Unidos* do not socialize much with members of the other cooperative, nor many of the "free" fishermen (*libres*) who are not cooperative members but sell to any of the local fish buyers. On the other hand, every time I observe Caguama in the cantinas (here the windows are always open to the sea breeze), he is always with someone different. Unlike most cooperative fishermen, Caguama has social ties within and among all the groups of fishermen and this appears to be related to his social drinking.[22]

When Caguama's non-diving crew member does not want to work, Caguama recruits a helper from among the non-cooperative members of the community. He invariably ends up fishing with someone I have never before seen in the community. Also, he always knows who in town is selling shrimp caught in the estuary the night before, who has just salted stingray meat for sale (usually the spotted eagle ray, *Aetobatus narinan*), and who is currently buying undersized red grouper to sell fillets in

[22] I do not mean to promote alcoholism as having social and personal benefits. I only mean to point out, what I see, as an unintended consequence of his drinking.

nearby towns. Caguama is also an extremely savvy fisherman who thinks through the costs and benefits of his fishing decisions, often discussing these with me. Explaining why he continues to fish with nets when other fishermen feel that those species caught have too low a value per kilogram, he notes that he still gets a one peso per kilogram deduction on his health insurance premium, no matter the value of the fish. As he tells me this, he points and taps his temple with an expression meaning, “smart.”

Because of his social connections and access to local information networks not just within the cooperative but with the entire community of fishers, he is in a better position to hear of new opportunities. Caguama made an agreement with a longline fisherman to purchase the coordinates where the fisherman had caught a lot of very large groupers. The coordinates marked a very deep place to dive, 14 *brazas* (28 meters), which is beyond the usual fishing grounds of most divers. In the agreement, the man gave Caguama his coordinates for Caguama to explore while diving. If Caguama made a good catch there, he would pay the man 1,000 pesos (approximately $100US). This was a one-time exchange and Caguama can return to dive those coordinates again, as often as he chooses.

The fishing spot turned out to be especially good, Caguama told me. There were three caves right in the same area that netted 18 kilograms of lobster on his first trip. Plus, he speared a lot of large grouper. The downside was that he also got decompression sickness and was not permitted to dive for one week. (During that week, he recruited another diver as crew until he was able to return to diving.)

Given the secrecy that is associated with fishing spots (Forman 1967), I was surprised to find that local fishing spots could be sold. Coordinates are information

about good fishing spots; they have a use value. When this information is sold, it obtains an exchange value. Thus, information and knowledge are not just socially exchanged, an economic value of a piece of information was negotiated and exchanged. The agreement was also, notably, between fishermen using different gear; the coordinates were sold specifically to target a different fishery using different gear and not an exchange made between divers.

Canxoc and Xoc-cito

As mentioned, the trend toward diving in deeper waters entails greater risks to the diver's personal health. Long bottom times and rapid ascents greatly increase a diver's risk of decompression sickness and embolisms. Until recently, the increase in these types of accidents has left some older divers with some lasting mobility problems, but more severe accidents (including deaths) had only occurred to divers in other communities. The fact that as of yet, no divers from San Felipe had yet died was regularly repeated by San Felipe's fishermen as evidence that other communities' divers take less care than they. This attitude likely led to a feeling of security where dive accidents, at worst, resulted in a few hours of pain and a trip to the hyperbaric chamber. In November 2007, however, the first death occurred.

Canxoc is regarded by nearly all in the cooperative as the biggest producer, yet other fishermen, recognizing the risks he takes, choose not to follow his example. When Canxoc and his younger brother, Xoc-cito, travel to fish in deep waters, they always return with large groupers. Despite their status as local super-producers, increasing scarcity had led Canxoc to often forgo the practice of taking the non-diving (thus non-producing) helper, another younger brother. Without having to give the helper his half-a-

share, the catch is split more favorably between the two divers. The flip side means that the crew is one man less should a problem arise.

One day, Canxoc was unable to dive because he had gotten the bends just a few days before. Xoc-cito was thus left to do all of the diving. When Xoc-cito surfaced from the last dive of the day, he immediately collapsed, foaming at the mouth. Canxoc radioed to shore to apprise the cooperative officials of their situation. To add one more factor to an already bad situation, the seas were very rough this day and without a third crew member to help, Canxoc was unable to both tend to his brother and drive the boat. Rough seas meant a rough ride and there was noone to support Xoc-cito's unconscious body as the boat struck waves. The boats do not carry oxygen for immediate first aid which, according to the doctor who pronounced Xoc-cito dead, did not believe it would have made a difference. Just 26 years old, Xoc-cito died leaving a young wife pregnant with his first child.

On that day, two other divers from nearby communities were also taken to the hyperbaric chamber in Tizimin. The chamber only holds two people and Xoc-cito required the attention of a nurse and doctor while inside the chamber. This meant that the other injured divers were unable to begin recompression treatment inside the chamber for several hours.

I watched to see how the death of a fellow diver would impact dive practices. Following the loss of two net fishers whose boat capsized in February 2002, many fishermen sold their nets, giving up the use of this gear type. These fishermen decided that for themselves, the risks of capsizing when using nets was too great. I expected that following Xoc-cito's death, many divers would limit the depth to which they dove.

Xoc-cito's death, however, did not appear to have the same effect and in the following month, December 2007, another severe accident occurred leaving another young cooperative member paralyzed from the waist down. As of March 2010, he has rehabilitated himself so that he is able to walk supported by a cane. He refuses to believe the doctor who says he can never dive again.

I talked with some fishermen about why the death of two net fishers would lead them to sell their nets, but the death of a diver had not encouraged them to dive more safely. I came to understand the answer in two ways. One, the net fishing accident was considered unavoidable. The fishermen who died were not seen as pushing their limits. With net fishing, it is always a possibility that a wave may hit and cause the boat to capsize. This was an accident that could happen to any of them and it made many fishermen think twice about using nets.

A second, but not so clearly expressed difference was that nets do not offer an equivalent potential for economic returns as does deep diving. All too often, net fishers return to shore with hardly enough fish to take home to eat and may not catch enough to cover fuel expenses. Those that dive deep, on the other hand, consistently return to port with large catches. In talking with many fishermen, I became aware that those that dive deepest are regarded as the greatest risk takers rather than the most knowledgeable fishers. For those that accept the risks of diving deeper, these large catches are worth the occasional week of doctor ordered prohibition on diving. These large catches seem to be worth the occasional week of doctor-ordered cessation of diving. As members of the cooperative, the divers receive state-funded medical insurance that covers the entire cost of treatments in the hyperbaric chamber of Tizimin.

In the event of chronic problems, costs incurred from consultations with specialists are not covered by the insurance.

In addition to diving deeper, the three examples of traveling to distance fishing grounds together, purchasing coordinates, and cutting the number of crew members benefitted the fishermen with large catches, but also entailed costly accidents. That the divers rarely incur a direct economic cost from dive accidents might be a factor in divers' disregard for conservative dive practices. The dive days lost while recuperating from an accident do not seem sufficient to offset the increased production for which a diver is willing to adopt greater risk.

Chokam

In addition to targeting deeper waters, some fishermen are working longer days or a greater number of fishing days in order to fulfill economic responsibilities. Figure 4-18 shows the total number of days fished, with any gear type, by each cooperative member and their total lobster production. This figure shows the same total lobster production data as from the previous graphs, but the total sample of interviewed fishermen are represented, not just the diving captains.[23] Those having caught the greatest amount of lobster, again #184 and #148, fished an average number of days as other fishermen and dedicate themselves principally to diving. One of the lowest lobster producers, however, #151, fished by far the greatest number of days.

Chokam, #151, engages in the most diverse fishing strategy of any cooperative member. A small guy with a gray moustache, he is always working. Originally from a

[23] For example, #148 is the diving captain and #147 is his second diver. Although they always fished together on the same boat, #148 is shown to have a much greater lobster production. As captain, he gets an extra share of the catch that goes toward boat expenses. This is why only diving captains were shown in the above graphs, because their lobster production is more comparable as a group owing to a similar adjustment in share of the total catch.

neighboring fishing community, Chokam works part-time as a driver for a local independent buyer, hauling truckloads of octopus and grouper to regional exporters. He works this second job after his fishing days. Chokam owns his own boat but does not own the dive equipment. At the beginning of the season, he works as the second diver on another boat. Due to a past dive accident, he says he is willing to dive to 10 *brazas* (20 meters), maximum, but prefers to dive shallower. He stops diving and switches to use jimba soon after the opening of octopus season, August 1. Chokam also fishes with nets, including cast nets (*tarraya*) that he uses in the estuary to catch Pompano for Lent. His catch during this time is entirely for local consumption with much of his cast bought by people waiting for his arrival at the dock where he estimates weights and negotiates prices. His daily catches remain small but he fishes on more days than other fishermen.

Those that are fishing the most days are also fishing year-round. Many members of the cooperative do not fish during the four months when both the lobster and octopus seasons are closed. Some have saved their money, others have opportunities for shore labor, others live on loans from the cooperative. Chokam is one of the few that does engage in fishing activity year-round.

Innovation

One boat is owned by three brothers, *Los Hermanos*, who always fish together. Los Hermanos have innovated a way of fishing that combines diving and netting; no other fisherman in the community fishes this way. The technique is similar to purse seining but on a much smaller scale. First, one or two of the brothers will dive in shallow water and look for a school of fish, usually snook (*robálo*) or several small species of shark (*cazón*). After finding a school of fish, they return to the boat and circle the school

of fish with their nets. As they pull in the nets, they gaff the fish and land them. Fishing this way, they are diving in shallow waters where the risk of decompression sickness is less. While their total lobster production is lower than most (#086 is one of the three brothers and the only one in the sample), it is important to point out that they focus on lobster only at the very beginning of lobster season and quickly shift to targeting snook and small sharks. They have found a niche that is not exploited by other fishermen in the community; and is one which might not support many fishermen, for that matter. But, the low lobster production is offset by their large catches of snook which have a high value (Table 4-4). In addition to netting for snook and shark, Los Hermanos also own the nets for bait fishing, described below. As cooperative members they are obligated to sell this catch to the cooperative, even though it is not for export but to supply other fishermen with bait. The cooperative president may agree to a lower percentage of their catch when demand is low. The bait fish is then sold back to the cooperative members who need bait for longlining. The cooperative does not make a profit from the exchange; it is considered part of their responsibility, to ensure that the members have bait.

Breaking the Rules

Octopus, regarded as the second most important commercial species in the community, is caught two ways: with *jimba* and diving. From August 1 when the octopus season begins, some cooperative fishermen replace their air compressors with *jimba* poles and begin to fish for octopus. Others continue to dive but begin hooking one or two octopus opportunistically along with finfish and whatever lobsters they can find. Many, however, begin to dive in the fishing grounds preferred by octopus, called "*chol-chol*." *Chol* is a Maya word that roughly translates as "hole" and the limestone substrate

is pocked with holes in which octopus hide. This contrasts with the ledges and caves which lobsters prefer.

Chol-chol terrain is relatively shallow, compared to the deeper waters where larger lobsters and grouper are found. Thus, in diving for octopus, the greater risk is of getting caught rather than getting decompression sickness. The capture of octopus while diving is legally prohibited. The federal enforcement agents, often reluctant to castigate fishermen if harvesting for home consumption, have confiscated speared octopus destined for the cooperative's plant. I accompanied a group of agents, along with the enforcement official of the cooperative, to patrol the fishing grounds. We encountered a group of several boats, lashed together while out to sea, taking a break. The boats, equipped with compressors and lacking the bamboo *jimbas*, required for octopus fishing, were clearly in violation of possessing octopus. All the boats were from the cooperative and all were diving for octopus. The agents boarded the boats and checked the ice chests of each boat. The agents collected the octopus from each boat, roughly ten kilograms per boat (worth approximately $40US) and transferred the contraband octopus to a cooler in their patrol boat. After we departed, the fishing boats all returned to shore for the day, writing the day off as a loss and shrugging off the agents' actions. Regarding the risk of getting caught as minimal and rare, all were back diving the next day.

Another example of rule breaking is "pirating." Cooperative rules require members to sell all of their catch to the cooperative. Pirating refers to the practice of selling one's catch to any buyer other than the cooperative and is the term used by the fishermen

(*piratando*). Cooperative members may be tempted to break this rule when an independent buyer is offering a better price.

When members are caught pirating, they are subject to cooperative-imposed sanctions, usually a fine. After a member is caught and accused by the official charged with rule enforcement, the issue is raised at the next cooperative assembly when an appropriate fine will be voted on by all other members. Following two fines, a third offense results in expulsion from the cooperative, as happened to one cooperative member in December 2007. Due to care that is taken in negotiating socio-political relationships within the cooperative, the officials are often reluctant to castigate a member until his violations become so obvious that they are standard practice. By the time the cooperative member was voted out, he had not been selling any of his catch to the cooperative for some time.

The son and two sons-in-law of the expelled fisherman remain members of the cooperative. The officials talk about the pirating by these younger men, but recognize that they are under pressure to do so from their father (in-law). There is thus some flexibility allowed for compliance at time. Lack of enforcement due to sympathies within small town social relationships is a continuing pattern that limits both enforcement and compliance.

Legal Inconsistencies are the third example of breaking the rules. Although it is legal to fish with longlines that require bait, the bait used with longlines is federally protected. This presents a contradiction that even the enforcement agents acknowledges is problematic. *Pico rojo* (ballyhoo) is caught by nets owned by only a handful of mostly elderly fishermen in the community. The netting of *pico rojo* was made

illegal to prevent the development of a local export fishery, based on the awareness that such a fishery would serve to supply the recreational fishing industry of the Cancun area. The prohibition on harvesting *pico rojo* was enacted to prevent this export rather than its use as bait. Most of the *pico rojo* caught locally is bought by longline fishermen who pay six pesos per kilogram (roughly $.60US for six fish). Those six fish are worth 60 pesos ($6US) in Quintana Roo, an enticing profit that leads some to engage in its illicit export.

An elderly former cooperative member nets *pico rojo*, giving it to a local driver to deliver directly to the deckhands of the big sportfishing yachts. He will earn one peso per fish this way ($ .10US), with the driver who accepts most of the risk, keeping the rest of what he sells. The driver brings along a bribe for the state border guards; some barracuda fillets, should he be stopped and inspected. Barracuda from the Gulf coast is the preferred fish for use in *ceviche*. The president of the cooperative complains about these fishermen who do not sell the bait locally, but stops short of using anyone's name. Sometimes, there is no bait available to fish with longlines, leaving local fishermen unable to work. Yet, he does not end the behavior by calling the enforcement officials; one, socially that would be unacceptable and two, he recognizes the net fisher's decision is to earn as much as he can for his catch.

Subsistence

Nearly all fishermen take home some part of their catch for household consumption. In an interview, I asked the fishermen (n=45) what they took home and how often they took home some part of their catch. I generally assume that taking fish for home consumption is standard practice and a part of the culture for fishermen, regardless of scarcity, and I do not categorize 'subsistence' as an adaptive strategy.

Only one fisherman, Cambuay, informed me that his family used to eat fish twice a week, but now they are eating fish four times a week because of the “crisis.” Even if more fishermen take home part of their catch for meals more often when money is scarce, I cannot differentiate between taking home part of the catch or selling it, as an adaptive strategy because it does not involve a change in fishing behavior. The catch is caught the same way and whether a fisherman takes his catch home to eat or sells it and buys something to eat, is not a decision made in response to scarcity. It is possible that, as a result of scarcity, fishermen catch and keep more prohibited species, however this is not something that I felt comfortable collecting data on. (I did in field notes but don’t want to make conclusions about).

What is interesting, and relevant, is the practice of taking home some part of the catch that cannot be sold to the cooperative. This part of the catch can be sold locally, eaten at home, or saved and served to visitors, as is the case with undersized lobster tails. I present the responses from the interview here (Figure 4-19 and Table 4-5) in order to show what fishermen commonly take home to eat, but because much of this is not legally permitted, I avoid much further discussion pertaining to this part of the catch. All fishermen mentioned at least one thing that they usually take home to eat and are represented in the table except for one fisherman. His answer to what he usually takes home to eat was, “*todo, hasta una tortuguita*” (everything, even a little sea turtle). I choose to treat his answer as hyperbole.

Looking at Figure 4-19, fishermen take home part of their catch with greater frequency than they report eating it at home. Nine of 45 fishermen said they bring home part of their catch daily, but only one fisherman said that he eats fish or seafood at

home more than three times per week. Table 4-5 shows that 71% of the fishermen noted taking home undersized groupers, with some adding that the ones they take home are just barely under the legal size. People commonly take home undersized fish to eat, commercial species of low value (such as triggerfish), and *buches*, the stomachs of groupers, to eat. Some species of fish are regarded as local delicacies, or used in the preparation of special local dishes. One fisherman says that cobia (*esmedregal*) is only to eat, not to sell. I have heard this from several others, as well. It is a fish that people like to take home to eat. Snappers (mangrove or lane) are also often taken home to make *tikinxic*, a dish where the fish is dressed with onion, garlic, tomatoes, *achiote*, butter, and beer, and baked in an oven.

Undersized lobster tails are also taken home but are usually served to visitors who are known to regard lobster as a luxury food item. From observations, lobsters that are taken home are served to guests and are consumed far less frequently by the fisherman and his family. When invited to eat at someone's home for the first time, my host invariably serves lobster, an act of gracious hospitality based on his recognition that lobster is something special to eat.

Knowledge and Capital Management

While some fishermen take greater risks and dive deeper from shore, a couple of fishermen are able to average larger catches of lobster while remaining in more shallow water. In Figure 4-12 and 4-18, the two individuals with the highest production, #148 and #184, were the sample's two largest lobster producers. But, in the top graph of Figure 4-17, these two fishermen are outliers; they are the two with the highest production, but one (#184) reports the shallowest diving limit of all diving captains in the sample, and the other (#148) falls in the middle of the average reported dive depth. In

this graph, the R^2 value of .048 suggests that the relationship between lobster production and dive depth is completely random. When I removed these two individuals, a relationship, although statistically weak with a R^2 value of .295, is evident.

Ethnographic details about these fishermen suggests an example of Acheson's capital management (1981) and also the "Skipper Effect" theory (Durrenberger 1993), referring to the idea that some captains have a better skill set and are just better fishers. I also interpreted some parts of their fishing behavior as successful in adapting to overall resource scarcity. These two fishermen, Pontó and Balá, 46 and 43 years old respectively, consistently land successful catches without accepting the risks of diving deeper. They are among the cooperative's biggest lobster producers, but also share a kind of roughness that may be interpreted as grumpy. Perhaps it is a part of their personalities; both men are known for their directness. Yet, I interpreted their social interactions as indicative of a factor contributing to their fishing success. Perhaps being sharp-tongued with a quick wit is associated with an ability to make decisions quickly (Kottak 2006[1983]). Or, perhaps their reputation as sharp-tongued aids them when they wish to conceal specific knowledge or information (see below).

For many years, Balá has expressed his desire to be president of the cooperative, refusing to consider any of the other positions such as secretary or treasurer. While vocalizing support for his election to the secondary positions, many members express fear that his leadership would be overly strict and that Balá as president, would implement drastic, painful changes. While these other members recognize that he would be very honest in his execution of the job, they expressed a belief that the president should be someone with more diplomatic skills.

Because of the reputation for their bluntness, it is doubtful that either man will ever be elected president of the cooperative. Both are very responsible with their money; they may drink, but never go to the cantina and I have never seen either of them drunk. They are casual in appearance, however, not putting much effort into dressing up as some other boat captains do. They are also in-laws now, since Balá's daughter married Pontó's son. Besides personality and social factors, these two men are knowledgeable fishers; they do not need to go deeper to find good catches.

I originally designed this study to include an examination of how knowledge correlated with the adoption of different fishing strategies (Chapter 1). With the data collected, I used cultural consensus analysis to identify the most knowledgeable fishermen. This method of examining shared knowledge is based on the assumption that the correct answer to a question is the modal response (Romney 1999). That is, the correct answer is determined during analysis according to the most frequent emic response. By extension, then, the most knowledgeable fisherman in the community would be the one who gave the modal response to the most questions. My results, however, did not match those of my ethnographic observations made over the course of months of fieldwork.

There was very high cultural consensus for much of the marine knowledge investigated in the interview. This reinforced my observation that every fisher seemed to agree on seasons and gear types for different species. In this small community, this information is shared widely. Generally, there is a corpus of shared knowledge among the cooperative fishermen. Yet, some knowledge is not shared. The surprise concerned that both Pontó and Balá, whom I had previously regarded as knowledgeable fishers,

scored among the lowest in the sample. Yet, while their answers were considered incorrect according to the model of cultural consensus, their answers were more similar to the correct etic response, a response that was not always widely shared. Whether the differences in knowledge arises from Pontó and Balá's first-hand observations of the marine environment or from second-hand sources such as printed information or word of mouth, I cannot say. I am also unsure of how much these two individuals share information with one another, as well as whether or not they are consciously aware of how their knowledge differs from the shared cultural knowledge of the other fishermen. (I return to this issue in Chapter 6 where I discuss the position of Pontó and Balá within the social network of the cooperative.) What the difference does suggest is that some knowledge, in addition to fishing spots, is guarded (Kottak 2006[1983], Robben 1989). Such control of information is also regarded as an adaptation to resource scarcity under Acheson's (1981) model.

In addition to their knowledge and personalities, both Pontó and Balá share a common frugality similar to what Acheson (1981) describes as capital management. Fafchamps (1999) further notes the savings and selective selling of assets (i.e., capital management), as an adaptive strategy. Neither are customers of the cantina. Individually, each of them has talked to me about his practice of saving money from the good fishing season to sustain his family through the months when fishing is poor. Each was critical of other fishermen who do not budget their money and feel that such fishermen should bear the responsibility for their economic problems during closed fishing seasons. Although Fafchamps (1999) and Acheson (1981) categorize such financial management as an adaptive strategy, it seems likely that neither Pontó nor

Balá have started to budget their income as a result of scarcity. Rather, they may be better able to rely on such knowledge and skills in managing their income and capital in times of scarcity and that such practices likely correlate with successful fishing production over the long term.

Switching Species

The greater flexibility of small-scale fishermen to move between different gear types and fisheries, as opposed to industrial scale fishermen, is noted by (Sabella and Bort 1991). The ability to change species or gear types is an adaptive strategy when one species or fishery becomes scarce. The fishermen have flexibility to switch species and target another fishery.

In San Felipe, the annual cycle of fishing by the cooperative fishermen is principally guided by federal regulatory fishery closures and the commercial potential of a fishery, as opposed to being guided by non-production based factors. On July 1, all fishermen leave port to begin targeting lobster. From the opening of the octopus season on August 1, fishery and gear type differentiation begins. Some fishermen continue to dive for lobsters, some continue to dive but target fishing grounds with the substrate type favored by octopus, and some leave diving and outfit their boats with *jimba* poles.

When I asked fishermen about why they changed their fishing strategy, the answer usually concerned general preference. Many fishermen talk of their love of diving, but there are some who quickly switch from diving when other fisheries become available based on their preference for surface-based fishing. Crispin told me he hates the noise of the compressor when diving and quickly switches to the quiet of fishing with *jimba*. One fisherman, Caguama, explained that he calculates the type of fishing he feels is most economically successful. I asked him regularly about why he fished with a certain

gear type at that time. For him, there was no preference for gear type; he likes all kinds of fishing equally, he claims. Rather, he has his own algorithm of economic success by which he assigns value and makes fishing decisions.

Beginning in late October, bad weather begins and those days with the greatest production for the season are gone. Switching species, and diversification of target species increases at this time. Diving is impossible due to turbid water when the weather is bad, such as after a storm. During these lulls, many of those that have continued to dive now replace their onboard compressors and dive equipment with either longlines (*palangre*) or nets (*redes*); a diving captain usually owns one or the other and a handful own both. There are pros and cons with the use of each type of equipment and captains make the decision to buy nets or longline equipment. A few will wait out the week following bad weather while the sediment in the water settles, improving visibility, and then continue diving.

Maxkil

A group of women, all wives of fishermen, catch the bait used for octopus fishing, a kind of crab locally named *maxkil* (Figure 4-5). This is a Maya word that was translated for me as signifying someone who does not bathe frequently. Often, the ‘someone’ was specifically interpreted as a woman. The fisherwomen who harvest *maxkil* leave port at night and using only the small *alijos*, the small boats with no motors, they push their boats to the estuary and using headlamps, find the crabs on the sandy bottom, pluck them from the water and toss them into the bottom of the boat she pulls along behind her. Going together in groups of three or four, they will stay out as late as needed to fill the next day’s need for bait.

While supplying the bait during the 2007 octopus season, the women had noticed many *campechanas*, the local name for a type of whelk that is a local delicacy.[24] They began harvesting the *campechanas* and selling them locally for use in ceviche. Following the end of the octopus and lobster season, considered the low season for fishing activity, many cooperative fishermen began paddling out to the estuary at night to harvest *campechanas*. Going in groups, they would catch them for home consumption or to sell to locally. They were very popular and several people told me that they had disappeared since Hurricane Isidore hit in 2002. Shrimp and several species of conchs and whelks were no longer found as they were before the storm. This example of fishing information transmitting from women to men seemed counter indicative compared to how I otherwise observed gender relations in regards to fishing. But there seemed to be no conflict with both men and women harvesting the snails.

Obstacles to Diving

Returning to Figure 4-17, I want to describe the cases of the two fishermen with the least production. Fisherman #097 reported his maximum dive depth at 13 *brazas*, which is average, yet he had the least production of the 26 diving captains shown. Appearing as an outlier to the relationship between diving depth and lobster production, this diver suffered a barotrauma injury to his ear early during the season and was unable to fish for the remainder of the season. He has undergone a series of surgeries to his ear and doctors have told him that he will never be able to dive again.

[24] *Campechanas* (*Fasciolaria tulipa*) were one of four mollusk species that collectively made up 92% of the excavated molluscan remains on Isla Cerritos, the Post-Classic site of Satah-Zapil (see Chapter 3). The collection of mollusks from this site is the largest and most species diverse of any collection of shells found in Mesoamerica (Andresw et al. 1988).

Another fisherman, who reported a maximum dive depth of 12 *brazas* and produced the second least amount of lobster, told me that he was unable to find a second diver to work his boat. Without another diver, he switched to *jimba* at the opening of octopus season. Although most boats fishing with *jimba* take additional fishers to work from *alijos*, this is only to increase a captain's daily income. Fishing with *jimba* is ultimately a solo fishing activity. His lobster production is low because he only dove for one month.

I categorize the practice of diving to greater depths to find lobster as an adaptive strategy to scarcity. In looking at the relationship between reported dive depth and lobster production, there is a positive association (albeit weak) between deeper dive depth and lobster production. This section, however, addressed the outliers to this association in order to identify and discuss other adaptive strategies (capital management) or hindrances (injuries and dependence on reliable crew) to a stronger correlation.

III. Adaptive (Non-Fishing) Strategies

This study focuses on the fishermen of the cooperative who, by virtue of their membership, self-identify as fishermen (or divers, more specifically). With increased scarcity and feelings of insecurity about the future of the fishery, some fishermen look for new opportunities outside of fishing. Investing in non-fishing options is thus an example of livelihood diversification. It is common for small-scale fishermen, while self-identifying as fishermen, to engage in multiple livelihood strategies (Griffith and Valdés Pizzini 2002). The following examples of fishermen's non-fishing behavior are grouped together based on this idea of livelihood diversification.

Ranching

The economic importance of ranching in San Felipe dates to its previous integration with the ranching town of Panaba, to the south. Many fishermen own ranches or small plots of land where they raise cattle, pigs, goats, and chickens or for use as home gardens. Because San Felipe is built from cleared and drained mangroves, there is no soil around people's homes (Figure 4-20). These plots, located inland, are often filled with vegetable plants and fruit trees (Figure 4-21). Ranching can provide an income in three different ways. The owner of land may raise his own animals and sell them for butchering. Non-land owners may purchase juvenile animals to be reared on the ranch of a relative or *compadre*. The land owner receives a portion of the profit when the animal is sold, earning more or less depending on whether the non-land owner helps with tending the animal(s).

Finally, ranching offers wage labor opportunities as well. Tizimin, an older cooperative member, dedicates himself to fishing for only five months of the year; the remaining seven he works on his nephew's ranch where he earns a small, but stable, wage. The security of this wage, however small, is preferred to the risks of fishing his boat during the rest of the year. Tizimin is able to fulfill the yearly production requirements of the cooperative to maintain his membership although not fishing year round.

Ranching does not work for everyone. Three fishermen told me of how they bought a small parcel of land together and tried to raise goats there. They agreed to take turns traveling out of town to tend the goats. One of the parcel owners failed to go to feed the goats when it was agreed that he do so and the goats died. The three

friends, continuing to blame their friend and partner who let them down, sold the plot and each has given up the line of work.

Tourism

San Felipe's proximity to the international tourist resorts of the Cancun area has likely been the spark that has led many fishermen to a hopeful expectation that international tourism will eventually reach the community. In response to this possible future opportunity, many fishermen have formalized their social groups, and have completed the requirements and filed the paperwork with the State to create local tourism cooperatives. Not all are active; some exist on paper only, their members occupied with fishing or other jobs. The most active tourism cooperative is *Los Lancheros*, the boatmen, who use their boats to ferry paying tourists to the beach and back for roughly $1.50US.

During Mexican vacation periods, Yucatecan families arrive in San Felipe to go to the beach for the day. During these vacations, local fishermen vie for permits from the city council to sell fried fish, *ceviche*, and beer to the day-trip beachgoers. Palm frond covered *palapas* provide shade from which visitors hang their hammocks and represent the extent of the island's development. Although only busy a limited number of days per year, this is a lucrative opportunity for its members. In order to protect the ability of its current members to make money, the cooperative has ended entrance of new members.

Another group has formed an "Eco-tourism" cooperative, offering birding tours and other tours of the estuary, at much greater prices. One of their members proudly explained to me the importance of his cooperative's interests because of their focus on protecting the environment. Another who has already made business cards for yet

another new cooperative told me that he expects the lobster fishery to permanently crash. This fisherman told me that he hopes his new tourism cooperative will provide him with a new livelihood. I found this contrast interesting: adopting an alternative livelihood that touts the preservation of the local abundant biodiversity, but the alternate livelihood began as an adaptive strategy to replace an artisanal fishing livelihood lost to resource overexploitation and collapse.

Another group has formed a dive-tourism cooperative with the idea to introduce dive tourism in the community to attract foreigners. One of the members asked me to dive at a spot he knew, wanting my opinion on whether recreational diving in San Felipe would be an attraction for foreign tourists. Having worked as a boat captain in a tourist resort in Playa del Carmen, he sees a dive operation as a lucrative option to the increasing scarcity of lobster when diving. I include this example here because they do not propose (yet) to introduce spearfishing to tourists; this is a non-fishing activity, one that does not rely on fish stocks for harvest, only observation.

I predict that conflicts will soon follow this formation of so many small cooperatives, which apply for small start-up grants from the state. Already, among the individual cooperatives there is an expressed sense of entitlement to whatever feature of the environment is their claimed market niche. These claims are for that which are otherwise common spaces. For example, Los Lancheros now claim as their right, to have sole permission to ferry visitors to the beach; they regard the opportunistic fisherman who waits near his boat and offers visitors' passage to the beach, as a violation of their rights as these visitors are Los Lancheros' potential clients. The

Ecotourism cooperative makes claims on marketing to tourists using the label 'Ecotourism'; it has become a brand name.

In this part of Mexico, tourism is an obvious livelihood option. Those local children that go on to study at a university after finishing high school, invariably study "Tourism Management," telling me that the program trains them to work in the resorts of Cancun, at a pay scale above the cleaning crews that tend the hotels and resorts. Whether or not mass tourism ever develops San Felipe is an open question. But, the fishermen speak proudly about the good life they have with their families in San Felipe and compare it to the traffic and crime of the big cities such as Cancun. As San Felipe becomes more accessible and more tourists visit, it is certain that other changes will occur, such as more visitors purchasing local homes (Chapter 3).

Some fishermen have traveled to Quintana Roo to work seasonally in the tourist industry and other members have worked as boat captains in Akumal, a small-scale version of Cancun tourism. These fishermen return to their families following three to four months of the tourism wage labor. Although there are some children of fishermen who live in Quintana Roo, none of these worked as fishermen before emigrating. Those that leave for seasonal work have all returned to San Felipe to continue fishing.

Wage Labor

Wage labor opportunities are limited but do exist. The owner of one local supermarket has recently built a bigger building for his business. He hired a group of local fishermen to paint and stock the shelves. This was a temporary position but provided much needed income during the low season.

Most of the fishermen's wives engage in some activity to earn cash. From baking birthday cakes to making tamales to sell in the street, the work of women contributes to

the financial well-being of the household and is especially important during the closed seasons for the important fisheries. A smaller number of men will find work using a skill or trade, such as carpenters, brick layers, and electricians. Two young fishermen in the cooperative have left the country with visas to do agricultural work in Canada. Each returned with substantial savings after six to eight months of picking and packaging vegetables. To date, one remains a member of the cooperative while the other has quit, having decided to continue the seasonal work to support his young family.

In one sense, I cannot separate strategies of tourism, wage labor, and seasonal migration; they are different components of an adaptive strategy. Tourism can provide a lucrative income. It is interesting to note that San Felipe fishermen do not leave the community for seasonal construction or agricultural work in their own country; such jobs would not only pay less, but do not involve the fishermen working at sea. For the most part, when San Felipe's fishermen look for work outside of the community, they seek jobs as boat captains. They return from these trips wearing the long style of surfer shorts worn by the American tourists they meet and sporting a brand of sunglasses favored by the recreational fishers and divers they meet as customers. Those fishermen who have left the community for such seasonal work are not driven by the same degree of financial stress that leads many Yucatecan migrants to the Cancun area resorts for hard labor construction jobs. These are not the fishermen that Griffith and Valdés Pizzini write of (2002), who must diversify their livelihood with seasonal hard labor in the sugar cane fields. San Felipe's divers hold out for prized captain jobs that, in addition to a wage and tips, provide additional benefits in the form of bragging rights.

Conclusion

This chapter described fishing in San Felipe. After describing the different fisheries and gear types, I reviewed the various adaptive strategies I identified, in response to declining resources. I organized these strategies into three sections: those in which the cooperative, as a community institution, participate; and strategies engaged in by individuals that involve fishing, and those that do not involve marine resource production.

In using the narrative form for the adaptive fishing strategies of individuals, I described how I encountered and observed these behaviors in response to the perceived problem in the fishery, also discussed in this chapter. The data about each of the fishermen was compiled from numerous sources including the series of formal interviews, daily conversations while weighing fish, encounters around town, and during fishing trips with their crews. Nevertheless, the different adaptive strategies are not easily separable. Some strategies are complex and are influenced by numerous factors including social relationships, knowledge, and experiences, in the context of available and culturally-appropriate options.

A

B

Figure 4-1. Typical fiberglass fishing boats (*lanchas*). A) Nets are neatly stacked in front of the ice box (*nevara*), located in front of the console. B) Boats moored up to the main dock, decorated with flags and balloons for the Day of the Mariner festival.

Figure 4-2. Photos show examples of typical substrate of the area targeted by divers. Notice the presence of algae and the ledges or caves in photos C) and E). In photo E), divers usually see the antennas of lobsters protruding from the algae, revealing the existence of caves and ledges below.

A

B

Figure 4-3. A) Diver taking aim with his speargun. B) The diver carries his speargun and *enhilador*, a rod on which he threads his catch. He also carries a *gancho*, a hooked rod for pulling lobsters out of caves.

Figure 4-4. When a diver surfaces from his dive (A), a crew member pulls his catch aboard (Photos B and C), after which the diver is helped aboard (D).

Table 4-1. Date of first incidence of decompression sickness among all divers in San Felipe for five seasons. Each year, the date of the first accident is closer to the beginning of the season, July 1.

Dive Season	Date of first accident
2003-04	7/22/03
2004-05	7/19/04
2005-06	7/15/05
2006-07	7/6/06
2007-08	7/5/07


A


B

Figure 4-5. The *maxkil* crab is used as bait for octopus fishing and is most often harvested by women in the estuary at night. A) A fisherman holds a *maxkil* to demonstrate scale. B) A *maxkil* crab.

Figure 4-6. A fisherman in an alijo, or chalana, using jimba to catch octopus. A larger motorized boat (lancha) will return to pick him up at the end of the day for the trip home.


A

B

Figure 4-7. The longline (*palangre*) fishing gear. Up to 300 hooks are baited and placed in order into the slots in the wood frame, called a piano. The fishing line falls neatly to one side (A) and the baited hooks are wedged through the slots on the other (B), ready to be cast by hand into the water.

Figure 4-8. Fishermen eagerly wait along the breakwater (*malecón*) for the bait fishers to separate and distribute their catch. After the lobster and octopus seasons close, longlining is the primary fishing gear in use. During this time, demand can exceed supply for the bait necessary for fishing.

Figure 4-9. A group of fishermen help repair nets (*redes*) in the central plaza.

A

B

Figure 4-10. Two fishermen pulling in their nets.

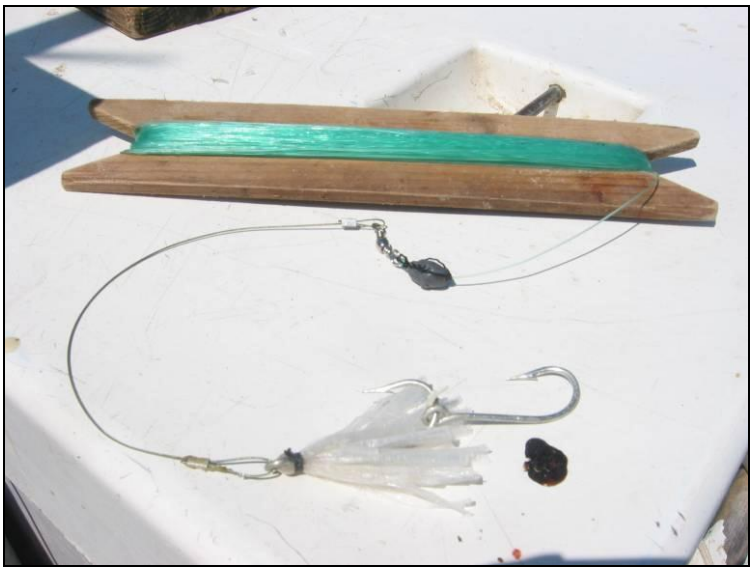


Figure 4-11. A *cordel* is a simple handline used to troll for barracuda or bottom fish for snapper and grouper.

Table 4-2. A selection of answers to an interview question that reflect fishermen's participation towards the problem of declining resources. Instead of using the verb form for "they", the fishermen include themselves by using the "we" form of the verb.

"What is the biggest risk to the marine resources of San Felipe?"		
Age	Spanish response	English translation
31	"*Nosotros, nosotros estamos* bajando; ya *somos* muchos."	Us, we are declining [the resources], now there are so many of us.
39	"La tecnología, ya *estamos* bajando, todo el producto, no solo la langosta."	The technology, we are reducing all of the production, not only the lobster.
50	Que no *respetamos* las reglas de pesca.	That we don't respect the rules of fishing.
44	No respetan nada… lo que mueve, recogen. Lo que vean, la sacan, *estamos* acabando todo.	They don't respect anything … whatever moves, they take it. Whatever they see, they take it, we are using up everything.

Table 4-3. Responses to interview questions showing fishermen's use of the word *producto* to refer to marine resources.

What types of changes have you seen in fishing?	
'Cada ano, ya disminuyendo el producto'	'Each year, it is decreasing, the product.
'Ahora no hay mucho producto.'	'Now there is not much product.'
'Cada ano que pasa hay menos, baja mucho la producción. Mucha exigencia en el producto en el manejo del producto.'	'Each year that passes, there is less. It goes down a lot, the production. Much demand for the product en the manner of its production.'
'Es escaso el producto, todo el producto.'	'It is scarce, the product, all of the product.'
'Cada vez hay menos producto. [pero] Mas embarcaciones, mas pescadores.'	'Each time there is less product. [but] More boats, more fishermen.'
Have you seen changes in the environment?	
'Antes, no habia [las mareas rojas] o habia muy afuera. Por esta vez paso muy abajo y es por eso no hay producto.'	'Before, there were not [red tides] or they were very far out at sea. This last time, it passed by very shallow and it is for this reason that there is no production.'
'El agua lo ves esta normal; solo no hay producto. Se acaba, poco a poco.'	'The water you see it is normal; only there is no production. It has disappeared, little by little.'
'Muy caliente, el agua. Entonces, el producto no baja.' [Las especies que vienen.] …'El pulpo no viene cuando el mar esta caliente.'	'The water is very hot. So, the production does not enter the shallow water.' … 'The octopus does not come when the sea is hot.'
'Ahora, los nortes son menos intensan. Vienen menos nortes. Cuando vienen los nortes, traen producto… la pesca estaba mejor con mas nortes.'	'Now, the cold fronts are less intense. Fewer cold fronts come. When they come, they bring product…the fishing is better with more cold fronts.'
What is the biggest problem for the future of fishing here?	
'No hay producto.'	'There is no product.'
"*Va a llegar el tiempo cuando ya no hay producto*,"	'A time will come when there is no product,'
'Mas escasez el producto.'	' '[It is] more scarce, the product.'
'Que va a ver menos producto por sobre explotacion del mar de los pescadores.'	'You will see less product due to overexploitation of the sea and by fishermen.'
'Que ya va a acabar el producto.'	'It is going to be finished, the product.'
'Cada ano hay menos producto, mas explotacion del producto.'	'Each year there is iess product, more exploitation of the product.'
'Va a ver mas gente que se dedica a la pesca y … mas embarcaciones. El producto esta lo mismo pero esta dividido entre muchos.'	'There is going to be more people dedicated to fishing… and more boats. The product is the same but it is divided among many.'
What is the biggest risk to the marine resources of San Felipe?	
'La tecnologia, ya estamos acabando, todo el producto, no solo la langosta.'	'The technology, we are diminishing it, all the product, not only lobster.'
'Depende en el ano, habia pulpo el ano pasado pero dice que vino el agua roja y ha veces se aleja el producto.'	'It depends on the year, there was octopus last year but it is said that the red tide came and sometimes, the product flees before it.'
What should be done to protect the marine resources of San Felipe?	
'No, es demasiado. Mucha gente acaba el producto. Este ano, en febrero y marzo, habia mucho mero pero hay ellos que sacan chicas. Hay ellos que respetan la veda pero otros los sacaban.'	'No, it's too much. Many people using up the product. This year, in February and March, there was much grouper but there were those who took the small ones. There are those that respect the closed season but others take them.'
'Eso es el loram, si se prohibido, uno o dos años, no vamos afuera y el producto alla no acaba.'	'This is the GPS, if it was prohibited, one or two years, we don't go far and the product there will not be gone.'
'Cada año hay casi igual el producto. Lo que pasa, somos muchos.'	'Each year there is about the same amount of product. What happens is that we are many.'
'No, no podemos cambiar nada, es el poder del dios. La marea roja, no podamos hacer nada. Huracanes traen producto y quitan producto.'	'No, we are not able to change nothing, it is the power of God. The red tide, we are not able to do anything. Hurricanes bring product and take it away.'

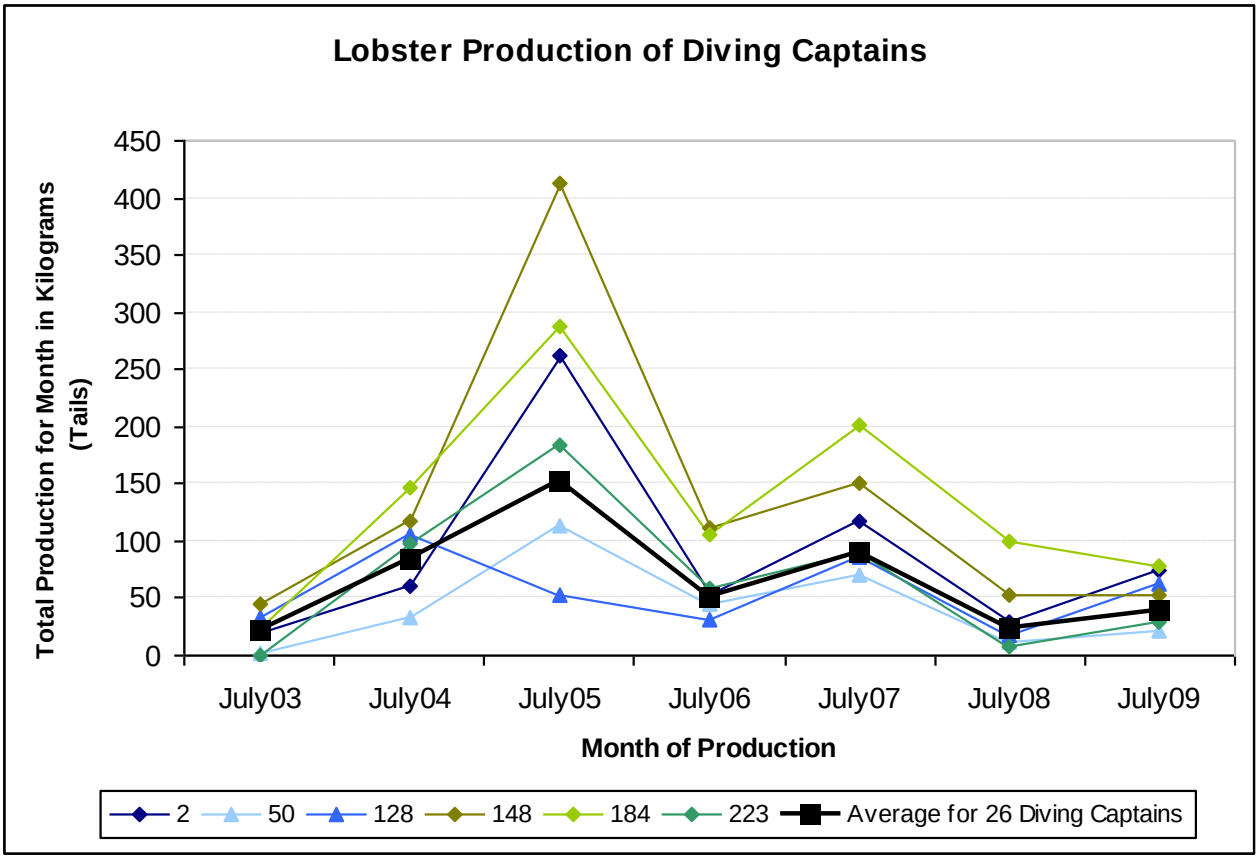


Figure 4-12. Graph shows the total lobster production of six individual fishermen (identified by numbers) plus the average of 26 fishermen (black line), for the first month of each lobster season, from 2003 through 2009. Of the sampled 44 cooperative fishermen, 26 both dive for lobsters and are captains of their own boat. The production of these fishermen is more appropriate for comparison as they receive a similar share of the boat's catch. I selected six individual fishermen to show how, generally, an individual's catches are consistent with his success in relation to the average.

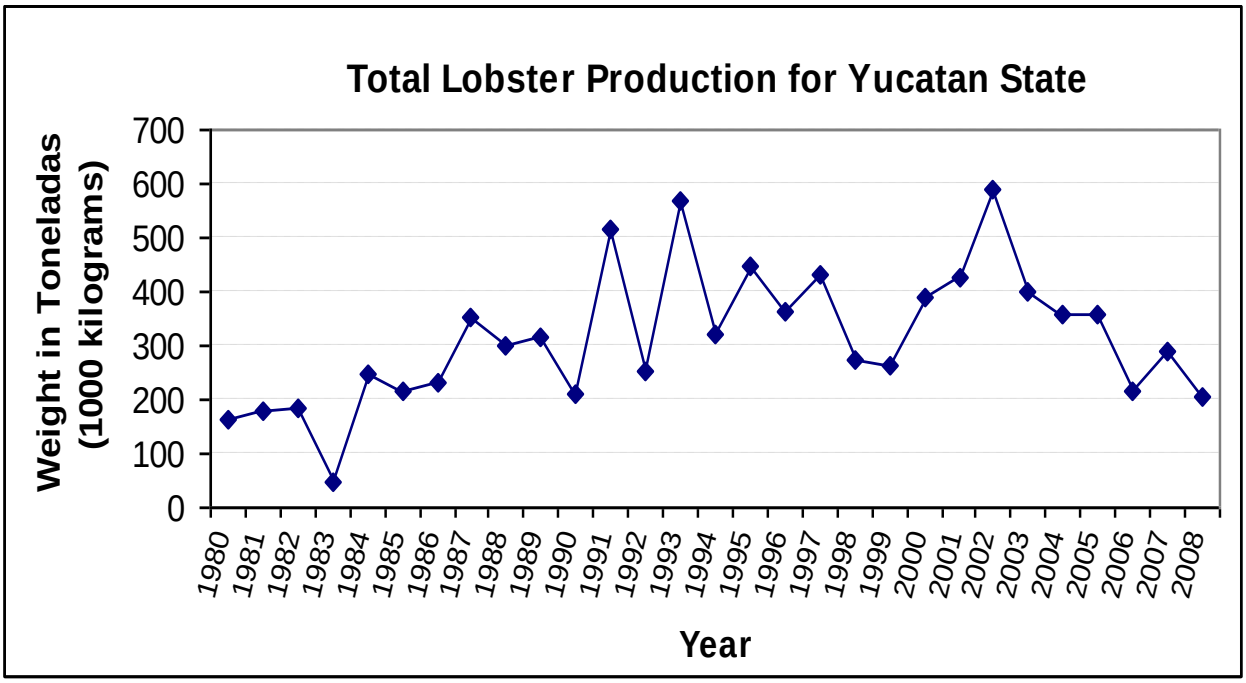


Figure 4-13. Graph shows the total weight of spiny lobster production from the whole coast of Yucatan state. In Figures 4-13 to 4-15, the data point for the year 1983 stands out in contrast to the surrounding years. I attribute this to faulty data collection, or an error in data reporting. (CONAPESCA 2010)

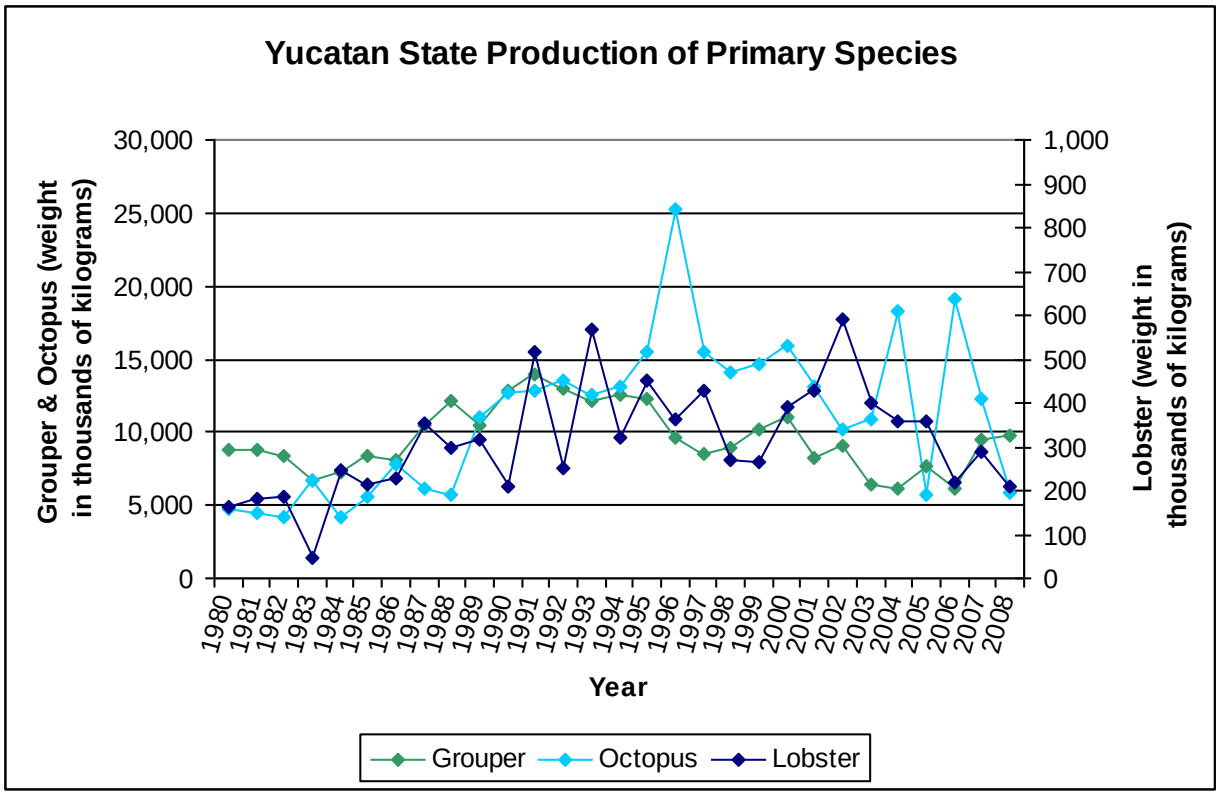


Figure 4-14. Comparison between the total commercial production by year for spiny lobster, octopus, and grouper, in the state of Yucatan. Note the scale of weight for the primary axis showing octopus and grouper, compared to the second axis for the weight of lobster. (CONAPESCA 2010)

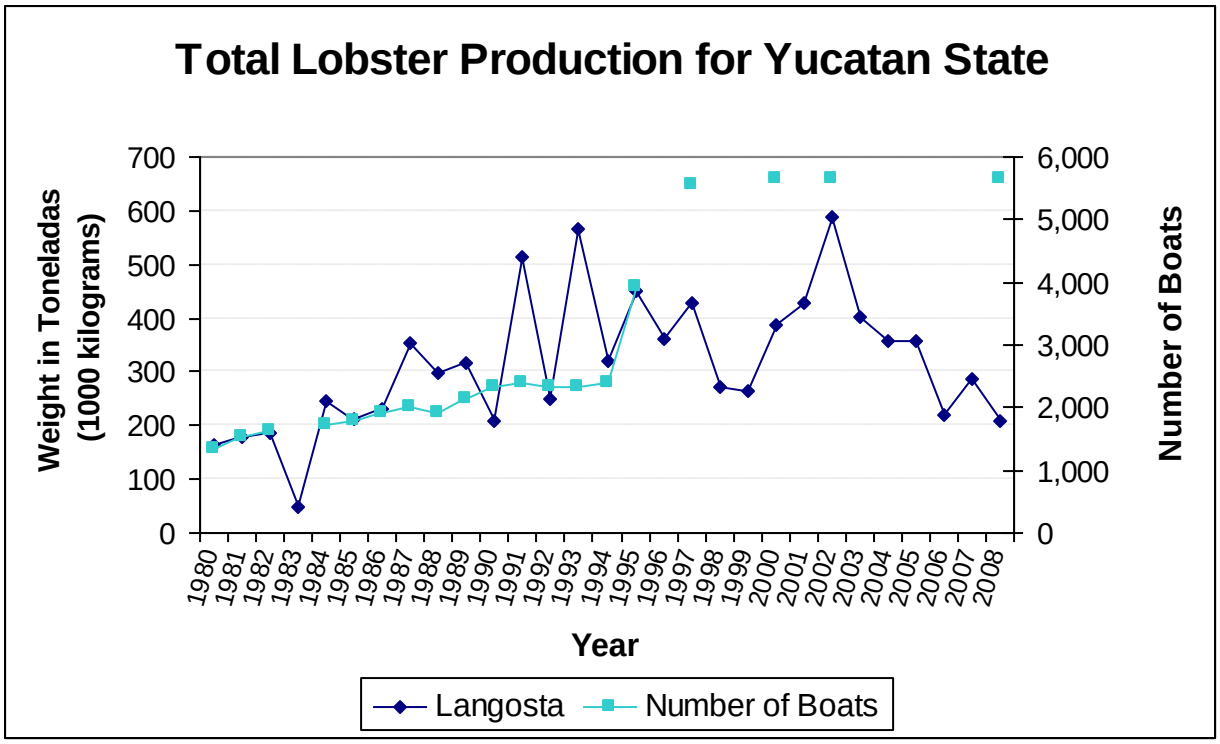


Figure 4-15. Graph shows the change in total lobster production by weight and number of boats. Between the years of the jump of 1994-1995, the number of boats was broken down differently; from 1995 on, the number of boats were reported as *total embarcaciones* and those of *menores* or *gran escala*. It is possible that the new system of accounting was at least partially responsible for the dramatic change in the number of boats. Also, for the subsequent years for which there is no data point, the quantity of boats for those years were reported as identical to the preceding data point. This seemed suspicious and I elected to omit these data points, assuming that this data was not collected for the year at hand, but was recycled from the most recently collected and published data. Still, with each new boat count published, the number increases.

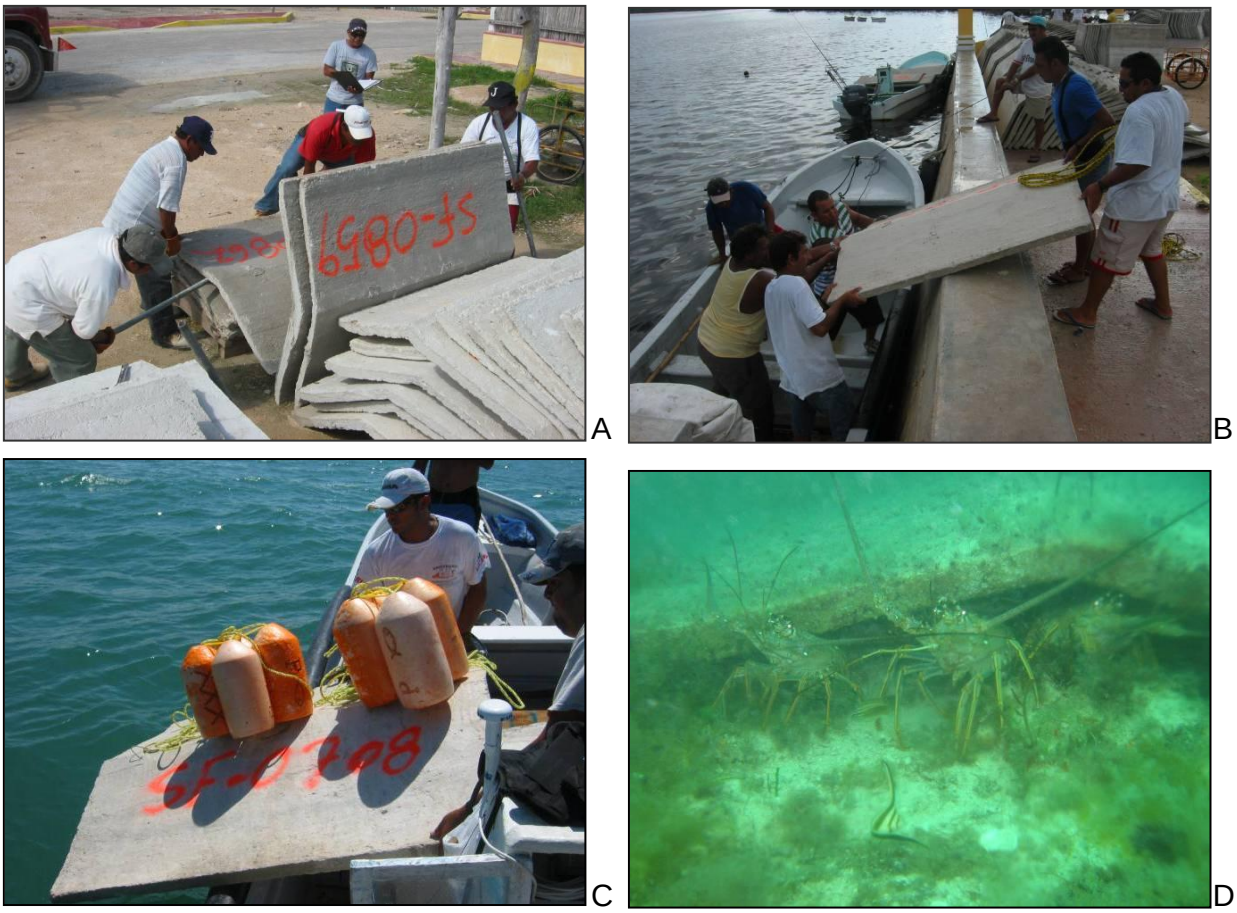
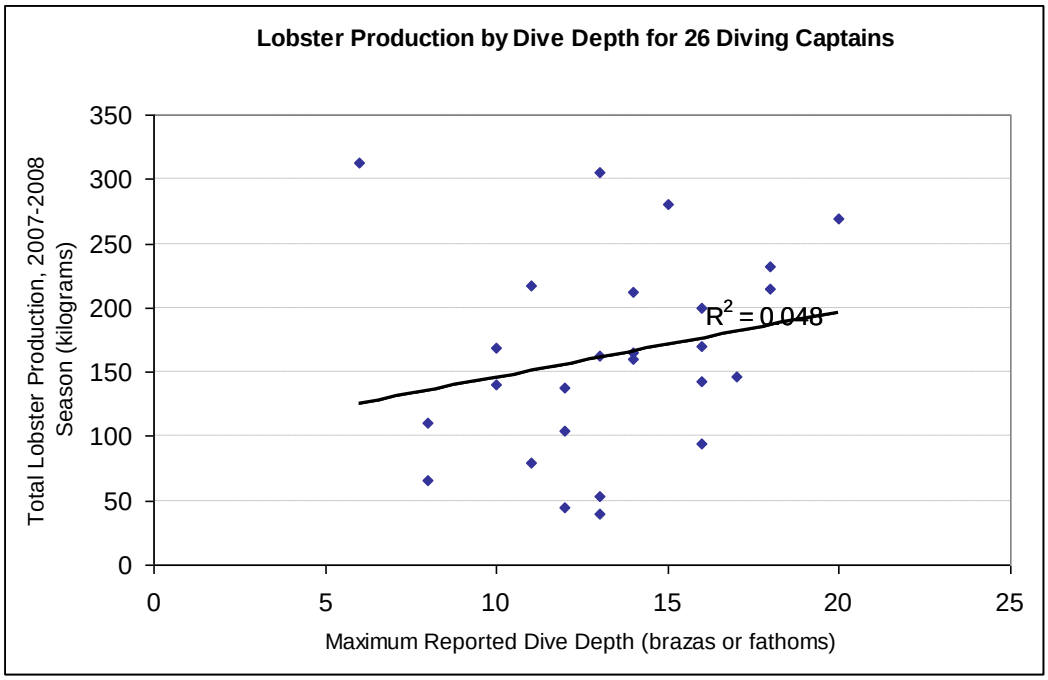
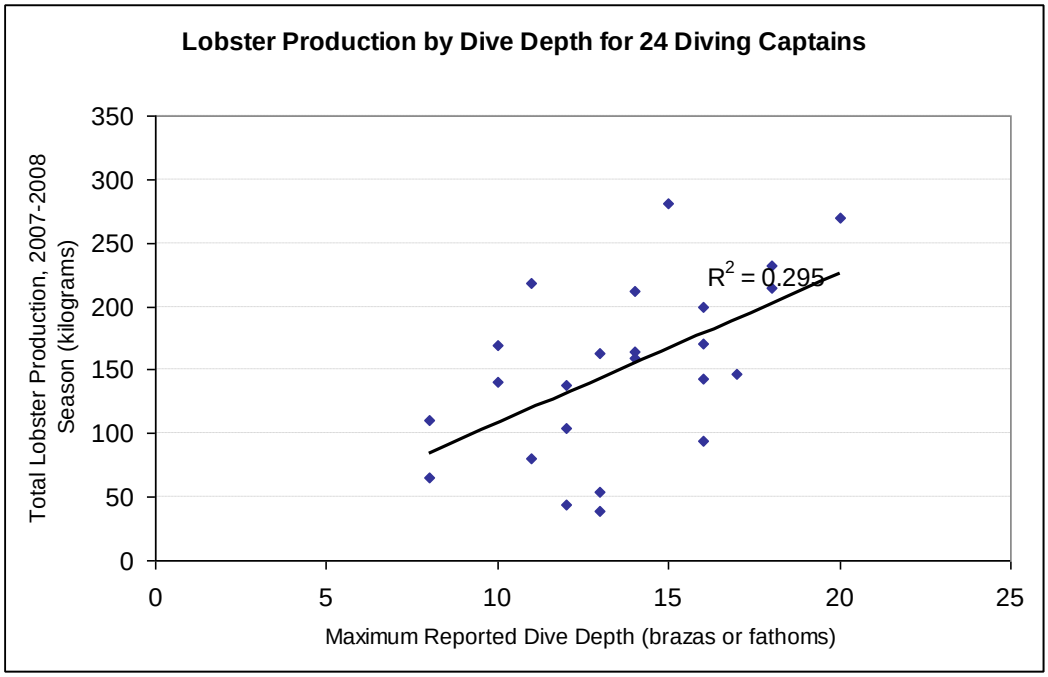


Figure 4-16. Artificial lobster habitats called *casitas cubanas* or *refugios*. A) The concrete slabs arrived from the manufacturer in Merida and were stacked and numbered on the breakwater. B) The cooperative members then loaded the *casitas* onto boats. C) Each lobster house is attached to buoys before being pushed overboard at a selected location. This is to prevent breakage by slowing the descent to the bottom and to assure that the *casita* lands in the correct position. D) A lobster house with resident lobsters.



A



B

Figure 4-17. A) All 26 diving captains from the sample of 44 total fishermen. B) Two diving captains were removed: numbers 148 and 184. (In Figure 4-12, these are the same two individuals who landed the most lobster.) The removal of these two individuals resulted in a change in the R^2 value, from .049 to .295. I discuss the case of each of these removed fishermen in the text as examples of other factors involved in adapting to scarcity. Only diving captains are represented in the graph in order to examine a sub-population that receives an equivalent share of a day's catch.

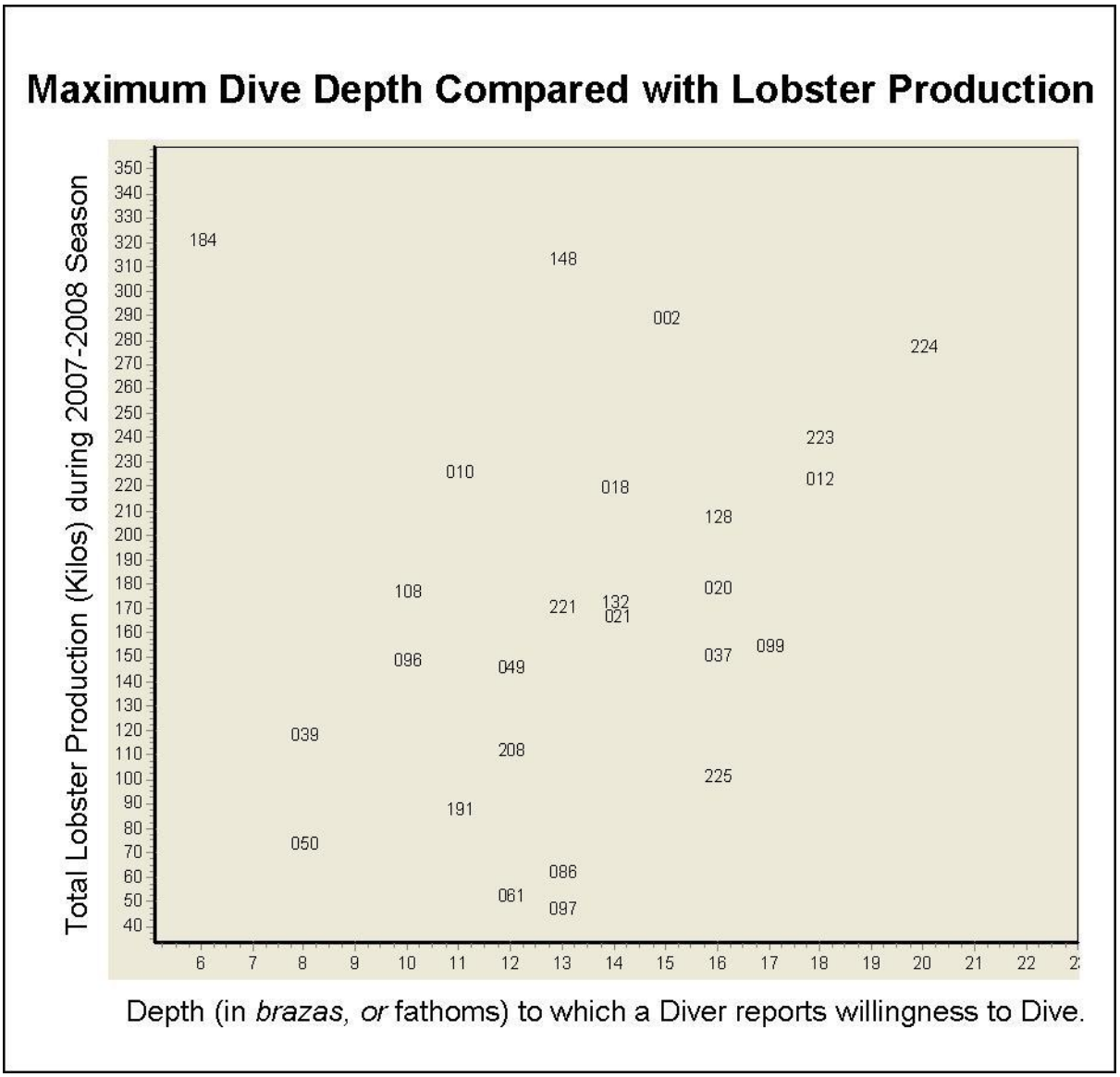


Figure 4-18. Scatterplot showing the relationship between how deep a fisherman is willing to dive, and his lobster production during one fishing season. (same data set as Figure 4-16) Generally, divers report the need to dive deeper from shore as lobster scarcity increases. The figure above shows how the sampled diving captains' production relates to their maximum dive depth. The three-digit number represents a diving captain (n=26); because a diving captain receives a greater share of the day's catch than other crew members. (Only diving captains are represented in the graph.) There appears to be a general overall trend that supports this idea, but there is variation as well.

Table 4-4. The prices for different fish species changes frequently due to numerous factors with the value of grouper being one of the most volatile. The table shows the prices paid by the cooperative to the member fisherman for each kilogram of the particular species. These were the prices paid at the beginning of the lobster season May 5, 2008. (Lobster and octopus are in closed season at this time and these prices reflect their value at the end of each species' season.)

English Name	Spanish Name	Value in Pesos Per kilogram	Approximate Value in US$ per kilogram
Lobster	Langosta	285	$28.50
Octopus (viscera removed)*	Pulpo	45.41	$4.54
Octopus (viscera intact)*	"	26.09	$2.61
Grouper (greater than 2.5 kg)	Mero	34.76	$3.48
Grouper (1.5 – 2.5 kg)	"	30.61	$3.06
Grouper (less than 1.5 kg)	"	14.06	$1.41
Snook (greater than 1.5 kg)	Robalo	44.69	$4.47
Snook (500 – 1500 grams)	"	34.76	$3.48
Small shark (greater than 1.5kg)	Cazon	14.06	$1.41
Small shark (800 grams – 1.5 kg)	"	10.75	$1.08
Hogfish (450 - 750 grams)	Boquinete	12.40	$1.24
Hogfish (greater than 750 grams)	"	19.03	$1.90
Snapper lunar (greater than 1.8 kg)	Pargo Lunar	19.03	$1.90
Snapper lunar (.5 – 1.8 kg)	"	13.63	$1.36
Yellowtail Snapper (less than 450 grams)	Canane	22.35	$2.24
Yellowtail Snapper (greater than 450 grams, for export)	"	26.48	$2.65

*The value is greater if a fisherman removes the internal organs from the octopus himself. Until recently, most fishermen did not remove the viscera themselves. Now, it is rare for a fisherman to accept the lower price and nearly always do this task themselves.

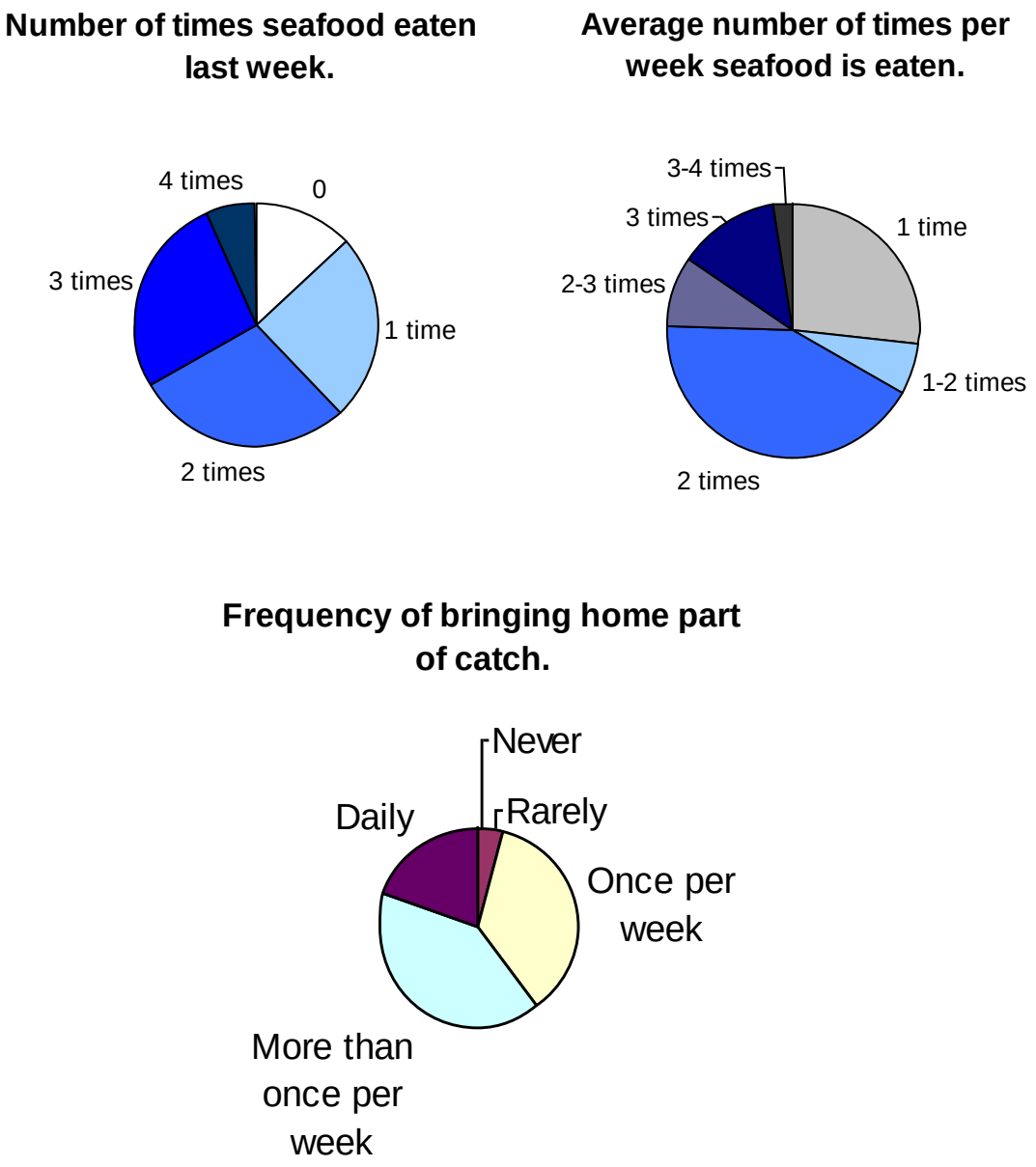


Figure 4-19. Summary of responses from the sample of 45 fishermen for the following questions: 1. In the last week, how many times have you eaten fish or other seafood? 2. On average, how many times each week do you eat fish or other seafood? 3. When fishing daily, how often do you bring home fish or other seafood to eat?

Table 4-5. Responses to the open ended question (n=45) about what each usually brings home to eat from his catch.

What do you usually take home to eat?			
Species taken home to eat	Number of Mentions*	Percentage of Interviews	Status
Small grouper (*meritos*)	32	71%	Undersize
Grouper stomachs (*buches*)	21	47%	No value
Octopus (*pulpo*)	16	36%	Legal
Small lobster tails (*colitas*)	14	31%	Undersize
Conchs & Whelks (*caracoles*)	14	31%	Illegal
Fillets & Fish, generally (*escama*)	9	20%	Legal
Hogfish (*boquinete*)	7	15%	Legal
Snappers (*pargos*)	6	13%	Legal
'Campechana' snails	3	7%	Illegal
Cobia (*esmedregal*)	2	4%	Legal
Triggerfish (*cochim*)	1	2%	Legal
Sea Trout (*corvina*)	1	2%	Legal
Barracuda (*picuda*)	1	2%	Legal (but caught in marine reserve)

*Out of 45 interviewees.

A

B

Figure 4-20. San Felipe is built on reclaimed land, out of the mangroves, as seen from above in (A) a Google Earth image. B) A house is built on rocky fill, where the mangroves are still growing adjacent to his house.

Figure 4-21. Home gardens are planted in the patches of soil around the large rocks that cover the ground. This is common in this part of the north Yucatan peninsula and is why the land is better for raising drought-resistant Brahman cattle than for agriculture.

CHAPTER 5
MODELING ADAPTATION

In this chapter, I connect the ethnographic descriptions of fishing behavior from the previous chapter with a model of adaptation to resource scarcity in another fishing context.[25] I then elaborate on the model of adaptation to resource scarcity, centered on adaptation as a process of intensification and diversification that occurs at both short and long term scales. While Chapter 2 presented a theoretical review and discussion of the concept of adaptation, the analysis presented in this chapter addresses two specific issues with the way the concept is often currently employed. First, adaptation is frequently used tangential to explorations on resilience, socio-ecological systems, and environmental change where the commonly used terms of adaptation and vulnerability vary greatly in their usage and definitions. This has led to theoretical confusion as scholars employ diverse definitions that make comparative work problematic. Also, these concepts remain in the realm of abstract theorizing and researchers continue to struggle with how to operationalize the concepts for testing the premises in real contexts.

The second issue concerns scale. In much of the recent literature on climate change, the concept of adaptation is used to refer to processes at the scale of a region, nation, or an even broader global effort to make coping adjustments. While the body of theorizing adaptation at a broad scale is useful to get scholars thinking about these concepts as processes, for a dissertation, I needed a theory or definition of adaptation

[25] Throughout this chapter, I refer to the following paper: McCay, Bonnie J. (1978) Systems Ecology, People Ecology, and the Anthropology of Fishing Communities. Human Ecology 6(4):397-422.

that was better defined, and with which I could use as a lens to explore the process of change in my research site.

Some recent literature, reviewed in Chapter 2,[26] applies the concept of adaptation to specific case studies. This research, principally sited in agricultural communities, examines specific human responses to environmental change. The papers note that historical and geographical factors circumscribe viable adaptive strategies. Economic and cultural factors also serve to render some coping mechanisms more favorable than others. The authors identify specific adaptive strategies that are employed by people experiencing change, but they do not propose a model of adaptation to resource scarcity that could be employed cross-culturally for comparative purposes. Rather, the scope of these papers is to provide "Local Evidence on Vulnerabilities and Adaptations to Global Environmental Change," as the title of the issue's editorial clearly states. Yet, this special issue provides valuable case studies of adaptive responses to resource scarcity, in these examples, mostly to water scarcity. This recognition that adaptation consists of behaviors and responses of human actors is important because it affects the broader scale of management. It is human behavior that is modified in the implementation of resource management.

In order to examine the adaptive strategies of the fishermen of San Felipe comparatively, I searched for a model of adaptation in the literature. While I found an abundance of theoretical discussions of adaptation, there were few examples where a case study had been analyzed along a framework that could be compared (as noted above). This chapter focuses on one such framework set up by McCay (1978), and to

[26] Specifically papers from *Global Environmental Change* (2008), special issue, volume 18.

an extent, the classificatory scheme Acheson lays out (1981). As a review article, Acheson offers a template of adaptive strategies where fishermen are seen as employing one of four strategies. He categorizes adaptive behaviors in comparable terms, but does not go on to interpret the behaviors as processes. I will return to Acheson's typology of adaptive strategies in the discussion section of this chapter.

McCay's Model of Intensification and Diversification

Bonnie McCay's work forms part of the core literature that led to the development of an anthropology of fishing. Her work on fisheries as common property resources shows that the Tragedy of the Commons is not inevitable but rather, a product of particular circumstances where local management has broken down or does not exist. Having read her work while developing my own research ideas, it is not surprising to return to her work to examine the present study comparatively.

In a 1978 paper published in *Human Ecology*, McCay sketches a model of adaptation to resource scarcity while calling for a focus on people in the analyses of systems under change. McCay notes four characteristics of what she terms, a "people ecology," focused on individuals, in contrast to a systems-based ecology: (1) an emphasis on intracultural diversity, (2) populations and ecosystems are not the units of analysis, (3) interactions may reflect the diversity of strategies amongst multiple individuals, and (4) incorporating the social structure of the group in the analysis. She also emphasizes that adaptive behaviors are not only responses to a particular biophysical environment, but to the socio-cultural environment in which people are a part. Thus, the people ecology she proposes maintains the recognized complexity of a system, but focuses on the agency of individual human actors.

McCay's categorizes adaptive strategies into two types: diversification and intensification (Figure 5-1). Diversification refers to "spreading of the risk and expanding alternative modes of coping with environmental problems." She calls this "the expansion of alternatives." Intensification refers to an "increased commitment to an investment in one or another mode of resource procurement." She notes an ordinal relationship between the two where strategies of diversification occur before those of intensification, based on the idea that "minimal, less costly" and reversible strategies will be attempted before "deeper, more costly" and less reversible strategies are attempted.

Under this schema, strategies of (fishing) capital investment, changing fishing strategies, migration, and accepting government subsidies are classified as either diversification or intensification, depending on (1) the degree of investment and (2) reversibility. McCay discusses an example where fishing gear is changed at minimal cost, but as resource scarcity worsens, people try more dramatic, "costly" experiments with gear. Thus, changing fishing gear is a strategy of diversification or intensification, depending on the cost and reversibility of the new fishing gear. Migration is also presented as an example of both strategies. McCay's differentiation in these two strategies, then, is that when faced with scarcity, people dabble before investing fully. There is a tendency to avoid uncertainty and risk when first faced with scarcity prior to attempting a strategy that is less reversible, should diversification not pan out.

In McCay's field context, diversification refers to both the adoption of non-fishing (terrestrial) labor activities and also the adoption of new fishing gear in order to target different fish species. The former decreases pressure and effort on marine resources while the latter maintains fishing pressure, but on a different fishery. Intensification

under McCay's model is exemplified through an "increased reliance on welfare assistance; increased commitment to wage labor, which replaced fishing as the core of pluralist strategies; increased temporary and permanent out-migration; and investment in longliner fishing technology." With the exception of the investment in longliner technology, each of these intensification strategies involves *less* pressure on marine resources—less fishing is involved. Intensification, as used by McCay, refers to the intensified use and reliance on whichever strategy of diversification was employed. McCay bases her idea that diversification precedes intensification on the theory of "economics of flexibility." McCay's case study supports the tenets of the theory, that minimal and more reversible strategies are employed first and only when the problem worsens do people invest in more costly, less reversible measures. The theory of an "economics of flexibility," then, drove McCay to label the strategies temporally as diversification followed by intensification.

An important point to address in McCay's study is that she is not reporting on individual fishermen first diversifying then intensifying, but rather, pointing out a difference in the prevalence of strategies adopted, across two different time periods. She notes that the shift from diversification to intensification "cannot be viewed simply in relation to characteristics of the natural environment." Following an intensification period of longliner investment, there occurred another period of diversification once there was room for flexibility again.

Comparing the Communities

Before using McCay's conceptualization of adaptive strategies to consider the strategies of San Felipe's fishermen, I first want to compare the contexts of the two settings: San Felipe and Fogo Island. The population, fishing species, gear, technology,

and crew size are compared in Table 5-1. The population of the communities of Fogo Island, Newfoundland, the setting of McCay's research, is approximately twice that of population of San Felipe. Also, the Fogo Island population is divided into nine settlements, whereas San Felipe is aggregated into one settlement, with another settlement nearby (Rio Lagartos, 12 km to the east) that has access to the same lobster fishing grounds.

On Fogo Island, the cod fishery varied from year to year. Fishermen coped with such regular fluctuations by changing gear and technology, fishing during the fall (later in the season), and targeting secondary species (salmon and lobster). The fishermen also engaged in farming or other shore labor as a way of providing additional income. Government financial assistance provided additional economic support.

In San Felipe, the lobster fishery also varies greatly from year to year, and the fishermen also change their gear and technology. However, an example of gear change in San Felipe is to leave diving and switch to surface fishing strategies. Also, the secondary species that San Felipe's fishermen target may be caught by continuing to dive, rather than switching fishing technology. Thus, they switch fisheries but not gear type. This decision seems to be one of personal preference, as well as availability of crewmembers. This decision also involves an increase in the adoption of risk because the practice of taking other species while diving is illegal.

On Fogo Island, local resource management backed by government endorsements and small-scale technology in both fishing and processing served to prevent overfishing. Catches were stable until large-scale offshore trawling activity hurt the cod stocks; local resource management could do nothing to address this foreign

problem and so, became less important. This phenomenon has been observed by Berkes et al. (1991), when factors outside the system under a local management regime impact the availability of resources, such a system of management may succumb and dissolve. San Felipe, on the other hand, has lacked consistent enforcement of management directives, both of local origin and federally mandated. Also, although fishing is small-scale, many fishermen point to the now ubiquitous use of GPS devices as having had a devastating impact on the fishery. Other fishermen regularly blame offshore, deep water lobster trappers for the decline in resources although I have not been able to find data to support this claim. Thus, just as McCay attributes the cause of resource stress to numerous factors, including a population of "other" fishers not under study, so the fishermen of San Felipe recognize their own scarcity problem as due to management problems, fishing technology, and over-population of fishermen.

Another interesting comparison between the fishermen of Fogo Island and San Felipe is the political inability to bargain for better prices for their catches. McCay compares the truck exchange system of Fogo Island to sharecropping, similar to how I compared the fishermen of San Felipe to debt peons (Lasseter 2006) in their relationship with an exploitative regional buyer. In both situations, the fish buyer makes necessary loans to the small-scale producers, which are needed for domestic needs during periods of slow fishing, and through this arrangement, also control the cost paid for fishers' production.

McCay has long term data on catch declines, from the years 1958 to 1972. The data shows that not only has the number of fishermen decreased by half, which means

a decrease in effort on the fishery, too, but that the catch per fisherman, despite the decrease in competition from other fishermen, also fell by half. Equivalent longitudinal data on the catches of fishermen for the community of San Felipe is not available.[27] The available production data for the last seven years does not conclusively show an overall decline in catches among fishermen (Table 5-2), and it would be difficult to conclude that the lobster fishery is facing collapse. Fisheries landings are often volatile from one year to the next, which could even relate to natural cycles of population boom and bust. As seen in Table 5-2, the average catch per fisherman in 2009 was greater than the average catch in 2003, but less than that of 2004. (Figure 4-12 shows how the catches changed per year for six individual fishermen.)

Therefore, while I am unable to quantify the decline in lobster landings on a similar temporal scale as McCay's data, the fishermen of San Felipe complain about a decline in resources. I was told repeatedly of the trend for fishermen to target lobsters in waters deeper and farther from shore. Fishermen claim that they used to return every day with over 10 kilograms of lobster tail; now, a good day's catch would be two kilograms. The fishermen also point out that the average size of lobsters gets smaller each year; by the end of the season, only undersized lobsters are caught and these are sold on the local black market. This sense of scarcity is recognized beyond the community, as well. Detailed further in Chapter 3, a group of scientists at the Universidad Autonomo de Yucatan's CINVESTAV (Centro de Investigación y de Estudios Avanzados) implemented a project in San Felipe to place artificial lobster habitats (*casitas cubanas*) in the fishing grounds in order to improve lobster catches.

[27] Data is available on the total lobster harvests for the entire coast; see Figure 4-11. Cooperative production data is not available prior to the split of the cooperative in 2003-2004 (see Chapter 2).

Contrasting the Studies

From the narratives of adaptations in the previous chapter, I created the list of adaptive strategies in Table 5-3. These behaviors may involve greater personal or financial risk, or an increased resilience or vulnerability to further resource scarcity. Although all fishermen report the need to dive in deeper waters, farther from shore, in order to find lobsters, fishermen differ in the maximum depth to which each will dive. Furthermore, diving deeper does not necessarily produce greater catches; other factors dictate fishing success as well.

Examining the list of strategies and recalling conversations with fishermen, I recognize that some of the strategies are employed by many fishermen. These include the strategies of diving deeper or investing in cattle, for example. There are also many fishermen who mix these behaviors into new combinations of strategies according to personal factors such as preferences. There are also examples of innovation.

When attempting to apply conceptually McCay's operationalization of diversification and intensification to the divers of San Felipe, some problems arise. McCay's analysis examines adaptation over a longer time scale; intensification of adaptive strategies comes about after extended and repeated resource scarcity. Also, as McCay interprets the adoption of adaptive strategies, people do not change behaviors so much as increase their commitment to a particular strategy or behavior. With continued scarcity or stress, people feel more pressure and respond by increasing their degree of investment. She analyzes the adaptive strategies of the Fogo Islanders as an example that supports the theory of "economics of flexibility."

In the case of San Felipe, I treat strategies as responses to one episode of extended scarcity, as opposed to multiple episodes of scarcity over multiple decades.

To examine the future, I could only ask people what they *would* do if scarcity continues or worsens. Thus, McCay's definitions of diversification and intensification are not the most appropriate to my analysis. Nevertheless, I find the idea of strategies of diversification and intensification to have utility in examining adaptive strategies when defined in terms of the human-environment interaction, as opposed to long-term stress on communities.

Finally, there is great intracultural variation in the strategies of San Felipe's fishermen; McCay draws attention to such variation in a people-centered approach. Some are willing to invest in increasingly risky strategies (diving deeper), while others prefer to invest in terrestrial strategies, finding that the risks to personal health are not worth the payoffs. This variation is not limited to strategies and decision-making, but also capital ownership and engagement in fishing activities. Therefore, I stratified the cooperative members according to those who own or do not own boats, and those who dive or do not dive. This is also an important intracultural distinction as, economically, the day's catch is divided and shares apportioned based on these factors. For a typical three-member crew of boat-owner and diver, second diver, and helper, the day's catch is divided into 3.5 parts. After the day's fuel expenses have been subtracted, the owner-diver receives two parts, the second diver receives one part, and the helper receives the remaining half-share. The extra part the owner receives for capital ownership of the boat, is the "boat's share" and it is the captain-owner's duty to use these funds for boat maintenance and diving equipment (compressor and regulator).

But, there are also other characteristics of those that belong in each of these groups: among boat owners, non-divers are mostly older, retired divers. Many younger

fishermen do not yet own their own boat. Figure 5-2 shows how the 123 cooperative members break down according to boat ownership and whether or not they dive.

Re-Defining Diversification and Intensification

The human-environment interaction that is the focus of this study is defined as the fishermen of the cooperative and the spiny lobster resource. Adaptations are the strategies employed by the member fishermen in response to scarcity of their primary resource. Given this focus on the fisherman-marine resource interaction, I define strategies as either increasing a commitment to fishing (intensification) or reducing dependence on marine resources (diversification). In defining strategies this way, the focus remains on the interaction, enabling analyses that could inform factors of management, such as when fishing pressure is increased or decreased in times of stress. Furthermore, lobster has a cultural and economic importance to the community. To examine strategies according to investment in effort committed to fishing reflects the importance of fishing to the community and the identity of divers. As the fishermen say, they are not just fishermen, they are divers.

Thus, the continued investment in fishing, or dependence on marine resources, is the factor that differentiates strategies of diversification and intensification. As a note, the most adaptive fishermen will engage in both strategies in order to minimize risk and maximize potential yields from fishing. Those components of McCay's intensification such as an increased commitment to wage labor and reliance on welfare are classified in my model as diversification. Diversification is 'spreading the risk' by adopting other livelihood strategies outside of fishing. Examples of diversification include shore based wage labor, where pressure and effort are not directed onto marine resources. Intensification involves adopting greater risk in fishing even when experiencing scarcity.

A livelihood dependent on fishing is already risky; catches, weather, crewmates, prices, all are unpredictable (Poggie 1980, Acheson 1981, McGoodwin 2001).

Strategies of intensification commit a fisherman further in fisheries. Often, this involves an additional investment in fishing capital, as well. Diving as a fishing strategy requires greater initial financial inputs for the equipment (air compressor, regulator) than other fishing techniques and their investment only earns returns when they use that gear. This could contribute to examples of what Bennett (1976a) noted was still an adaptive strategy: maintaining the status quo. Having the equipment to dive does not necessitate that a diver will dive deeper; he may curtail expenses and live more simply or is able to apply knowledge and experience to land good catches.

Nevertheless, the inputs for fuel and maintenance are greater for diving equipment. Air compressors break down frequently. Diving also entails greater risk from the contamination of the compressor's air supply as well as from decompression sickness and embolisms, caused in part by the common practice of making rapid ascents to the surface, long bottom times, and alcohol and tobacco consumption. These risks, however, appear to be mitigated by the economic value of lobster, which is much greater than for other species ($25US/kg for lobster tails versus $4.40US/kg for whole octopus). It is illegal for fishermen to harvest any species other than lobster while diving on compressed air, so the adoption of this adaptive strategy has the additional risk of formal penalization by enforcement agents if caught.[28]

[28] Treatment for dive accidents requires recompression in a hyperbaric chamber which is extremely expensive. Because the cooperative members' health insurance covers the costs of emergency treatments, there are no out-of-pocket expenses for such accidents, which might otherwise serve to encourage safe diving practices.

San Felipe's Strategies

In the interview I conducted on adaptive strategies, I asked the sampled fishermen about their strategies to lobster scarcity. As mentioned above, there is of course a difference between what someone reports they would do if resources continued to decline, and what they actually do. Therefore, I had created an individual report of each fisherman's production for the entire season, including who he had fished with and what he caught on each day he fished. I also tallied how many days he fished each month and with what technology. I used these production reports to help with informant recall and to prompt the conversation about his fishing strategies and perceptions of change.

The results of two sets of questions are shown in Figure 5-3. The average age of each group and proportion of the total interview sample are given. First, using a Likert-type scale for responses, I asked how likely each informant would be willing to adopt various strategies if resources continued to decline. The informants ranked each strategy on a scale of 1 – 5 depending on how likely they say they would adopt each one. The table shows those options that had a variation in responses, meaning that I asked about other strategies that I hypothesized would be important but that proved not to generate responses. I then stratified the responses according to boat ownership and diving engagement as discussed above.

I also asked the open-ended question: What will you do if fishing continues declining? I coded the responses into the various categories shown on the right side of Figure 5-3 and also broken down by boat ownership and diving activity. I also included the average age of each sub-group and its proportion of the total interview sample.

Looking at Figure 5-3, I want to interpret some of the data concerning the adaptive behaviors of the sub-groups of fishermen. In response to the Likert-type question where

respondents gave an answer on a scale of 1 - 5, there was much variation in the answers within each sub-group. That is, respondents tended to select a 1 (least likely) or 5 (most likely), as opposed to the more central options of 2, 3, or 4. In the table, the averages of the responses are given for each sub-group. The first observation I want to make is that, based on the average of responses for each group, non-boat owning divers are more likely to target deeper waters than are diving boat owners. Among the 28 diving boat captains in the sample, the average response to the question of whether or not they will continue to dive deeper is 2.29, compared to 3.42 for non-boat owning divers.

Diving for longer time periods is less likely used as a strategy but reproduces the same increased willingness among non-boat owning divers overall to dive longer (2.42) than boat owning divers report (1.75). Willingness to switch gear type to octopus fishing scored high in all groups, although this was reported as a temporary strategy by the divers who emphasized their preference for diving. Fishermen also ranked their willingness to diversify strategies by investing in ranching and other fishing capital quite high. Investment, of course, is a longer term strategy and also requires the initial capital investment; fishermen report a willingness to adopt this strategy but the ability to do so may not be as simple.

In the next question, I asked about future strategies if resource scarcity continues or worsens. For the long-term, the younger generation feels that they would have to emigrate. Most said they would go to Quintana Roo for seasonal work, leaving their family in San Felipe, but a few would move with their whole family. The older generation will most likely stay and live on their pension.

I was surprised by the reported willingness to migrate from people who have such a strong cultural identity tied to being a fisherman, and being a diver specifically. This was an open-ended question; I did not prompt the word, “migration.” Although so many fishermen stated that that is what they would do if resource scarcity worsens, this may more accurately reflect the fact that migration is a well-accepted strategy in Mexico. There is a historical trend in the Yucatan and Mexico more broadly to emigrate for work. The rise and fall of henequen production in the Yucatan provides an historical example of people migrating for work (Joseph 1982); seasonal or permanent migration to the U.S. and Canada is, of course, another. Due to San Felipe’s proximity to Cancun and accounts of American tourists’ generous tipping habits, it makes sense that this option remains in the back of a fisherman’s mind. However, the point of economic pressure at which they would decide to emigrate is difficult to predict, but likely distant.

Finally, the average age of the three non-diving boat owners in the sample is 46 years old. But, based on data obtained for the entire cooperative (ten fishermen are non-diving boat owners, see Figure 5-2), non-diving boat owners fall into one of two groups. Eight of these are retired divers who, having reached 60 years of age, are no longer permitted to dive once they begin to receive their pension.[29] The remaining two are younger fishermen, in their 40s, who choose not to dive. One prefers other fishing strategies in which he is consistently successful and the second openly admits that he is afraid to dive.

[29] The reason for this policy is based on the possibility of a dive accident that would require treatment in the hyperbaric chamber. This would be an overt indicator that the individual was engaged in work while receiving a pension, which is not permitted. These fishermen are restricted to non-diving work as a fisherman.

Table 5-4 identifies some further general trends from the data on the sub-groups of fishing investment. For all but the non-diving boat owners, who are, for the most part, retired, the idea of migration is the primary option for an uncertain future. The other three groups share intracultural characteristics that relate to their investment in diving. The non-divers with no boat have only their membership in the cooperative (there are nine of them) as an investment in fishing; this group is the most flexible. Those that dive but do not own a boat are generally younger than their diving boat-owner captains (average of six years younger as measured in the sample). They take bigger risks, reporting a higher willingness to dive deeper and for longer times than do diving captains. Overall, for the entire sample, they report a willingness to dive deeper, to switch fishing gear, and to switch fisheries.

Short-Term and Long-Term Strategies

Returning to the strategies in Table 5-3, I classify all but the final three as strategies of intensification because they involve an increased effort in fishing. The last three involve alternate livelihood strategies away from fishing and are thus strategies of diversification. Considering the answers from the interview, I further stratify the strategies into a schema of short-term decisions and long-term plans, which is more similar to McCay's description of diversification preceding intensification (Figure 5-2). Among San Felipe divers, diving deeper is a short-term, immediate decision for responding to economic stress. Fishermen recognize that this strategy is one that involves accepting greater risks, including the risks of decompression sickness. I found migration is mentioned as a last-resort only. Migration is thought of as an option that is always available, but whether or not it would be used is not certain.

Overall, in adapting to lobster scarcity, short-term decisions, driven by economic stress, are exemplified by fishermen intensifying effort in fishing, either in diving or switching fishing technology with minimal further investment. Recalling the discussion in Chapter 4, some fishermen maintain secrecy about their fishing knowledge and continue to have good landings. Others accept greater risk, diving deeper and farther from shore, switch species, or innovate new ways of fishing.

Long-term strategies involve plans to migrate if the fishing is no longer viable, economically. Although the fishermen report willingness to migrate should scarcity worsen, the jobs they envision themselves doing entail fishing or marine tourism. Nobody reported willingness to emigrate for agricultural or other manual labor. Diving is regarded as a skill that will enable the fishermen to find well-paid work in marine tourism.

The fishermen conceive of strategies as short-term strategies, that is, those that produce immediate results in terms of economic returns, and differentiated from long-term plans for their family's well-being (such as the investment in cattle and ranching). Among the sample of fishermen, when stratified for age and boat ownership, there were no evident groupings between some that intensify and others that diversify. Rather, the results show that fishermen engage in both types of strategies, for their immediate needs and long-term well-being. The specific strategy of intensification, for the short-term, does vary according to the individual fisherman.

Conclusion

Under McCay's model, the move from diversification to intensification corresponds with less reversibility and investment in more costly investments. Intensification means an intensified degree of the same behaviors that were classified as diversification.

People spread the risk first then intensify efforts in those same strategies in ways that may prove more costly should they fail. It is a difference in adoption of risk; increased economic pressure from resource scarcity pushes people to try ever more costly and less reversible investments in the same strategies. Yet, the data from San Felipe shows that fishermen adopt behaviors that entail greater risk in the short-term, as an immediate response to economic needs. Also, long-term strategies such as investing in cattle entail a spreading of risk, not the opposite as suggested by McCay's model. Although migration is offered as a strategy, it has yet to be adopted by anyone and seems to remain a part of a future where anything is possible.

Recalling Bennett (1976a), it is important to specify how 'adaptive strategy' is defined, and to identify to what people are adapting. I define adaptive strategies in terms of the interaction between fishermen and their fishery. That is, do people diversify out of fishing or do they intensify their efforts to maintain a livelihood from fishing?

So far, this analysis has ignored the social structure in which fishermen are a part and in which they make decisions. In the next chapter, I take up McCay's note emphasizing the importance of examining how social structure influences adaptive strategies in examining the social networks of the fishermen. The chapter ties together the discussion of adaptation from the preceding chapters and considers the meaning of adaptation when examining social structure.

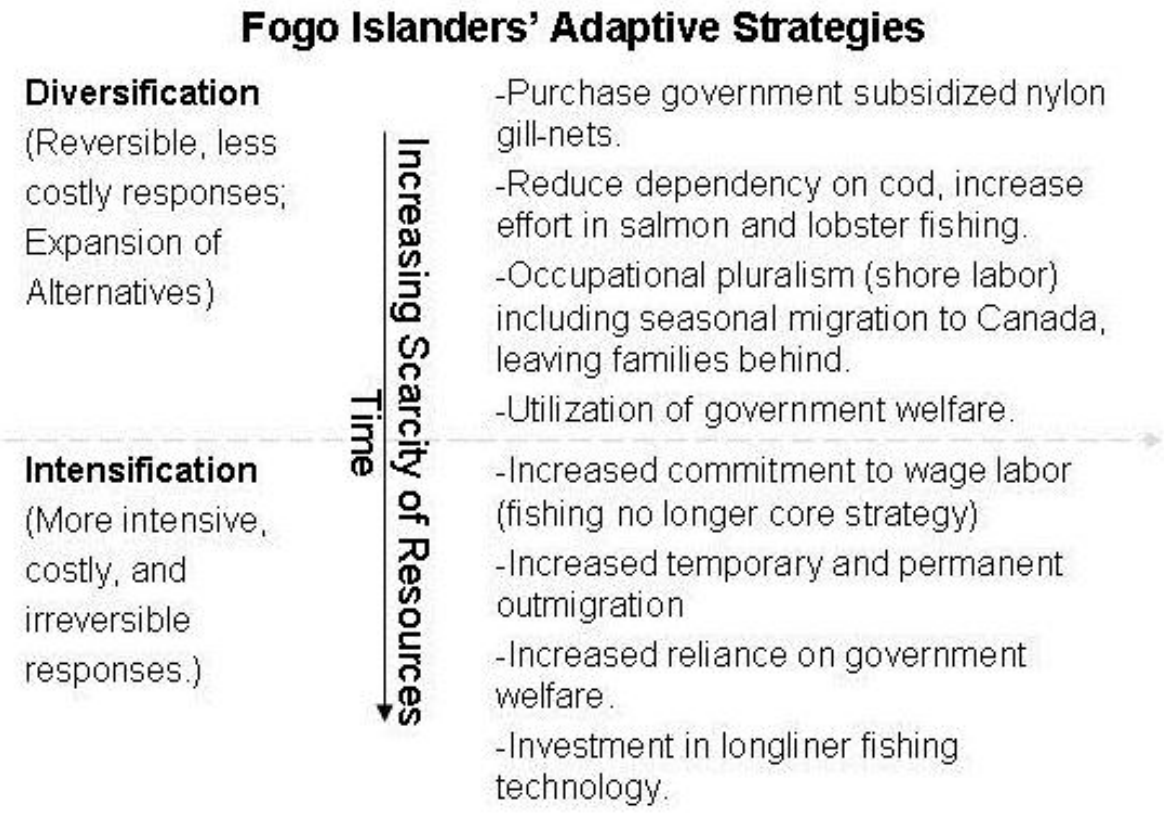


Figure 5-1. Summary of McCay's (1976) model of adaptation to resource scarcity for the Fogo Island Fishers (two different time periods).

Table 5-1. Comparison between the communities of Fogo Island (McCay 1978) and San Felipe.

	Fogo Island*	San Felipe
Population & Settlement	4,257 spread out amongst 9 settlements.	2,400 within one community.
Primary resources	(late May to August) Cod, salmon, lobster Sept-Nov: fish stay deeper and on shoals. Seasonal, inshore, based upon low or intermediate levels of technology.	(July to October) Lobster, Octopus, Grouper
Fishing gear	Handlines, line-trawls, gill-nets, (elaborate) cod trap.	Air compressor and dive gear, handlines, manual longline.
Crew	1-3 men, usually close agnates	3 men (lobster); 2 men (grouper); 1 man (octopus)
Cooperative	1969-1970: forms and provides fresh fish to market (previously salted and dried fish)	1980: forms and provides fresh lobster and fish to market (previously salted and dried fish)
Fishing trips	Daily, rarely more than 10 miles from shore (except longliners)	Daily, rarely more than 10 miles from shore.

*Fogo Island is the site of McCay's (1978) study.

Table 5-2. Total lobster landings for the first month of each year's season are shown with the number of active fishermen, and the average landings for each year. The cooperative can have up to 125 members at a time; here, I removed the non-fishing members, including the elected officials who serve two-year terms then return to fishing.

Year	Total Catch of Lobsters*	Number of Fishermen active in Cooperative	Average Catch per Fisherman*
2003	2050.73	105	19.53
2004	7649.96	112	68.3
2005	13587.91	114	119.19
2006	4955.75	119	41.64
2007	7736.78	120	64.47
2008	2146.27	117	18.34
2009	3583.60	115	31.16

*For the month of July, in kilograms.

Table 5-3. Adaptive Strategies identified among the fishermen in San Felipe.

Adaptive Strategies
• Dive deeper, farther from shore
• Buy longline GPS Coordinates
• Travel to deep spots in pairs
• Dive longer times
• Dive for other species
• Innovate fishing strategy
• Switch to use poles for fishing octopus (*jimba*)
• Invest in cattle and/or ranch
• Look for wage labor
• Join tourism cooperative

	Boat	No Boat	
Diver	61	43	
Not a Diver	10	9	Total: 123

Figure 5-2. The 123 members of the cooperative broken down according to boat ownership and dive activity.

As lobsters become more scarce:

			On a scale of 1-5, how likely are you to...						What will you do if fishing continues to decline?				
	Avg Age	n=	Dive Deeper	Dive for a Longer Time	Leave Diving For 'Jimba'	Fish for other species (Camp)	Invest in Ranching	Invest in Fishing Capital	Emigrate	Ranch	Fishing	Work in S.F.	Don't Know
Boat Owner and Diver	38.89	28	2.29	1.75	4.68	3.12	3.54	3.34	17	6	1	3	1
Diver No Boat	32.75	12	3.42	2.42	4.92	3.58	3.83	3.58	7	0	2	3	0
Non-Diving Boat Owner	46	3	1	1	5	3.67	4.33	2.33	0	0	1	1	1
Non-Diver, No Boat	29	1	1	1	5	5	1	5	1	0	0	0	0
Total	37.44	44*	2.48	1.86	4.77	3.32	3.61	3.39	57%	14%	9%	16%	4%

* Sampled out of 123 cooperative members.

Figure 5-3. Responses to Likert-type and open-ended questions, stratified according the the sub-groups of boat ownership and dive activity. Due to intracultural variation, the adaptive strategies for each sub-group differs. For the columns noting the likelihood to adopt any of the several behaviors, the corresponding number in the cell represents the average for all respondents (n) in that sub-group, based on the Likert-type scale of 1-5. For the open-ended responses in the remaining columns, the value represents number of mentions.

Table 5-4. Comparison of short-term and long-term strategies based on boat ownership and dive activity.

	Short-term	Long-term
Boat Owner and Diver	More conservative than non-boat owners.	Migrate
Diver, No Boat	Younger, haven't bought own boat yet. Take bigger risks, more willing to dive deeper and for longer times.	Migrate
Non-Diving Boat Owner	Oldest; at end of career so likely to keep fishing and live simpler (on what can earn). Will not leave San Felipe.	
Non-Diver, No Boat	Changes crew; flexible with least investment.	Migrate
Generally…	Dive deeper (dive to longline coordinates); switch fishing gear; look for other species.	Age determines willingness to migrate; work in ranching.

CHAPTER 6
THE COOPERATIVE

Introduction

An underlying idea behind this study is that better knowledge of human adaptive behavior to resource scarcity can help inform better community management of resources. In this chapter, I make the connection between human behavior at the individual level and community management by situating the adaptive behaviors of fishermen in their social context. In order to describe the social structure of the cooperative and how social structure relates to the adoption of different strategies, I first review some theoretical ideas underlying this analysis of social structure. Then, in addition to ethnographic data about how fishermen adapt to scarcity, I use social network analysis as a way to visualize social relationships that reflect aspects of social sharing and trust. Using these visualizations, I focus my analysis on the social relationships of the fishermen described in Chapter 4.

Common Property

Returning to the discussion in Chapter 2 on common property, the concept of community is integral to the study of common property resource management. McCay and Acheson (1987) aptly identify common property as a social institution. Unregulated common property, called open access resources, may succumb to the Tragedy of the Commons (Hardin 1968) if these resources lack the social institution of community management. Ultimately, self-interest dominates. Common property institutions, on the other hand, negotiate self-interest with the interests of the community (Durrenberger and Palsson 1987).

Common property resources are thus community resources, and these resources, such as fish and forest products, share two common problems (1) delineating a community of users and (2) regulating use and conflicts among community members (Schlager and Ostrom 1992, Feeny et al. 1990). In order to successfully achieve community-based natural resource conservation it is important to (1) identify the community of resource users and (2) involve local community actors in regulating resource use and resolution of local conflicts. In the case of San Felipe, the community of users is established by the two cooperatives and membership is now capped.[30] Yet, there is variance in enforcement and compliance of the regulations, both locally and federally imposed. Existing conflicts are another social issue that continue to impair successful local management.

Community

To examine human behavior as adaptive to common property resource scarcity, then, the social rules that govern use of the resource warrant consideration. By focusing this study on a cooperative, the boundaries of the community were easily defined according to formal membership. However, in many contexts of common property resource use, it is more difficult to define community boundaries. In the U.S., for example, common property marine resources are formally regulated by Federal and State governments. Local communities are not empowered to regulate themselves or their industry. In fact, under national policymaking, many fisheries are undergoing a process of privatization, converting whole fisheries from common property to private property.

[30] Access is limited to the boats that are owned by the cooperative. This means that an independent, *libre* fisherman is allowed, by the local interpretation of the rules, to dive for lobster.

An ongoing debate in the community-based resource management literature concerns how communities are defined. This literature highlights some of the assumed characteristics of a community, providing an analytical frame for comparison with San Felipe. For example, Agrawal and Gibson (1999) problematize the way community has conventionally been defined as occupying a small space and having a homogenous structure with shared behavioral norms among members. Rather, they propose a focus on the heterogeneity of actors' interests, processes, and institutions within communities. In response, Igoe and Fortwangler (2007) note that past interactions between community members and outside institutions have often influenced how a community has been defined; previous interactions have often defined a community in terms of the institution's intentions. These authors also note the importance of recognizing historical use of the resource and any conservation measures, as well as the role of non-government governing hierarchies, including NGOs (Non-Governmental Organizations).

Agrawal and Gibson (1999) further argue that successful community-based conservation must be able to rely on local actors to make and implement rules concerning resource use and conservation, and to resolve disputes that occur out of this process. Too often, when conservation initiatives aim to involve a community, it is local elites who are identified as local leaders and who benefit most (Igoe and Fortwangler 2007, Thoms 2007). Thoms (2007) adds that the success of community-focused conservation efforts reflects the local social hierarchy and previous community organization prior to or in response to conservation initiatives.

The incorporation of a community in local resource management and conservation is sometimes criticized for romanticizing rural peoples as stewards of nature (Brosius et

al. 2005), just as the goals of biodiversity conservation and economic development are often in conflict, especially in settings identified as needing both conservation and development (Brechin et al. 2002). Yet, humans are inseparable from nature (Jentoft 1999, Berkes 2004) and a reversion to exclude humans from involvement in the management of their community resources is not the solution to failed attempts at community involvement. Instead, we should work to develop better ways to enable local communities to identify local leaders and to develop skills and rules with which to manage their local resources.

Community and Social Structure

Agrawal and Gibson (1999) qualify the idea that a homogenous structure is part of how a community is defined, by noting that as population and density increase, differentiation within the group also increases. Social status and power are not distributed evenly among the members of a community and differences in social power often correspond with differences in access to and use of resources within a community. For example, newcomers may not have full access to community benefits as do multi-generational members due to exclusion or a lack of knowledge. Just as communities are made up of people with diverse interests, perspectives, and personalities, the combination of this diversity is represented in equally diverse social structures.

People behave deliberately but according to personal, albeit socially structured, interests (Porpora 1987). There are elements of both heterogeneity and homogeneity in any community, depending on the factor under examination. When examining shared knowledge of species available in different seasons, the fishermen's knowledge is homogenous. In a consensus analysis I conducted on one component of fishermen's knowledge, the results placed informant agreement at 96%. On the other hand, the

fishermen differ in the fisheries they pursue at various times of the year, each weighing the costs and benefits for himself and making his own decisions: dive for lobster, *jimba* for octopus, net, or longline. The members of a community can be said to have a shared culture, but there will always be human behavioral differentiations.

How does the heterogeneity among the members of a community, detailed above, affect the adoption of adaptive strategies under conditions of scarcity? Why do some members of a community adopt a particular strategy while others do not? To examine the adaptive strategies of the Pescadores Unidos in their social context, I used a social network analysis as a platform for discussing the social relationships of a sample of fishermen.

Numerous factors influence not just how people adapt, but the selection of particular strategies, as well. The diffusion of technological innovations within agricultural communities has a long history of study. Among the studies, factors including education, income, “cosmopoliteness,” and contact with external actors were found to be associated with technological diffusion (Wellman et al. 1988). Here, I am focused on examining the social relationships between people in a community and considering these relationships in terms of how strategies differ or align, and less interested in explaining the process of innovation.

Burt argues that the diffusion of innovation or “social contagion” as he calls it, can be explained through one of two models: cohesion or structural equivalence (1987). Contagion can occur through contact, communication, and competition. Referring to the proximity of two fishermen to one another in order for information transmission to occur, cohesion describes the process where attitudes about a prospective strategy become

shared over time. Due to this growing familiarity, “ego comes to a *normative* understanding of adoption’s *costs and benefits*, a *social understanding* colored by the interests of the people with whom the innovation has been discussed” (Burt 1987:1288). Structural equivalence, Burt’s other model for the diffusion of innovation occurs in situations of competition where people evaluate the appropriateness of an innovation by observing others in a comparable social position.

Social structure can be examined through two broad formats. Formal aspects include rank hierarchies of elected leaders, kinship and family relations, or structured work arrangements such as crewmates. Informal aspects include networks for sharing information and knowledge, and social support (Boorman 1975, Boster et al. 1987). These social relationships may facilitate or restrict the flow of information, and access to wealth, power, and resources (Wellman 1983).

Formal aspects of social structure are more easily identified by outsiders and thus usually receive more attention (Boorman 1975), a fact reflected in the failed attempts of community management initiatives detailed above. On the other hand, network analysts are concerned with systematically addressing the informal aspects of social structure as it is data on informal relationships which are collected and analyzed as network data. Systematic data on informal aspects of social structure is increasingly being collected and quantified (Boorman 1975), as the social sciences call attention to the importance of structure in understanding human behavior (Mayhew 1980). An analysis of the informal relationships embedded within a community’s social networks can reveal how resources, information, and knowledge move within the social structure (Borgatti et al. 2009, Wellman 1983, White et al. 1976).

Also, relying on formal aspects of structure would tend to identify wealthy actors as being socially important. Such actors, however, may actually be socially marginal due to envy from others or by maintaining social distance themselves. Rather, socially important individuals may not be the wealthiest nor biggest producers, but rather, maintain their social standing by sharing information and knowledge. Such members are at the nexus of information and knowledge exchange among community members (Wellman and Berkowitz 1988), occupying a position as social brokers (Burt 2004).

Social Network Analysis

Social network analysis is both theory and method (see Borgatti et al. 2009 for a review). It is one way to study informal aspects of social structure (Wellman 1983) and social networks have been used to build theories about positions within such structures (White et al. 1976). Based on these theories, by examining social networks it is possible to tease out relations of power within a population based on network position in relation to other actors. Social networks allow analysis of “the ordered arrangements of relations that are contingent upon exchange among members of social systems” (Wellman and Berkowitz 1988). As a method, it is a quantitative way to represent an underlying structure of social relationships (Quinlan and Quinlan 2010). The interpretation of patterns in the overall structure of the network can aid in identifying socially important individuals, such as social brokers (Burt 2004).

Social Network Interview

In order to formally examine the informal social structure of the cooperative, I collected whole network data on the social relationships of each cooperative member, meaning that I interviewed each and every member of the population, in this case, all 123 members of the fishing cooperative. I asked each fisherman to name five other

members of the cooperative who he would go to in different situations and provided a laminated list of all the cooperative members' full names and nicknames to be used during the interview as a memory aid, if necessary.

Two of the situations were: Tell me five cooperative members you would go to (1) to talk to about the cooperative, and (2) to talk to about fishing. These questions solicit information about the most respected and knowledgeable individuals within the cooperative, in regards to the livelihood of fishing and the organization that regulates that livelihood. The questions aim to elicit relationships showing the flow of information and knowledge regarding a fishing livelihood. The answers represent each actor's support network within the cooperative and identify the most sought after individuals for advice on their livelihood as fishermen.

Each interview took roughly 10-15 minutes and provided me with the opportunity to have a short, informal discussion with each member of the cooperative. I conducted these interviews between September and November, 2007, when most cooperative members were active fishing. The fishermen were easy to locate for interviews on the docks while cleaning the day's catch; waiting in the production facility to have their boat's catch weighed; or arriving to the cooperative office in the evening to collect cash for the day's catch.

Attributes

In addition to the social relationships between people, I collected information about each person (attribute data). I created two ordinal attribute scales, one for wealth and one for lobster production. The wealth scale represents each fisherman's ownership of a boat, ranch, livestock, car, house, and/or store. The production scale is based on the total kilograms of lobster each fisherman caught during the 2007-2008 lobster season

according to the cooperative office's daily production records. Because of the high value and lack of black market buyers for legal size lobsters, all legal size lobsters are sold to the cooperative.

I also wanted to compare fishermen depending on whether they own a boat and whether they dive (Table 5-4), as these are ways to stratify fishing intensity and investment. Lobster is caught by diving, but not all cooperative members dive for lobster. Diving entails risks to personal safety including decompression sickness, pulmonary embolisms, and carbon monoxide poisoning.

A lobster fishing crew typically consists of three men: a diving captain, a second diver, and a non-diving helper (*manguerero*). Table 5-4 shows that over half the members own boats, and ten of these captains do not dive. It is apparent that there are an insufficient number of fishermen to fill typical crews for all boat owners; some captains do not dive and take two divers and some divers and helpers are not cooperative members. To catch lobster, a boat's owner must be a cooperative member; this is one rule that is consistently enforced.

Social Centrality

A principle concept underlying social network theory is centrality. Centrality interprets the relationships among actors (nodes) within a community according to various properties of the connections, or ties, with other actors. Less central actors have fewer or weaker ties to others in the community. Greater centrality can infer power in terms of social influence.

Several measurements of centrality have been developed where each interprets the properties of the ties among actors in different ways (Hanneman and Riddle 2005). In the visualizations in this chapter, I use degree centrality, measurement that assumes

social centrality and power to be associated with a greater number of reported ties to other actors in the network. Socially central actors are usually respected and have influence among community members, despite their lack of formal authority (White et al. 1976). Some scholars have argued that these actors are best capable of affecting change through adaptive leadership (Manolis et al. 2009; Heifetz 1994), and I argue, in turn, better able to achieve the goals of community management.

Comparing the Networks

With the data from the interviews, I constructed a binary adjacency matrix for each of the questions in which each fisherman was represented in the same order in both the rows and columns. In each cell, a ‘1’ designates a tie between fishermen and a ‘0’ designates the absence of a tie between the fishermen. I created a profile matrix of the attribute data I collected (wealth and lobster production scales; boat ownership and dive activity) to describe each cooperative member. With these matrices, I was then able to run various social network analyses using the software package UCINet (Borgatti et al. 2002).

I first ran an analysis (QAP) on the symmetrized matrices to determine whether a similar structure existed for the two questions. This would tell me how analogous the scenarios are to one another. That is, is there a similar structure underlying who people turn to, to discuss (1) fishing and (2) the institution governing fishing? The results gave a Pearson’s r value of .322 (std dev .012; $p<.05$) for the pair of matrices.

Also, the matrix data is relational; that is, it is data about the relationships among informants (Scott 2000). Although, a value of .4 is considered a strong value for a Pearson’s correlation, a lower r value can be accepted as significant when using relational data. A value of .322, then, provides evidence for a common structure,

although this structure is not particularly strong. This means that who fishermen talk to about fishing is sometimes, but not always, who they talk to about issues in the cooperative.

Visualization and Description of Networks

Next, I visualized each network using NetDraw in UCINet (Borgatti et al.2002), a process that turns each network into a map of the social connections reported by each informant. I also entered attribute data about the people in the network. I made a separate network from the matrix of each question: (1) Who did the fishermen talk to about the cooperative (Figures 6-1 and 6-2) and (2) Who did the fishermen talk to about fishing (Figures 6-3 and 6-4)?

Network language is used to refer to the principal components of a visualized network and I provide a brief overview here. First, the shaded shapes in the figures represent people and are called nodes. The lines between the nodes represent ties reported between people with arrows pointing in the direction of the tie. These networks are very cohesive, being absent of both isolates (nodes that have no ties) and pendants (nodes that have only one tie to the network). The position of the nodes in relation to other nodes in the network is determined by the algorithm of the program that tries to push some people together and pull others apart. Care must be taken not to draw comparative conclusions based on distance alone, as distance may result from the program's attempt to place nodes in relation to the ties of other actors.

Returning to Figures 6-1 to 6-4, the nodes have been coded according to attribute data as follows:

1) The size of the nodes indicates degree centrality. This is a measure of how many ties each actor has; the larger the nodes, the more times other fishermen reported going to that individual to talk about the cooperative or fishing, respectively. Having a

greater degree centrality can be interpreted as having more social prestige for that particular scenario.

2) The shape of the nodes represents boat ownership and dive activity, mirroring the population breakdown shown in Figure 5-2. Diamond-shaped nodes represent boat-owning divers; triangular nodes represent non-diving boat owners; square nodes represent divers who do not own a boat; and circle-shaped nodes are those who neither dive nor own a boat.

3) The color of the nodes differs for the first and second pair of networks. In Figures 6-1 and 6-3, the nodes are colored according to an indicator of wealth. In Figures 6-2 and 6-4, the nodes are colored according to a scale of lobster production for the 2007-2008 fishing season. A darker color indicates a greater value for the scale of wealth or production, respectively. In Figures 6-2 and 6-4, the red colored nodes represent the cooperative's elected officials. During their two-year term of service, these individuals are not fishing, so have no lobster production to report.

Figures 6-1 to 6-4

An overall density is apparent in the networks for both questions. There is also a lack of distinct sub-groups (components or clusters) in the network. This is reflective of the fact that there is little vertical stratification of the social structure among the fishermen generally, and negligible economic stratification. As a community and as far as wealth is concerned, San Felipe is relatively homogenous. There is a relative affluence compared with other rural communities in Mexico. All houses have indoor plumbing and electricity and basic appliances such as refrigerators and stoves. There is a difference in income between boat owners and non-owners, which should correspond with differences in wealth, but this does not translate into any evident sign of differences in consumption patterns.

The Figures 6-2 and 6-4 have the elected leaders of the cooperative and community colored in red. Before analysis, I had expected that these members would score high for centrality, signifying importance to other members as people to talk to about the cooperative and fishing. I was therefore surprised to find that they were not

among the most central in either network. This speaks to the issue of formal versus informal hierarchies. In the formal hierarchy structure of the cooperative, the elected officials are at the top. But, in the informal social structure of the cooperative members, there are different (but similar) structures for the transmission of information and knowledge about the cooperative and fishing. One individual stands out for his centrality in both networks, Cambuay (#020). He occupies a position of importance in the transmission of information. Indeed, through ethnographic observation, he is, indeed, a respected fisherman. I will return to talk about Cambuay in discussing Figure 6-13, below.

Figures 6-5 to 6-7

In order to discuss adaptive strategies in terms of social relationships, I focus on a subset of fishermen, about whom I have the most data: those fishermen who I discussed in Chapter 4 and who were also among the 45 with whom I conducted the adaptive strategy interview. I coded the following questions from this interview into attribute data:

1) To what depth do you dive? I also asked “Why do you dive to this depth?” Most answers concerned “risk.” That was the maximum depth for which they feel comfortable with, or at least accept, the risks.

2) Among the Likert-type questions referred to in Chapter 4, I asked the diver “How willing are you to dive deeper [if resources continue declining]?” One for not at all likely; Five meant extremely likely.

3) Another Likert-type question asks, “How willing are you to switch to ranching [if resources continue declining]?” One for not at all likely; five for extremely willing.

Because I only collected this data for the sample of 45 who participated in the interview, I extract their nodes and corresponding networks from the whole network of 123 cooperative members. Showing the networks of only the 45 sampled fishermen

allows their relationships to be more easily seen. Figure 6-5 shows the whole network. The diamond and circle shaped nodes represent the fishermen in the sample; the remaining square nodes represent the remainder of the population who were not interviewed individually about their adaptive strategies. This figure should be referred to for its representation of relative density and position of extracted nodes within the whole network.

In Figure 6-6, I show the social networks of those 45 fishermen in the sample who were interviewed about their adaptive strategies; this network depicts the structure for the question about who each member talks to about fishing. It is important to keep in mind that while #083 appears to be an isolate here, he is not an isolate in the whole network (Figure 6-5). He does, however, rank lower than average for centrality in the whole network. This network only displays the randomly sampled cooperative members. This visualization includes only those ties that are either to or from another sampled fisherman.

The shape of the nodes in Figure 6-6 represents dive activity; diamond-shaped nodes represent divers and circles represent non-divers. The color of the divers' nodes is coded according to the maximum dive depth (in *brazas*) reported by the diver. The shallowest depth reported was six *brazas* (12 meters), and was reported by only one diver, Balá (#184). Muán (#224) reported the deepest dive depth, 20 *brazas* (40 meters[31]), Non-divers are in white, representing a value of zero. (Figure 5-2). Next, I add the attribute of lobster production to the visualization. In Figure 6-7, the size of the

[31] 40 meters is the recognized maximum depth for recreational diving.

nodes corresponds to each fisherman's production of lobster for the 2007-2008 season representing an indicator of success in lobster fishing.

Balá and Pontó (Figure 6-8)

The nodes of two fishermen stand out in Figure 6-7: Balá (#184) and Pontó (#147). Balá's is the largest by a small margin, yet he restricts himself to the shallowest waters. Where Balá fishes regularly in the shallows, other fishermen repeatedly claim that there are no lobsters there; they have to go to deeper waters. Balá and Pontó are the same two fishermen mentioned in Chapter 4 as successful, knowledgeable fishermen. I suggested that they maintain their success through their social position. Balá is secretive. I was told that when he sees a boat approach his own, he quickly moves away, careful to hide the exact location where he was diving and what he found there. His knowledge is not shared.

In the visualization (Figure 6-7), Balá and Pontó, are not tied directly together; neither one named the other as among the five members with whom they talk about fishing. The shortest distance from one to the other is through one other member, Chaspat (#147). Both Balá and Pontó named Chaspat as one of their five ties, and he named both of them. Chaspat, in fact, lives across the street from Balá, and Pontó is his older brother. Such relationships are common in San Felipe. Kinship is important as a social relationship in fishing. Sons fish with their fathers and brothers often fish together and may even share ownership of a boat. Neighbors form another opportunity for frequent interaction and exemplify Burt's ideas about social networks and the diffusion of innovation (1987).

Figure 6-8 shows the personal networks of Balá and Pontó, extracted from the whole network, and the combined network of these two together. From among my

sample of 45 fishermen, these are the two biggest lobster producers. They also share interesting relative positions of centrality in the networks for the two questions (Table 6-1). Balá is a socially central individual for information about the cooperative and its politics, while Pontó scored fairly high for someone to talk to about both the cooperative and fishing, although he scored much higher than Balá for someone to talk to about fishing. These results surprised me at first because I had observed both men to be impatient with others and quick to criticize. But in fact, their opinions are sought after. Most other fishermen know, however, not to bother seeking fishing knowledge from Balá given his tight-lipped reputation.

Balá and Pontó are connected by one fisherman in common, Chaspat (#147). Chaspat is the younger brother of Pontó and lives across the street from Balá, representing relationships of kinship and social proximity. Chaspat is a diver without his own boat. He works as the second diver for Pontó. As mentioned in Chapter 5, it is more common for the younger fishermen, yet to own their own boat, who are willing to take greater risks and dive deeper. In Figure 6-8, the darkest colored node represents Chaspat and signifies his reported willingness to dive deeper, compared to Balá and Pontó.

Jaquetón and Muán (Figure 6-9)

These divers reported the deepest maximum dive depths among the sampled fishermen. From conversations with the remaining cooperative members, I can say that they are among a group of only five boats in the whole cooperative that dive to such depths. In Figures 6-6 and 6-7, Jaquetón (#223) and Muán (#224), the two men are inward from the bottom left corner, and in Figure 6-7, they are shown to have similar and above average amount of lobster production, but clearly diving deeper (darker

node) than the nodes larger than their own (principally #184 and #147, discussed above), the greater size representing lobster production.

Caguama (Figure 6-10)

Caguama is the diver who bought the coordinates for a longline fishing spot, finding it to be a good lobster spot as well. As mentioned previously, he has more social relationships with fishermen both libres and those in the other cooperative. Although he remained in the Unidos cooperative, a PAN (Partido Acción Nacional) supporting organization, Caguama regularly reminds me that he is a PRIsta, as members of the other political party (Partido Revolucionario Institucional) call themselves.

Caguama's centrality score, a 10 for talking fish, is similar to Pontó and Balá. In contrast to the other two men, Caguama's centrality score decreases to a 9 for talking about the cooperative. But, these centrality scores relate to Caguama's relationships within the cooperative, only, and do not capture his relationships with those outside of the cooperative fishing community. In this case, although he appears less central, he talks to more people and moves in wider social circles rather than socializing mostly in the cooperative.

Cambuay (Figure 6-11)

Another fishermen I want to call attention to in Figure 6-7 is Cambuay (#020). He is the most central fishermen in the whole network for both questions. Looking at the node that represents him, he, is shown as diving quite deep (dark color), yet does not have a substantially large lobster catch (small size).

Cambuay's personal network is shown extracted from the whole network in Figure 6-11. Cambuay is willing to engage in any innovation or new strategy, whether in fishing or wage labor (although he tells me that he rarely having money to invest in cattle). At

the time of data collection, he did not own a boat, but by the end of my field visit, he had bought one. When I returned in 2010, he had already sold the new boat and was looking to buy another one. Apart from fathers putting their boats in the name of their sons, I know of no other instance of a cooperative member changing his boat ownership status. With a wife and four young sons, his income is usually stretched thin, prompting him to sell his boat. He is usually able to fish well and save money to buy a new boat, before needing to sell it, once again.

The production data I show in this study is aggregated by month or year. Using these totals provides an average for effort that can be compared across fishermen. Examining daily production totals often gives a different picture and in Cambuay's case, it shows him to be a very successful diver but one who does not fish the number of days as many other fishermen. For various reasons, Cambuay does not go fishing. If he did, his totals would be higher and although he would earn more financially, he would also, inevitably, occupy a different position socially.

Cambuay cited willingness to both diversify and intensify. He is willing to try everything and knows everyone. A married man in his early 40s, Cambuay is well-liked and charismatic. He is popular and trusted. He is regarded as an honest man, although not necessarily good at managing his own money. In the community, there is a stigma attached to those individuals who are seen as more wealthy; they are often accused of being stingy; of only eating eggs at home, for example. This individual's lack of money management skills serves to preserve his social prestige by shielding him from the envy of other fishermen.

After over a year of fieldwork, I could tell you that Cambuay was socially important, but the social network analysis is a systematic way to arrive at the same result. Although this method can be used to identify socially important actors in less time than extensive fieldwork, it is still important to stress the importance of working closely with a community. The data presented here shows that rank hierarchies (formal aspects of social structure) do not correlate with social centrality in terms of information flow and social support (informal aspects), in regards to the fishing livelihood.

Discussion and Conclusion

For the community of fishermen, the most reported adaptive strategy, described as the trend that fishermen follow as scarcity increases, is not adapted uniformly. The adoption of this strategy increases risk to personal health. Among the sampled fishermen detailed above, Caguama, Jaquetón, and Muán employ strategies that involve innovation and increased risk. Others, such as Pontó and Balá, do not accept such greater risks and continue to catch stable and consistent quantities of lobster. So, their strategy involves employment of knowledge and skill and as far as I know, do not accept greater risks.

But, through processes of social cohesion or structural equivalence, the depth to which a diver will dive deepens over time. Due to factors of scarcity within the fishing grounds that a diver dives presently, as well as familiarity of the successful catches of deeper divers (social cohesion), or feelings of envy with those divers (structural equivalence), the fishermen gradually increase their depths. This pattern can only continue for so long, however, as information about the incidence of accidents at greater depths spreads through the network. There are also limits to the technology of diving, an issue I will return to in the last chapter.

The case of Caguama serves as a reminder of the extent of the social network's validity: it is only capable of displaying the data collected. This study focused on members of the Pescadores Unidos. Although Mole may appear as socially central when it comes to talking about fishing as some others in the discussion above, he has connections outside of the cooperative with other sectors of the broader fishing community. Conducting a social network analysis with all fishermen on the community is a future step in this ongoing research.

Social network analysis is a tool that aids in understanding local social structures. In the case of informal aspects of social structure, this tool enables the identification of socially central actors who are respected and have influence within the local community, despite their lack of formal authority. As mentioned above, such actors are considered to be those capable of affecting change through adaptive leadership, by virtue of their social position within the community (Manolis et al. 2009; Heifetz 1994).

It is also important to point out that in order to better understand social relationships, it is necessary to understand the historical and contemporary context to really get at their significance. It is important to work personally with resource users in order to understand how problems are perceived and decisions made. It is also important for the interpretation of network visualizations to have ethnographic data to explain the patterns that appear in the networks. Social network analysis is a way to systematically examine the structure of a network, but the value of the analysis requires an intimate knowledge with the individual actors and their particular lives, as well.

Overall, I can see both homogeneity and heterogeneity in the group, reinforcing Agrawal and Gibson's (1999) argument about community. It is always possible to find

smaller sub-groups, or cliques, that have some things in common in contrast to the larger group. In fact, some of the most interesting results are revealed in examining the outliers. That is, new strategies can be identified by exploring the particular context of those individuals who deviate the most from the trendline.

The social relationships among fishermen are one factor that influences how individual decisions are made and some individuals within a group will invariably be social leaders. By consulting with such individuals in the design and implementation of new policy to conserve declining resources, better compliance may be achieved. Fisheries managers need to be aware that managing people is an integral part of designing successful fisheries policy. Policymakers implementing regulations without the support of resource users may face an uphill and expensive battle to achieve compliance. It is important to integrate the resource users from the beginning stages of designing policy, which means from the stage of where a problem, such as scarcity, is identified.

It is difficult to reduce the individual circumstances of each cooperative member to numbers, but it is also important to try to find systematic ways with which we can present such particular social information to policymakers. This study is an attempt to bridge these two goals: to more accurately present the socio-cultural factors of life in a small-scale, marine resource dependent community, and to present this life in a way that is possible to integrate into policy making. Although using social network data collection is initially time consuming, I argue that to achieve successful community involvement, such an involvement and commitment to understanding the local context is a necessary first step. In a centralized community of this size, completing 10 interviews

a day is feasible. Defining the community where this tool will be applied will depend on the research design. This method demonstrates the development and application of a social measurement that can identify individuals of influence among a population. With the support of such individuals, I hope that policy makers may better understand how small-scale producers make decisions when faced with resource decline.

This chapter used social network analysis to examine informal aspects of social structure among the cooperative's members, and to discuss the positions and relationships among a sample of fishermen. I discussed the adaptive behaviors of sampled fishermen in the context of individual decision-making within the broader community. It is my intention that the analysis described here can be adapted and applied for the purpose of integrating the study of adaptation into community management.

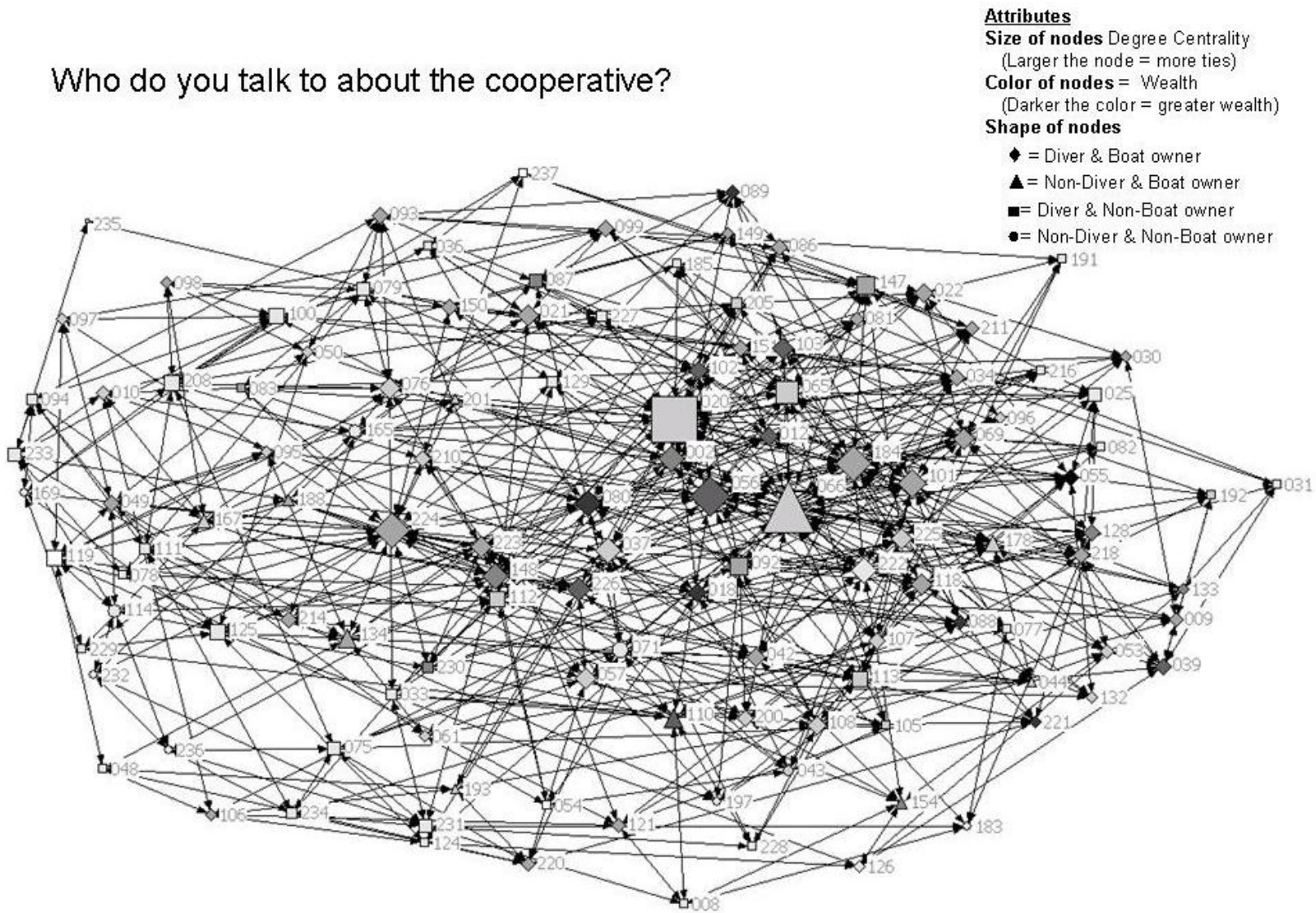


Figure 6-1. Social network of all 123 cooperative members in response to who they talk to among other members about the cooperative. The color of the nodes is coded for an indicator of wealth.

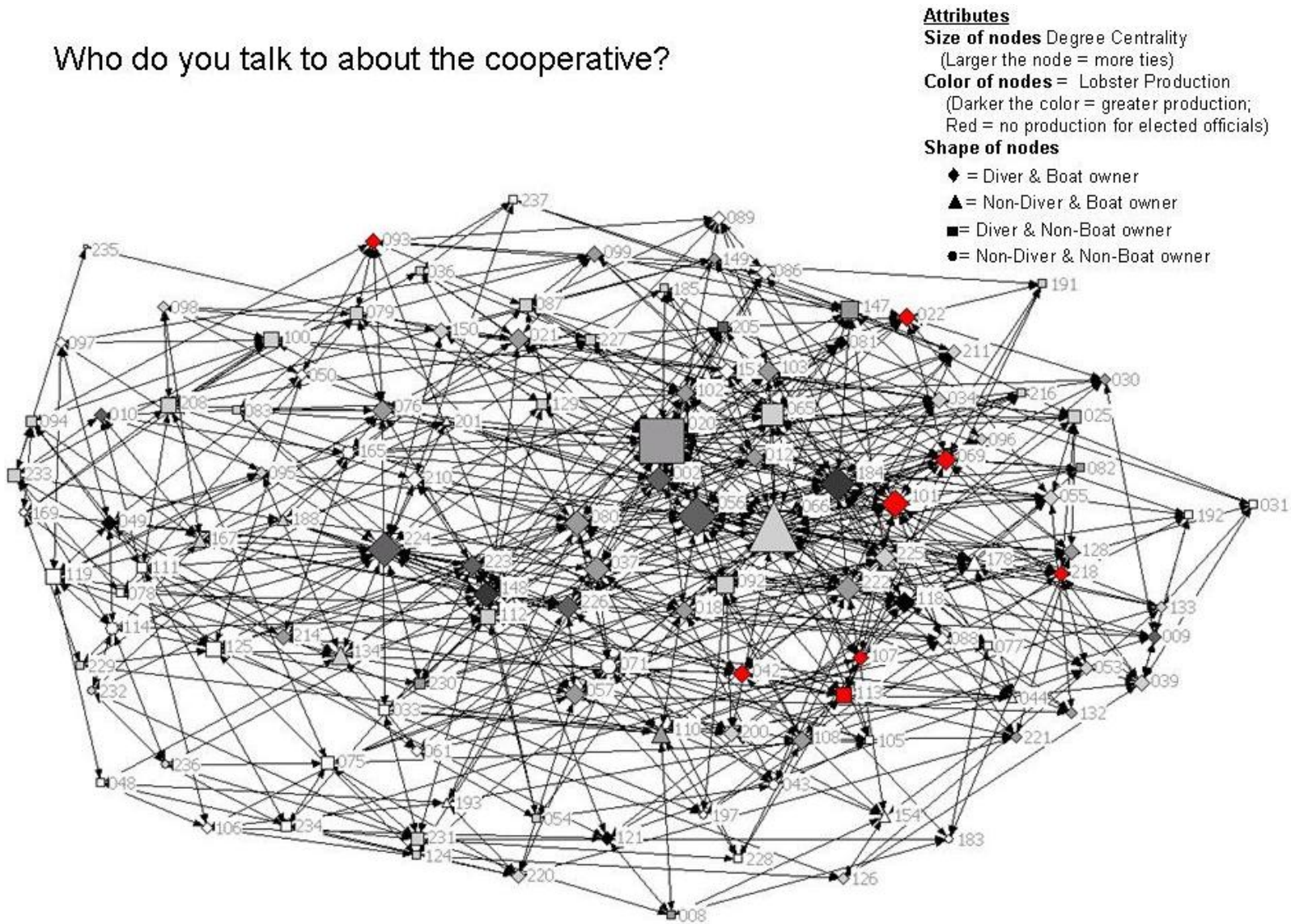


Figure 6-2. Social network of all 123 cooperative members in response to who they talk to among other members about the cooperative. The color of nodes is coded according to total lobster production for one season.

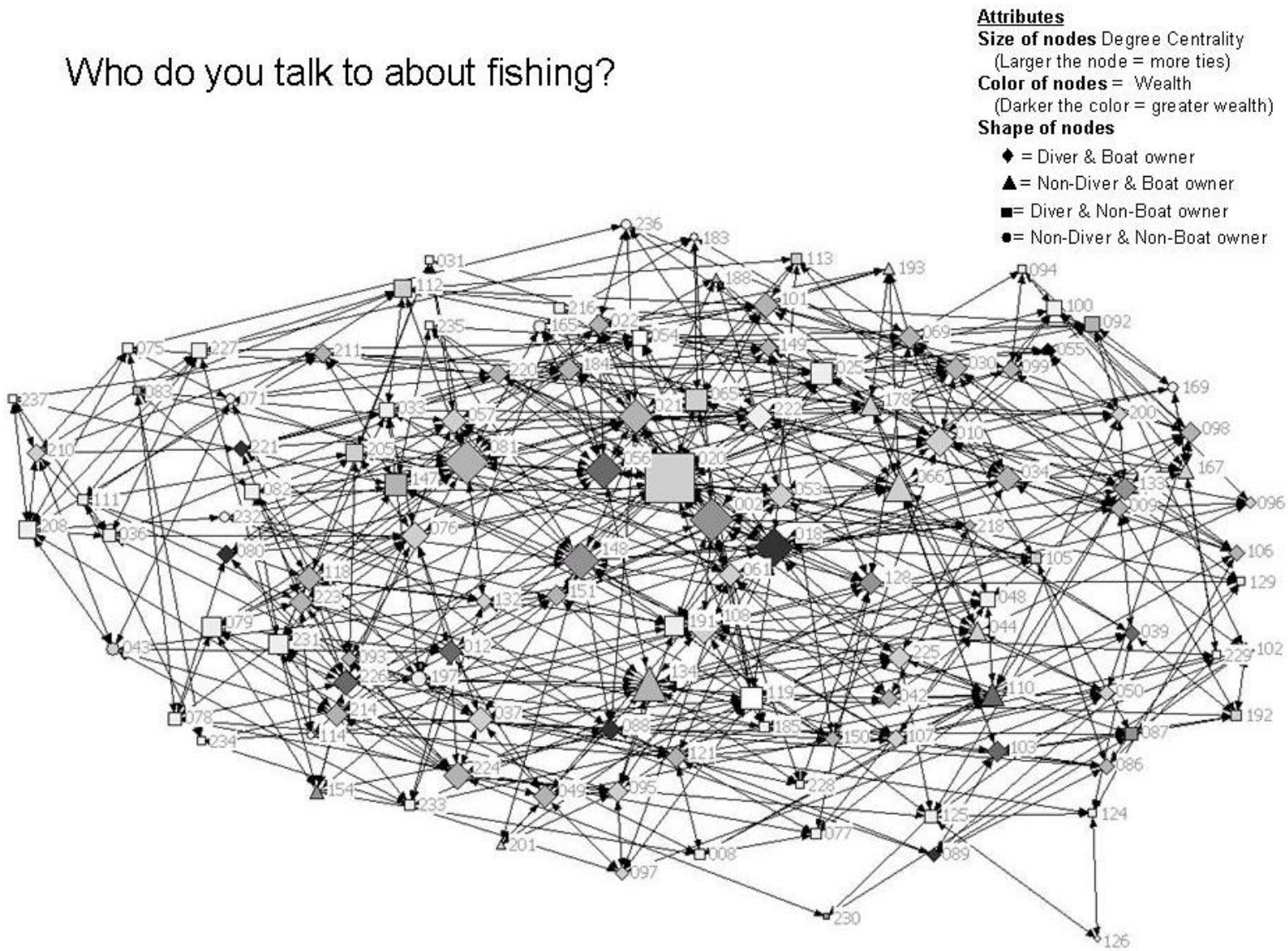


Figure 6-3. Social network of all 123 cooperative members in response to who they talk to among other members about fishing. The color of nodes is coded according to an indicator or wealth.

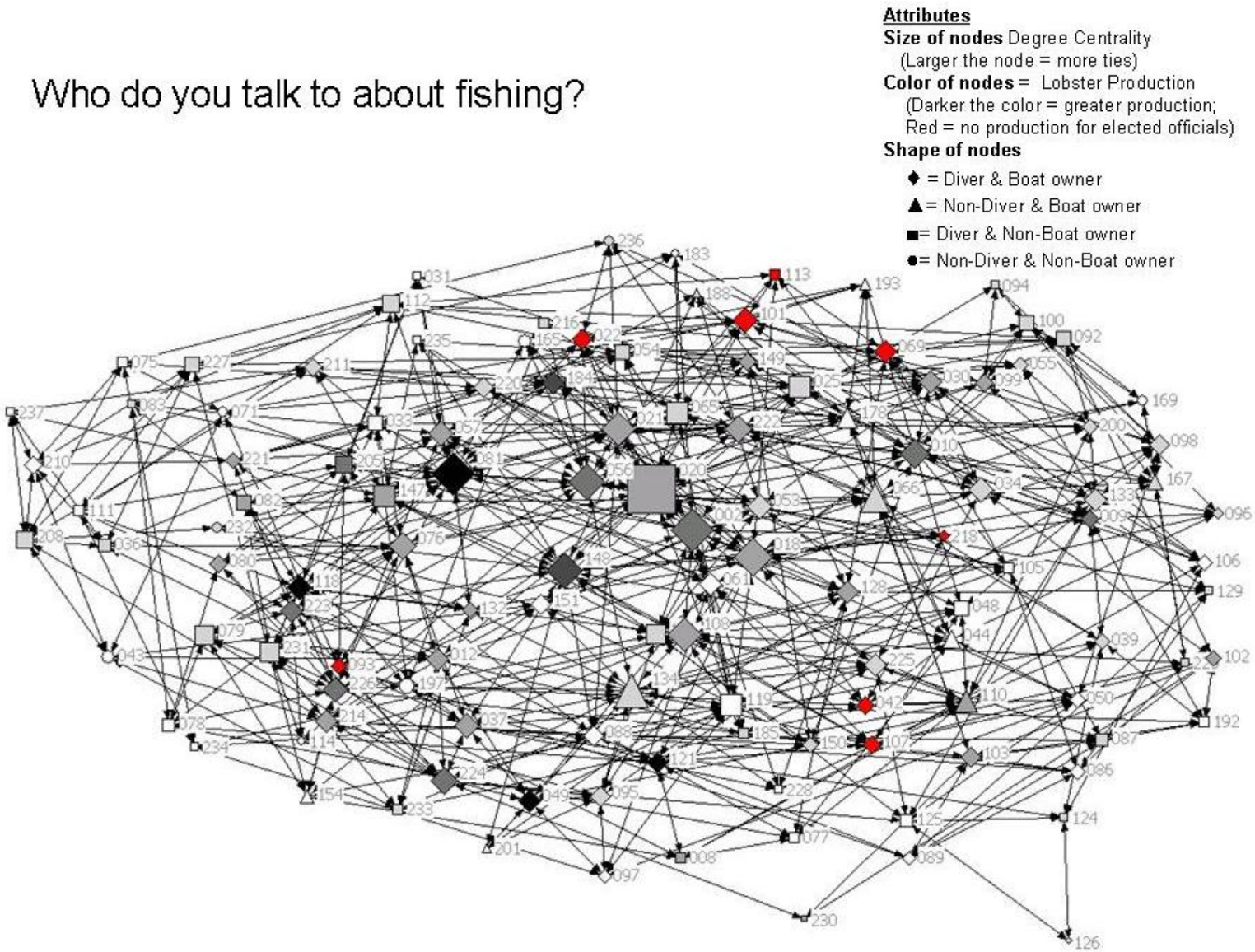


Figure 6-4. Social network of all 123 cooperative members in response to who they talk to among other members about fishing. The color of nodes is coded according to total lobster production for one season.

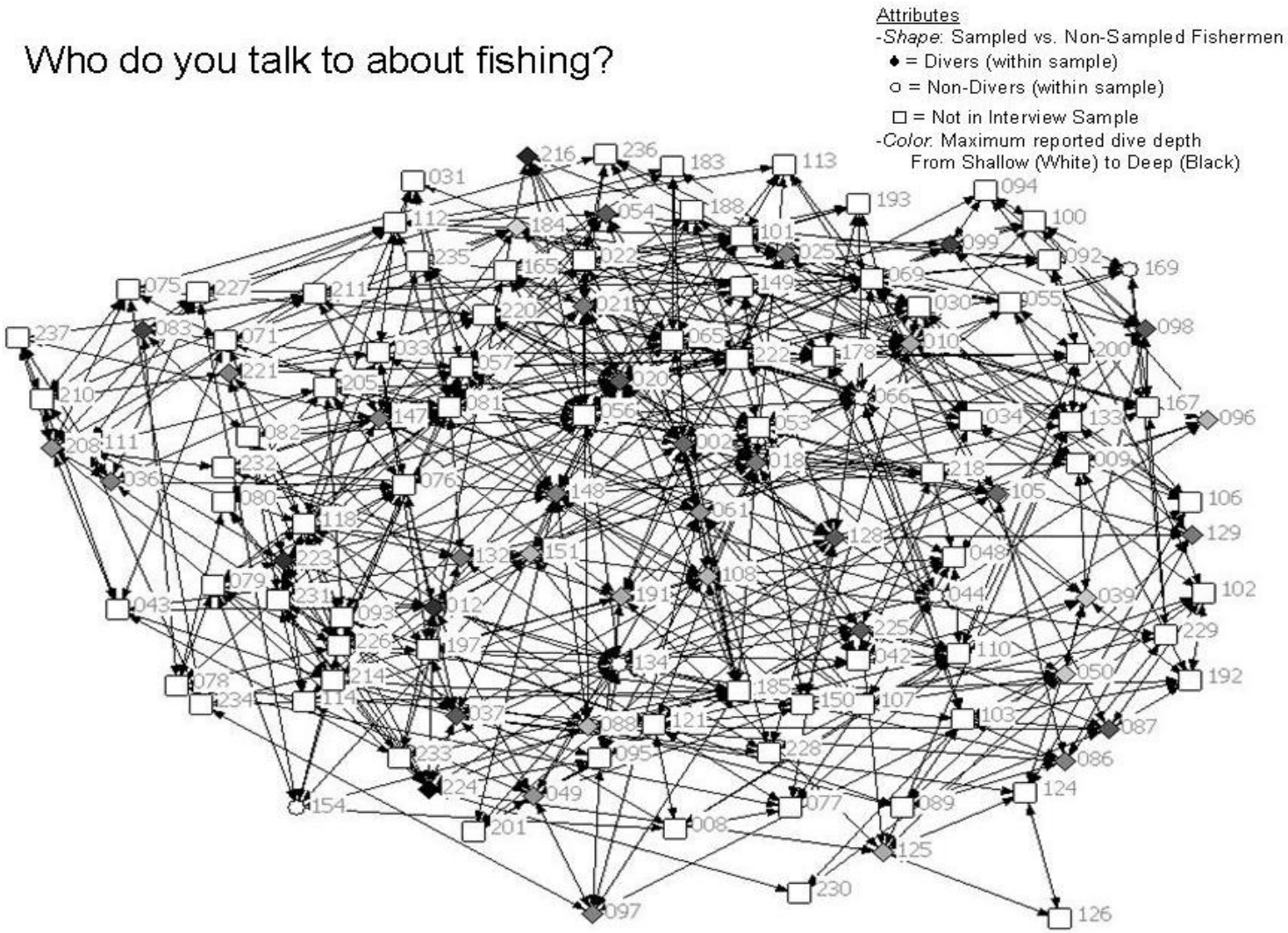


Figure 6-5. Figure 6-4. Social network of all 123 cooperative members in response to who they talk to about fishing. This figure is intended to identify the positions of those fishermen included in the sample, within the whole network. A square node represents fishermen with whom I conducted only the social network interview.

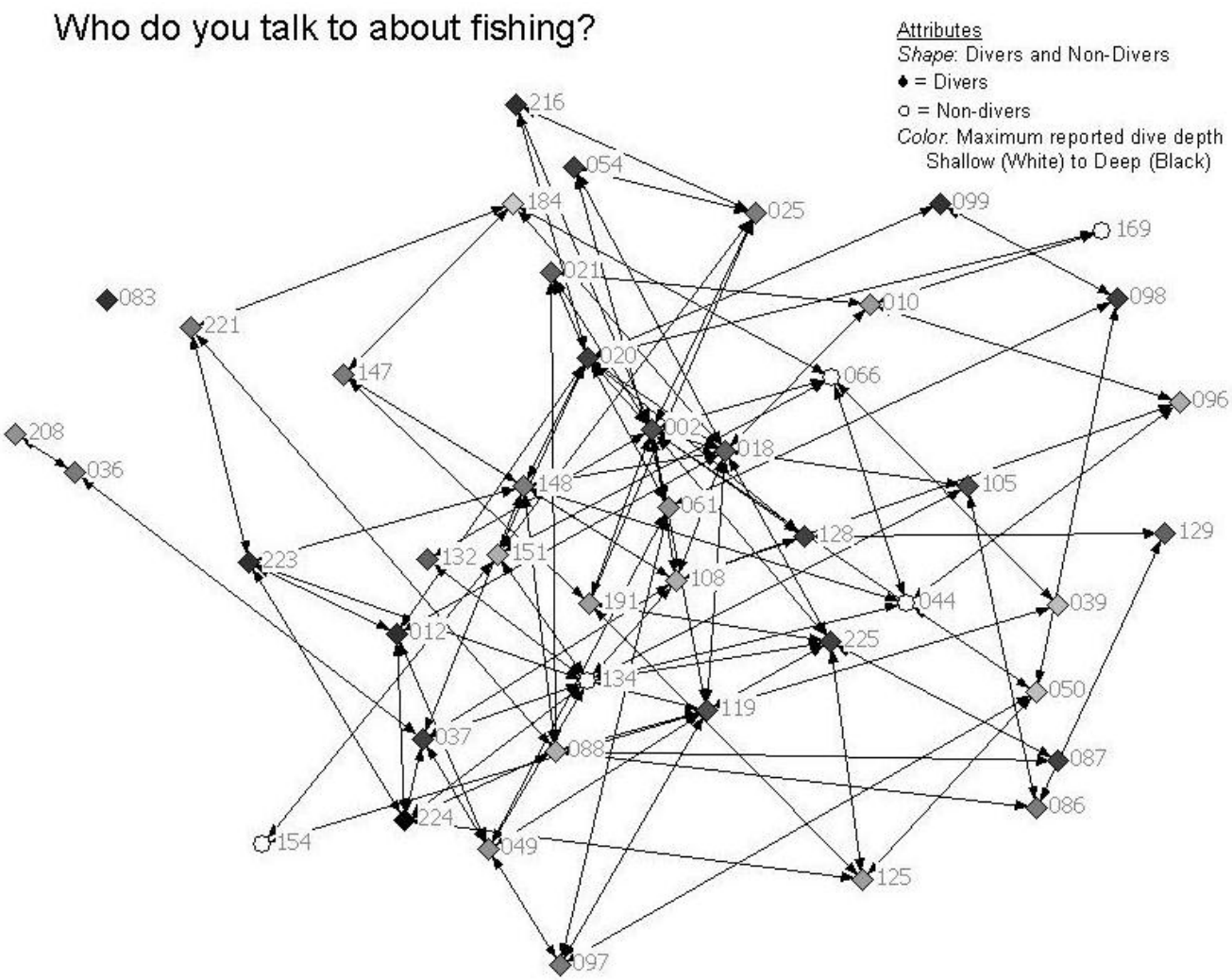


Figure 6-6. This network shows the nodes of fishermen included in the sample for additional interviews, extracted from the whole network.

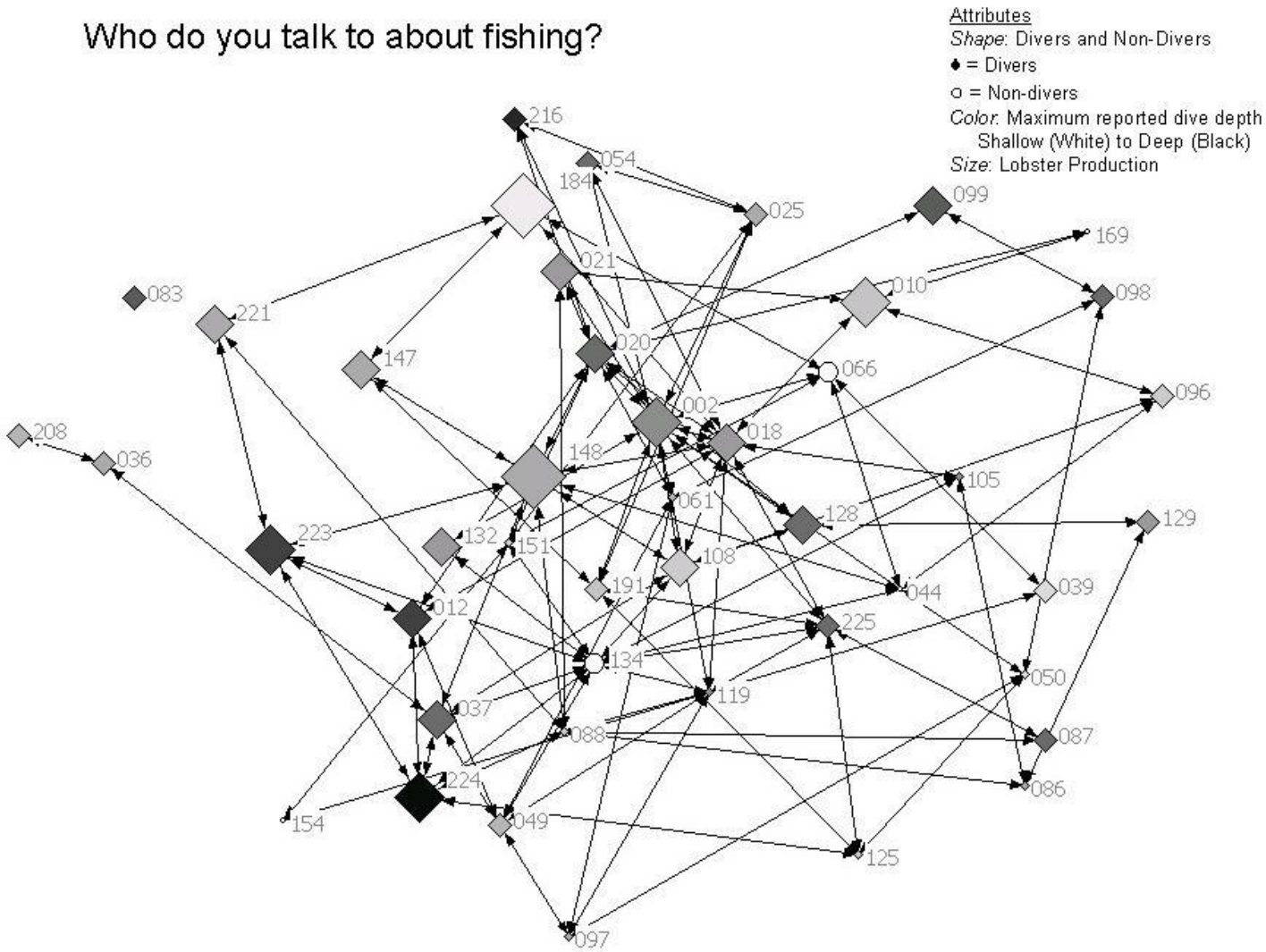


Figure 6-7. This network shows the nodes of fishermen included in the sample for additional interviews, extracted from the whole network. The nodes are then colored for reported dive depth, and sized according to total lobster production for one season.

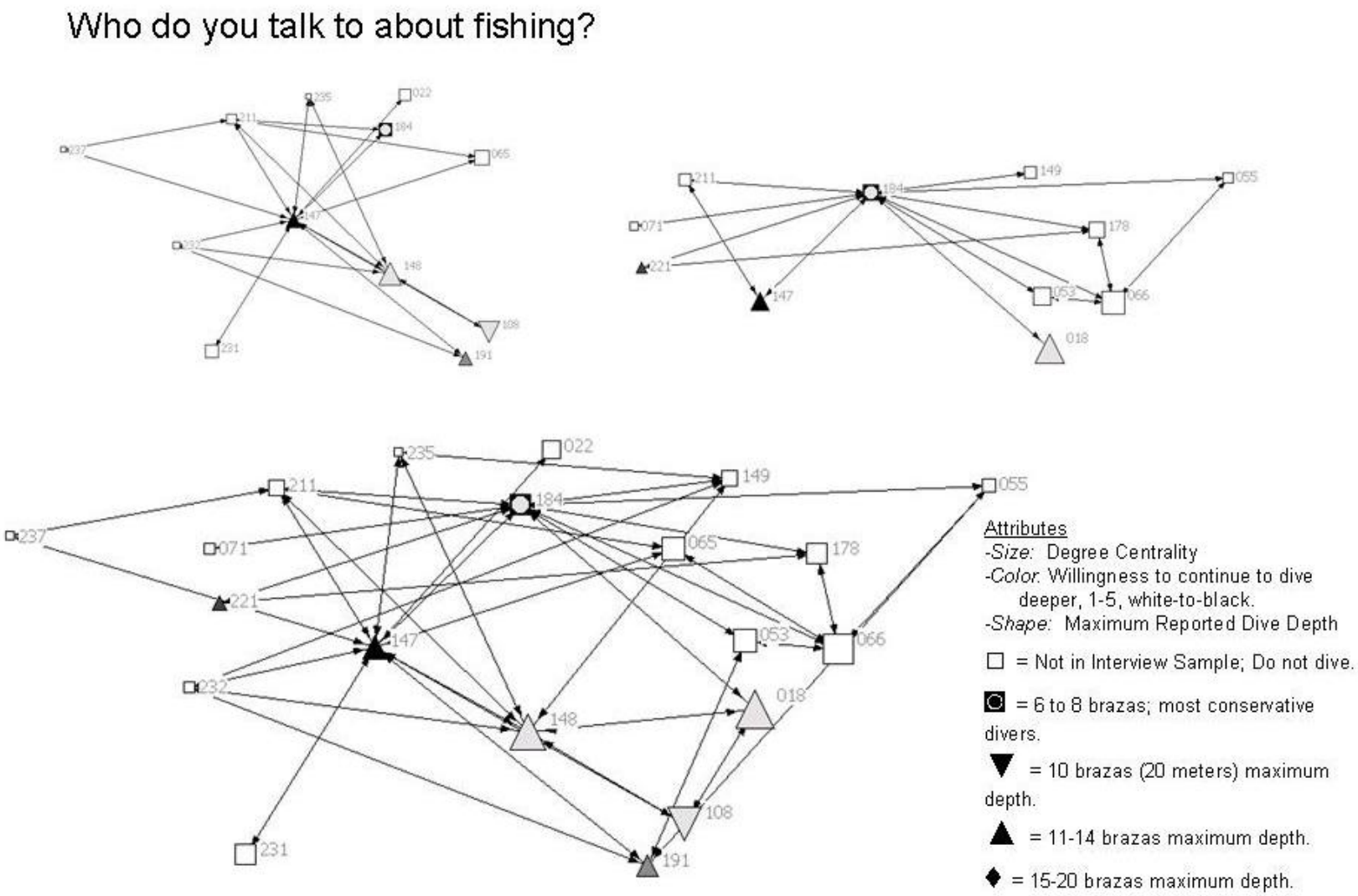


Figure 6-8. Personal networks of two fishermen, Pontó (#147) and Balá (#184) (top), extracted from the whole network. Their networks are well-connected to each other, shown at the bottom.

Table 6-1. Degree centrality calculated from the results of the social network analysis questions: Name five people with whom you talk about fishing, and with whom you talk about the cooperative

Nicknames	ID# used in figures	Fish	Cooperative
Balá	184	10	23
Pontó	148	18	16
Chaspat	147	11	12
Caguama	128	10	9
Jaquetón	223	10	13
Muán	224	13	23
Cambuay	020	26	32
Pech	065	12	15
Average (123 members)		8.8	9.1
Average (sampled fishermen)		10.2	10.3

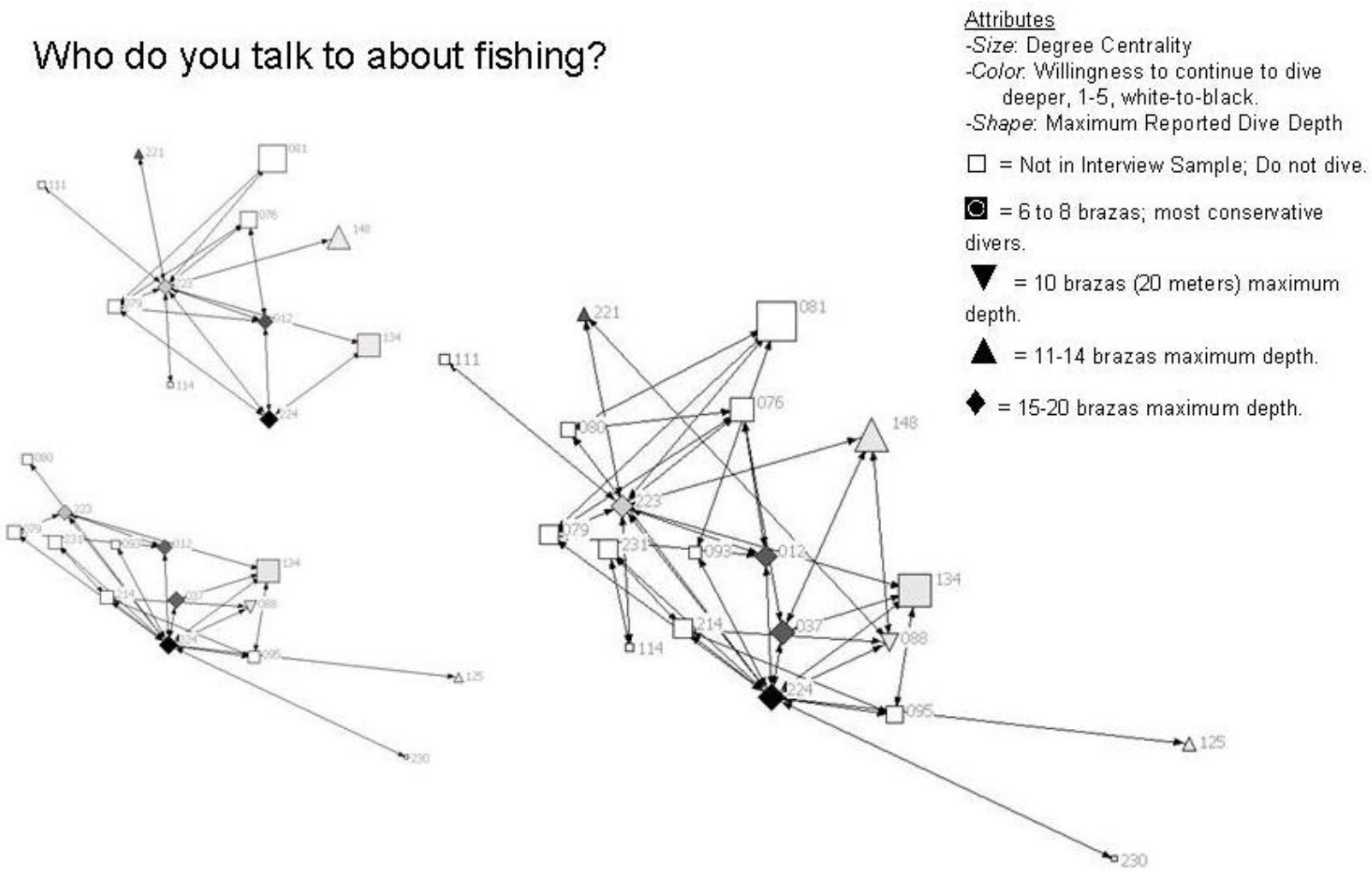


Figure 6-9. Personal networks of two fishermen, Jaquetón (#223) and Muán (#224) (left), extracted from the whole network. Their networks are well-connected to each other, shown center above.

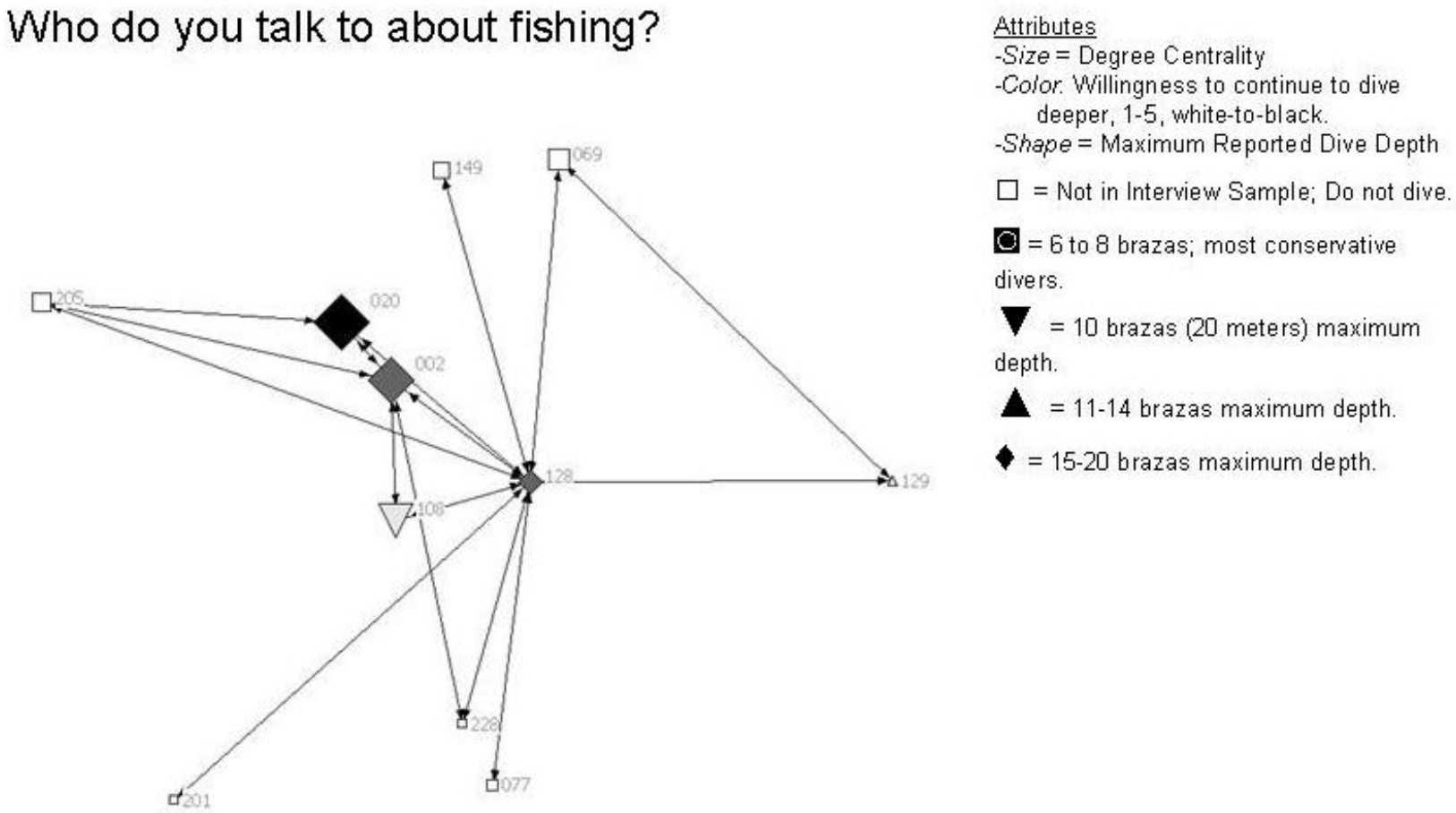


Figure 6-10. The personal network of Caguama (#128), extracted from the whole network. Previously described in Chapter 4, Caguama is one of the fishermen who is popular and well-liked within the cooperatve, but who is also very social with many other groups in the community.

Who do you talk to about fishing?

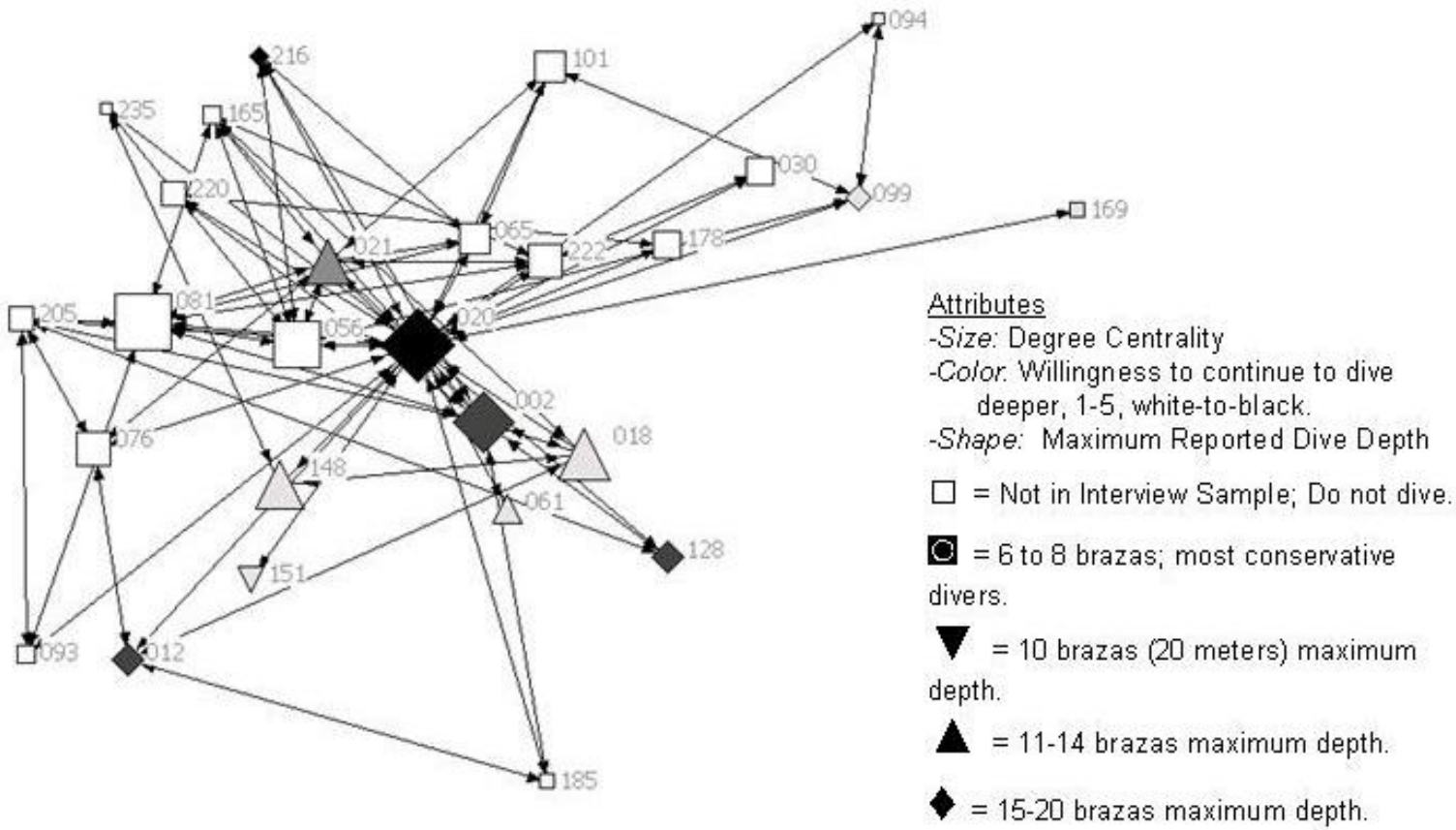


Figure 6-11. The personal network of Cambuay (#020), extracted from the whole network. Cambuay occupies a very central position in the informal network of the cooperative.

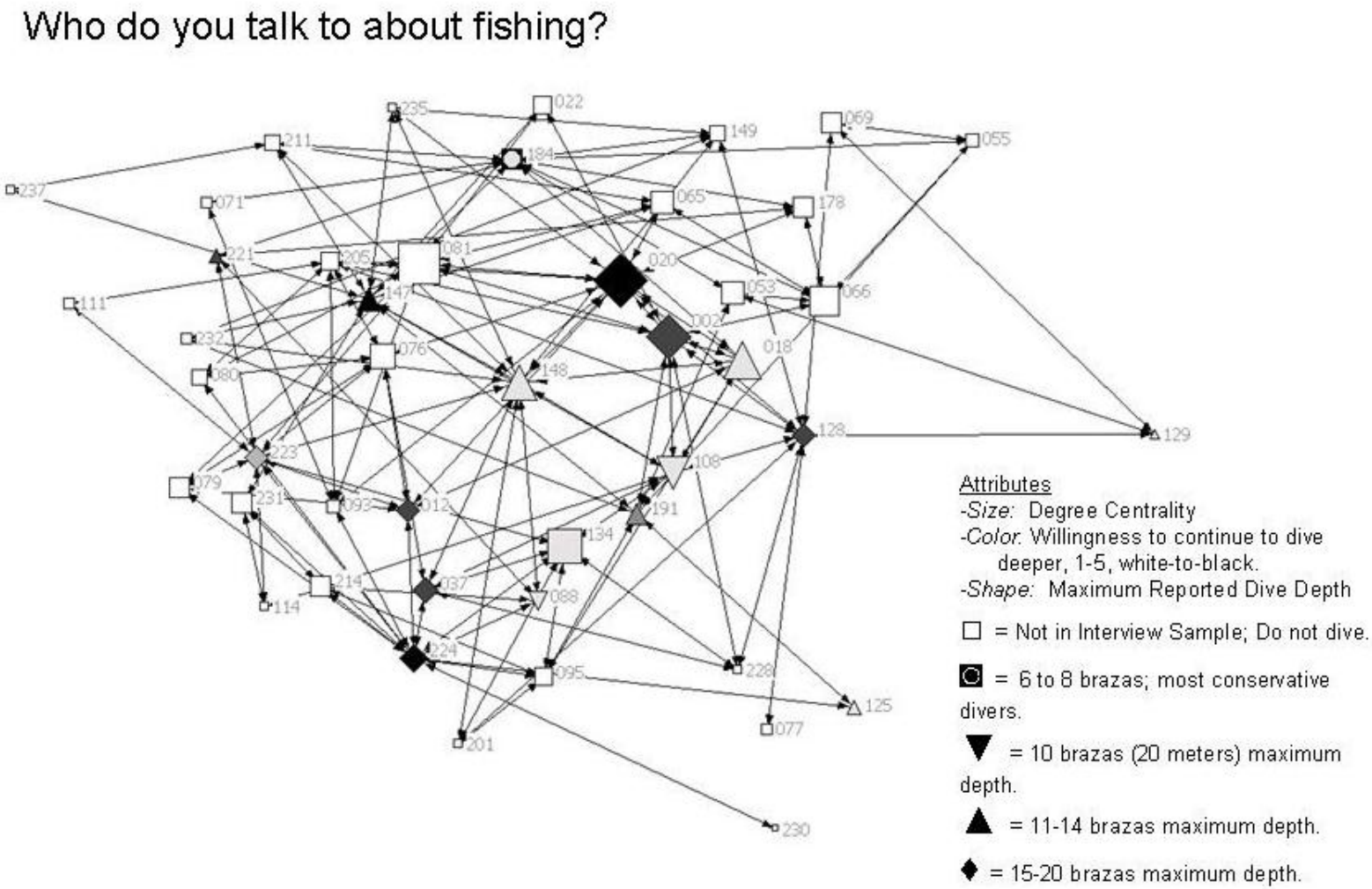


Figure 6-12. The personal networks of the fishermen shown in the previous figures are extracted from the whole network.

CHAPTER 7
EPILOGUE AND CONCLUSIONS

Adaptation in San Felipe

I began this dissertation with a narrative of a diver, to whom I gave the nickname *Kai*, meaning “fish” in Yucatec Maya. Kai’s story describes a pattern of behavior reported by not just him, but all fishermen. Their narratives express consciousness about the increase in the number of boats and divers. Self-reflexively, they blame their reliance on sophisticated GPS technology for putting substantial, consistent pressure on their resource. As a result, lobsters have become harder to find.

In the section on common property, I noted the features that characterize common property resource usage in order to avoid the Tragedy of the Commons: (1) the community of resource users must be defined and access to the resource must be restricted to membership in that community, and (2) the enforcing of appropriate rules about use of the resource by permitted users. These two measures are not absolutes. The members of the community and the terms of the rules are defined by the group of users best able to assert their rights over the resource. The rules are continually negotiated in an ongoing as pressure on the resource increases or decreases.

The scenario with which I began is a textbook example of a pending Tragedy of the Commons. Yet, the Tragedy is not inevitable, as McCay and Acheson and others long since argued. In the data I presented about San Felipe’s lobster divers, they have an awareness of (1) an increasing scarcity in their resource, and (2) their own involvement in the process. Rather than pursue self-interest, they adapt. They continue to act as individuals, altering their short-term behavior to provide immediate results. Or simply coping and reducing consumption and redefining needs. They also participate as

a group in the use and management of the resource. Their group interactions allow for the transmission of information and knowledge—while they talk under the shade of the cypress trees—of the risks and benefits of particular innovations, culturally defined, perceived benefits, and opportunities for work outside of fishing.

How the fishermen adapt also affects the environment. Those that dive deeper expand the fishing grounds, increasing trip expenses and costing more fuel. Over time, the depths have gotten deeper. Gradually, the depths first explored by the greater risk takers are followed, by the more conservative divers who were hesitant until they perceive that the added risk produces more benefits (better catches) that outweigh the risks. This process of diffusion sees once risky behaviors gradually become more acceptable potential fishing grounds (Burt 1987).

Of the factors above, defining the community of divers continues to be negotiated, ultimately allowing the number of divers to continue increasing. There are fewer permits for lobster than there are members in the cooperative. But, because it is the cooperative that exports the lobster, the cooperative is able to negotiate the permit, originally signed to individuals, to satisfy the legal requirement for any cooperative member. The cooperative, and the other cooperative, have expanded the domain of the lobster permits to cover any diver that is working from the boat of a member. This means that the owner of the boat does not need to be a diver himself; he can bring a *libre*, non-cooperative member on board to dive, as long as all lobster are sold to the cooperative.

Because the *libre* diver does not have health insurance, the member captain is required to pay a monthly insurance fee to the cooperative for potential costs associated with treatment in the hyperbaric chamber. This issue was under debate during my year

of fieldwork. When I returned, a solution had been voted in to place: member captains must pay a monthly health insurance premium for any non-member diver who dives from his boat. The fee was negligible, only 100 pesos per month, or roughly $10US.

The second feature is to regulate usage among the users. In San Felipe, there are rules in place governing how the resource may be used. Catching lobsters is not permitted before July 1 each year. Compliance is high for this Federal law, and enforcement exists; each year there are poachers who are caught. When I returned in August 2010, one member had just recently been expelled from the cooperative for poaching lobsters in the closed season (*veda*).

Another interesting finding concerns how the fishermen think in terms of the future. There are many fishermen who, when the low fishing season arrives, are out of money and taking loans to get through the rest of the season. Nevertheless, I was surprised to find a large number of fishermen who criticize those who are not able to manage their money. There are many who think in terms of investing; they purchase juvenile bulls each year, selling the adults when they are grown and living through the low season on the profit. The only local residents who have a bank account are perhaps the handful of local residents who also engage in commercial business outside of the community. The cooperative has a bank account, but none of the fishermen do.

After my departure from San Felipe in August of 2008, I made two brief visits early in 2010 and also kept in touch with text messages and the occasional phone call. I then returned for two weeks in August 2010 as I was finishing this draft. During this trip, I had the opportunity to catch up on the details of recent events. In the two years I was gone, numerous changes had taken place among the *Pescadores Unidos* that speak directly

to the issues underlying this dissertation. Here, I address these and tie them to data from previous chapters.

Changes in Lobster Production

On July 1, the first day of the 2010 lobster season, the divers found lobster. Although a handful of crews returned with only a couple of kilograms, several crews returned to port with up to 50 kilograms of lobster tails. Overall, catches were considered good for the first few days and the divers were excited. By the end of the first week, however, daily catches were back to low levels where two kilograms of lobster tail makes for a good day. Yet, this low level did not apply to divers like Pontó who continued to bring in approximately 10 kilograms each day. This is regarded as a very good catch and worth talking about. At the cooperative office in the evening, the arriving fishermen talk about who made such a catch.

The low catches continued into the month of August. Some fishermen had began to fish for octopus with *jimba*. Interestingly, Pontó would still bring in at least seven kilograms per fishing trip. During the time I was there, he would make a prediction for the next day's catch. Arriving at port the next day, he would show off his bucket full of lobster tails, demonstrating the accuracy of his prediction. It was easy to see how other fishermen, catching far less, would interpret Ponto's success for "luck" (Kottak 2006).

The abundance of lobster for the first few days was exciting for the divers. I asked several fishermen about why they believed this season had begun better than previous years. Each diver's response noted the cooperative-initiated early closure of the season. The cooperative had tried this previously and not seeing immediate results at the beginning of the next season, the other cooperatives of the Federation had not supported closing the season again. Closing the season early requires that all four of

the cooperatives of the Eastern Federation of Cooperatives in Yucatan, agree to comply with the closure for two reasons. First, the officials of the cooperative are instrumental in the success of such an initiative as they must enforce compliance among their own members. Second, the divers of the cooperatives share the same fishing grounds, requiring cooperation for closing the area to all divers. For the cooperative to close the season earlier than mandated by Federal law is an example of local management. Now, perceiving an improvement in catches, the divers feel that their deferral of short-term returns at the end of the season are worth greater gains when the season opens in July.

Changes in Local Politics

Changes occurred at multiple political levels which I will address in turn: both inter-cooperative and intra-cooperative, and between San Felipe and a neighboring community. Since July 2007, when I began the fieldwork for this study, the membership of the cooperative has changed. Several members were expelled from the cooperative in Janauary 2008, which was mentioned earlier. But, further expulsions occurred. Figure 7-1 shows the whole network data collected during the fall months of 2007. Since I completed data collection for this interview, 12 members have left the cooperative. Most were expelled after a vote by the other members at a cooperative assembly either for low production or for selling their catches to other buyers in the community. In their place, nine new members have joined the cooperative. Figure 7-1 highlights in red those members who were initially interviewed but are no longer members. All 12 have roughly the same, very low degree of centrality. They were already marginal members, for the most part.

A new president was elected by the cooperative in November 2009. Under Pech's new leadership, and building on efforts of the previous administration, Pech has

overseen the cooperative's dissolution of the cooperative's ties to the regional exporter in Merida, with whom they have been contractually obligated to sell their lobster since development of the fishery. The cooperative has achieved independence to sell their product to who they choose and currently export most of their lobster to a company that imports to Miami.

Pech was not included in the sample I took of 45 cooperative members. In Figures 6-2 and 6-3, he is identified by node #065, to the right of Cambuay (#020) in both figures. His score for centrality was average, yet since becoming president of the cooperative roughly two years after the social network data was collected, he has become a figure driving change. Not only has he expanded the cooperative's customers, he has also reached out to his counterpart in the other cooperative. The two have the best relationship of any pair of presidents since the cooperative separated. Looking forward, I feel certain that when I return, I will be able to work with both cooperatives. Although I believe my focus on the one cooperative has given me an insight that would not have been possible working with both, it will now be possible to attempt comparative data collection.

In addition to Pech's relationship with the Legitimos' president, there have been some big changes within the Legitimos Cooperative's political structure. The leaders of the Legitimos who led their faction of members to break away did not realize the promises made to their supporters. As the Legitimos members have watched the Unidos earn more and achieve other things, they have become dissatisfied with their leaders. This led to an internal revolt where during an assembly of the cooperative members, the members voted to oust the group of brothers who had long maintained

power. When this story was related to me, I was talking with both presidents, Pech narrating and the president of the Legitimos looking on, a big smile on his face. Given that the conflict between the cooperatives was a major obstacle to locally managing the resources to mitigate scarcity, the resolution of the hostilities is a very good sign.

Returning to the discussion about the agreement among the cooperatives of the Eastern Federation, San Felipe is the westernmost cooperative member in the Eastern Federation of Cooperatives. The closest community to the west of San Felipe is Dzilam Bravo; their fishing cooperative is a member of the Western Federation of Cooperatives. In Dzilam Bravo, octopus is a more important fishery than is lobster. In fact, the number of divers from Dzilam Bravo is small. Although the divers of San Felipe share their fishing grounds with the fishermen of Rio Lagartos, only 12 kilometers to the east, they may not dive in the waters of Dzilam Bravo and vice versa. Fishing with *jimba* for octopus is not restricted by boundaries as is lobster. There is a boundary (*frontera*) between the two fishing communities for diving. A boundary drawn across water is difficult to identify and enforce. Fishermen who are caught near to one side of the border or another could convincingly use the argument of ignorance. The relationship between the divers of these communities is described to me as cyclical: relations are good while boats comply under heightened enforcement. In time, divers from both sides begin to cross. Tensions rise and a poacher from either community gets caught, his equipment confiscated. These incidents increase in frequency until a point where the cooperative presidents of the different communities get together to discuss the problem. They decide to put buoys along the boundary, extending from shore northward into the fishing grounds. This happens every 10 years or so, I was told, and occurred during my

visit. Pech and the Legitimos president, along with a crew from the Dzilam Bravo cooperative, set buoys along the boundary between their communities, designating the boundary for their community's divers.

Intensification-Diversification

In the previous chapters, I discussed the practice in which divers accept the risks of diving to greater depths. Eventually, however, there will be limits imposed by diving to these maximum depths. This is due to the type of equipment they use: compressed air fed through a hose. Two crews of these deepest divers have realized physical limits in the use of this equipment in targeting greater depths. When I returned, a diver from one boat approached me. He explained to me how the equipment was not sufficient to reach the depths to which he wanted to go and he requested that I purchase for him a set of regulators for recreational SCUBA diving. If I would bring them on my next trip, he would reimburse me for my expenses. He regards this as appropriate gear to use at greater depths, based on knowledge he has gleaned about diving outside of San Felipe. Those that are diving to these depths are increasing intensification, including technological innovation, ahead of scarcity, I feel. Despite this season providing a good beginning harvest, these divers are eager to intensify.

In the case of lobster diving in San Felipe, adopting greater risk is a short-term strategy. In McCay's model, such a strategy that incurs greater risk should occur only after scarcity has worsened. Yet, divers are engaged in a pattern of diving deeper, a pattern that began since scarcity was perceived. The divers describe diving deeper as the behavioral response to scarcity. What was initially a short-term adaptive behavior has become common practice.

Another important difference between my results and McCay's concerns how adaptations are examined, on what scale, and at what time. Looking at immediate responses versus long term, McCay says that the immediate responses minimize the risk; fishermen adopt greater risk after scarcity has worsened. My data showed that the short-term responses producing the immediate effects are those of intensification and that the long-term plans are of investment and migration. Investment is a strategy that spreads risk; migration is supportive of McCay's model, however, there was no evidence of any permanent migration. This adaptation remains a hypothetical option for fishermen and not necessarily one that would be used (as Burt said, due to a lack of cohesion, 1987).

McCay's model defines the problem from the perspective of two moments in time and compares the strategies across a temporal scale of scarcity. This study is analyzing strategies at one point in time. Returning to conduct future research in San Felipe will add the temporal factor to the scarcity variable and enable me to determine if the results presented here remain valid.

This brings up an issue that this study does not address. I came to feel that San Felipe is a rather affluent community compared with other Yucatecan communities of similar size. For the people here, fishing is more profitable that farming corn. ReCruz (1996) wrote of a community in central Yucatan, where many residents emigrated for work in Cancun as construction workers. When San Felipe's young men have left for work in tourism in Quintana Roo, they work as boat captains, bragging about watching girls in bikinis and getting big tips from Americans. The construction jobs for which Chan

Kom's men emigrate are not desirable jobs, even in the event of economic stress, for the fishermen of San Felipe.

I believe the difference speaks to differences in perception of economic needs. Coping, or adjusting one's immediate economic needs does not have the width as an option for people who live closer to poverty. People also define for themselves an acceptable level of coping when adapting to stress, such as resource scarcity. Coping is an adaptive strategy, but adapting does not always include coping. Coping is one type of adapting, one result of a strategy. One is adapting when coping, but adapting is not all coping.

While mass tourism has greatly affected the region around Cancun in the state of Quintana Roo, it has had a lesser impact in San Felipe. San Felipe is described in two paragraphs in the Lonely Planet guidebook as a place "off the beaten path." Tourists are infrequent arrivals, sportfishing for snook being the most popular attraction.

Finally, the data on adaptive strategies in San Felipe reveals the complexity of fishing and social groups. While there are general trends that can be identified and measured, such as the trend to dive deeper to increase lobster production, interesting results are revealed when examining the outliers to the pattern. I introduced this data by discussing the context of those who deviated from the trendline in the graphs. Interestingly, this included the biggest lobster producers in the cooperative, Pontó and Balá.

Looking Forward in San Felipe

It is a given that as time goes on, San Felipe will become even more integrated with the outside world. When I talk with groups of fishermen's wives, this is a frequent topic of conversation. They talk about the changes that are taking place, such as the

man from Cancun who is buying up houses in San Felipe as a way to invest and avoid paying taxes. To date, he has purchased seven properties, more than are owned by any other individual in the community. While the women bemoan and complain about local politics and such changes, they temper this talk by adding to me that San Felipe is a good place to live. They know it. They talk about the community, how people are nice, how it is safe, that there is no harassment of anyone. They worry that change is going to alter their way of life, make it more like living in Cancun or Merida which they claim to reject deliberately.

Although I find the fishermen of San Felipe are unanimous in their predictions of a bleak future of the lobster fishery (Lasseter 2006), they are divided about the kind of future the community will take. Tourism and aquaculture development projects are most frequently mentioned as potential futures. Yet, aquaculture, already recognized by some Mexican scholars for polluting the marine environment (Paez-Osuna et al. 1998; Cruz-Torres 2000), seems incompatible with other fishermen's vision of ecotourism. Ruttan (2006) found that heterogeneity among community members negatively impacted the ability to successfully manage resources. The diverse visions for the community may complicate future cooperation. I suspect that different social groups within the community will elect to take different directions, tourism or aquaculture, and this could lead to hostility. Pollnac and Poggie (1991) found this to be the case in their study of fishing cooperatives in Ecuador. They found that heterogeneous opinions affected the success of the cooperative institution. These ideas of different future directions could provide seed for future conflicts.

As for now, the cooperative is strong and meeting the needs of the fishermen. The fishermen are engaged in collective behaviors of resource management and improving inter-community cooperation. The future for lobster production in the community is just as difficult to determine now as when this study began. Will closure of the coming season further improve harvests?

Ending with the adaptive strategies of the fishermen, it appears that the divers' early response to short-term declines in production was to adapt by adopting risky dive practices. Eventually, diving deeper has become practice. As deeper depths become normalized over time through the experiences of more and more divers, the average depth will continue to deepen. This will undoubtedly lead to further, severe dive accidents. It also appears to be leading to a search for technological solutions, in the form of new dive gear.

Implications for Fisheries Management

Through this study of adaptation to resource scarcity, my goal is to better connect the perspective and experiences of those who use marine resources (fishers) into marine resource management. As I move forward from this project and begin a new job as technical science staff for a fisheries regulatory agency in the U.S., this is the task that faces me. How can socio-cultural data be incorporated and represented in the science used by policymakers when designing and implementing fisheries regulations? This dissertation is my contribution to improving equitable fisheries management by better representing fishers' knowledge and experiences in their interaction with marine resources.

In fisheries management in the U.S., policy is principally based on available data for the species to be managed. Data on how policy might impact resource users is often

unavailable to policy makers. Yet, according to the way that fisheries policy is written in the U.S., the health of fish stocks, however defined, takes precedence over the well-being of fishing communities. It is my belief, however, that these two factors, the health of fish stocks and the well-being of fishing communities, are inextricably linked. Rather than privileging the health of fish stocks over the well-being of fishing communities, a better understanding of fisher behavior and decision-making, and improved participation of fishers in the management process, would help management to be more successful.

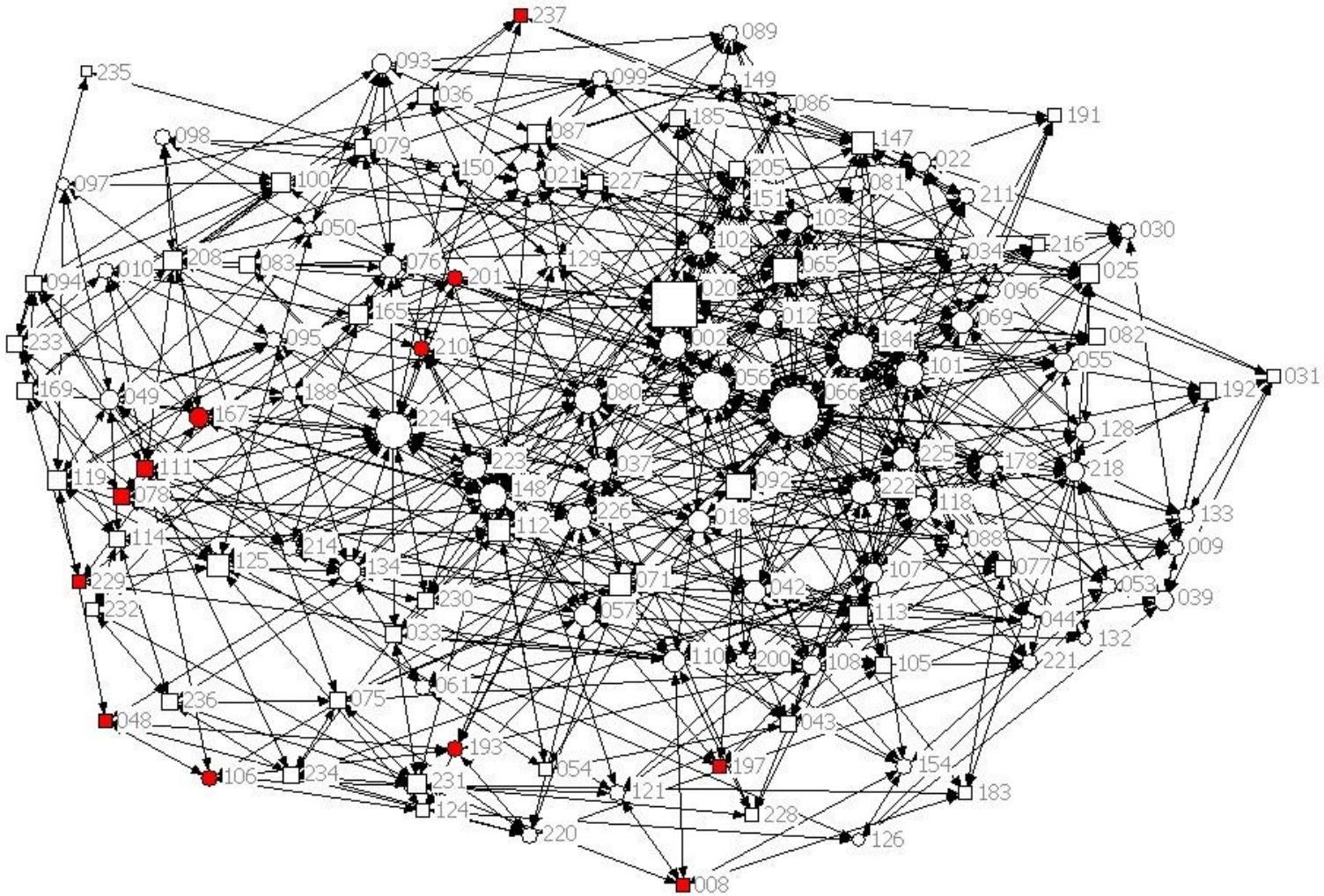


Figure 7-1. A visualization of the social network for all 123 interviewed cooperative members showing (in red) those who have left the cooperative since data collection. The size of the nodes is coded for degree centrality. The shape denotes boat ownership (circle = boat owner; square = no boat). The red nodes are cooperative members who have either been expelled or quit since data collection was completed in December 2007, updated as of August 2010.

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BIOGRAPHICAL SKETCH

Ava Lasseter was born in Jacksonville, Florida and grew up fishing and boating on both coasts of the state. After finishing her undergraduate degree in photography at the University of Florida, she spent several years working and traveling through 30 countries. Her jobs overseas included a year working as an English teacher for the royal family in Saudi Arabia; two years in Japan teaching English in a high school then spending a year on a cultural visa, learning printmaking with a Japanese folk artist; and two years as a SCUBA Divemaster guide in southwest Thailand. She returned home and began the graduate program in anthropology at the University of Florida in 2003, interested in studying human-marine environment interactions.

While working on her dissertation, Ava conducted two research projects for the Gulf & South Atlantic Fisheries Foundation, Inc. In one project, she examined the socio-economic impacts from the implementation of a marine protected area, on the fishing community of Fort Pierce, Florida. Shortly before graduating, she began her new job as social scientist with the Gulf of Mexico Fisheries Management Council in Tampa.