Community-based governance of artisanal fisheries Ngazidja island, Comoros

by

Melissa Hauzer
B.A., University of Victoria, 2005

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Abstract

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Tropical small-scale fisheries represent the main livelihood and protein source for a substantial portion of the global population. Growing pressures on marine resources, however, have left many fishing communities faced with declining catches and increased environmental degradation. Effective management strategies and governance institutions are thus critically important. Conventional top-down, exogenous approaches to fisheries management have been ineffective in more traditional and small-scale fisheries. Yet, there remains little understanding of the effectiveness of alternative approaches and few studies offer feasible solutions for managers in lesser developed nations. This case-study of artisanal fisheries in the Comoros examines how effective local fishing associations are at managing common fisheries resources, and provides some understanding of the underlying characteristics of effectiveness. To do so, qualitative methods were used to collect data on fishing practices, local knowledge and beliefs, governance structures, and livelihoods in male and female fisheries in five villages on Ngazidja island.

The results of this study are organized into three papers. The first paper focuses on current fisheries trends on Ngazidja and the implications of the gradual shift from traditional to modern fishing practices. This paper contributes to the overall goal of this study as the modernization of the fishing sector may affect both the ecological sustainability of the fishery and the ability of local fishing associations to effectively govern fisheries. Results show that although the fishery sector is not undergoing a rapid modernization, loss in traditional practices, beliefs, and values are occurring and may be linked to corresponding declines in marine resources. Improved monitoring systems will help inform local governing institutions about the need to develop enhanced management practices. The second paper examines the effectiveness of community-based governance of artisanal fisheries and addresses the overarching goal of the study by improving understanding of the key elements of success of the community fishing associations. These fishing associations collectively design, monitor, and enforce local regulations. Decisions are based on local knowledge and experience, and management strategies are

based on low-cost, practical solutions. Compliance with local regulations is high, primarily due to participatory decision-making, community-monitoring, and strong feelings of solidarity among fishers.

The last paper looks at fisherwomen on Ngazidja and focuses specifically on documenting their fishing practices, livelihood contributions, and potential participation in fisheries management. This paper is critical to enhancing understanding of the impacts and potential of the fishery on Ngazidja as the sector has so far failed to take into account all marine harvesting activities, particularly those undertaken by women. Moreover, authorities have recently attempted to ban women from fishing as their practices are considered destructive to near-shore reefs and juvenile fish populations. Results from the study indicate that women's fishing methods can be destructive and may have contributed to localized declines in intertidal marine resources and habitats. Yet, fisherwomen also provide substantial contributions to household livelihoods. Thus, banning the fishery altogether is not an acceptable solution. Instead, authorities should work to empower fisherwomen with the tools necessary to manage their fishery sustainably, which will eventually lead to improved conservation measures.

Overall, this case-study provides a unique example of how collective governance of common-pool resources can be achieved within communities, and how feelings of empowerment and shared responsibility among users can lead to effective management practices. There are a number of clear lessons learned from the successes of this fishery that can be applied to other similar small-scale fisheries. Future research priorities should concentrate on assessing the ecological sustainability of current fishing and management practices, and paying particular attention to the recognition and inclusion of fisherwomen. Marine conservation and sustainable fisheries systems are only facilitated when all users are recognized and engaged in management and policy decisions.

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Acknowledgments

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Dedication

To my little brother, Keane, who passed away so suddenly while I was conducting this research. Nothing will ever fill the ache that has been left in my heart. I miss you more with every day that passes, but will carry you with me wherever I go.

To my close friend, Zaka, who also passed away suddenly while I was writing my thesis. The friendship we shared is something that few people are ever fortunate enough to experience and for this I am forever grateful. Your voice and laughter will always resonate in my heart.

To the people of the Comoros: for your hospitality, your humour, and your passionate perseverance against all odds. If only the world could see the struggles you continue to endure while happily laughing and bouncing down your godforsaken roads.

Question: Why did you decide to become a fisher?

Response: “*Because when I was a kid, people thought that if you went to [French colonial] school you'd either become a Catholic or a drug addict. So my parents said they’d rather I learn to fish".*

- Expert Fisher, Hantsindzi

Introduction Chapter

Artisanal fisheries in lesser developed regions: Global context and issues

1. Introduction

The backdrop for this research is set against a rather bleak outlook for the status of global fisheries. Worldwide, fish stocks are being over-exploited, marine habitats are being degraded, and fish catch is declining (Achenson, Wilson, & Steneck, 1998; FAO, 2010; Holling, Berkes, & Folke, 1998; Defeo, McClanahan, & Castilla, 2007). Many argue that one of the main contributing factors to the current crisis is the result of conventional fisheries science which has focused almost exclusively on the biophysical aspects of resource management, while ignoring the importance of local ecosystem dynamics and the people who rely upon them (Berkes & Folke, 1998; Berkes, Mahon, McConney, Pollnac, & Pomeroy; 2001; Defeo et al.; Holling et al.; Jentoft, 2000). Substantial interest has thus been sparked in exploring alternative solutions to current fisheries management strategies which incorporate a more holistic and adaptive approach (Achenson et al.; McClanahan & Castilla, 2007). This is of particular importance for lesser developed countries where using conventional approaches are not often a viable option given the difficulties of collecting quantitative scientific information. To date, however, little focus has been placed on the importance of local fisher knowledge in the use and management of marine resources (Johannes, Freeman, & Hamilton, 2000), and few publications offer feasible management solutions appropriate for traditional resource managers in lesser developed nations (Berkes et al., 2001). Instead, much of the research on artisanal fisheries continues to focus on the ecological impacts of resource management and less on how and why people choose to manage their resources as they do.

Another significant gap identified by this study is the lack of research on women who fish. Studies on women in fisheries tend to focus on their roles as processors and vendors, but rarely on their direct involvement in fishing (Chapman, 1987; Chuenpagdee, Liguori, Palomares, & Pauly, 2006; Ruddle, 1994, Williams, 2002). As such, the contributions of fisherwomen to coastal livelihoods and food security are often overlooked (Bennett, 2005; Verebalavu, 2009) and fisherwomen remain marginalized from resource management and policy decisions. The aim of this study, therefore, is to contribute to these gaps by, 1) offering new perspectives on management strategies which are based on local ecological knowledge and operate within customary community-based management structures, and 2) examining the harvesting activities and contributions of women who fish.

Artisanal fisheries are the main fishery in tropical developing nations (Berkes et al., 2001) and are characterized by low-technology, low-investment, and low-energy (FAO, 2005; McClanahan & Castilla, 2007). Most artisanal fishers use traditional gears (e.g., small traps, nets, handlines, spears) and methods in coastal waters (Berkes et al.; McClanahan & Castilla). Of all the fisheries, diversity in catch is the greatest as gear is often non-selective and targeted species are dispersed over varied terrain. Targeted stocks also tend to be narrowly distributed and low in population numbers compared to those of large-scale fisheries (Berkes et al.). Artisanal fishers move within their range according to the season, at times harvesting for subsistence purposes and at times for the local market. Another important distinction of artisanal fisheries is the involvement of family and household labour in fish production, and the high number of families and communities who depend on these fisheries for their livelihoods (Berkes et al.; FAO, 2005). Berkes et al. (2001) estimate that approximately 500 million people depend directly and indirectly on small-scale fisheries; and, the FAO (2005), found that in small-island states, seafood represents up to 90% of the protein intake. Small-scale fisheries thus provide substantial contributions to food security and poverty reduction. Today, however, a combination of new pressures on marine resources (e.g., population growth, climate change, new gear technologies) and a critical dependency on fishing have created a situation whereby many small-scale fishing communities in lesser developed countries are being faced with tackling increasingly complex issues (Johannes, 1998).

Developing appropriate management strategies for artisanal fisheries is difficult, especially given that of all the fisheries, they are the least studied and documented (Berkes et al., 2001), and our knowledge of fisher behaviour is negligible (Abernethy, Allison, Molloy, & Côté, 2007). Due to the lack of uniformity in fisher behaviour and the complexity of these fisheries, using a conventional fisheries management approach is difficult (Abernethy et al.; Acheson, Wilson, & Steneck, 1998; Hickey, 2007; Johannes, 1998; McClanahan & Castilla, 2007). Thus, the extensive data-collection required by conventional management paradigms would never be adequate to support long-term and effective management policies. A number of case-studies have shown how different societies have been managing fisheries for centuries based on their own traditional knowledge and belief systems (Achenson et al.; Berkes et al.; Hickey; Holling, Berkes, & Folke, 1998; Johannes; Wells, Samoilys, Anderson, Kalombo, & Makoloweka, 2007). Today, however, fewer examples of successful community-based fisheries exist, as many have been unable to adapt in the face of change and modernization (Hickey, 2007; Kalikoski & Vasconcellos, 1997; Ruddle, 1994, 1996, 1998). This case-study of small-scale fisheries in the Comoros is thus an unusual example of a modern-day fishery that demonstrates clear evidence of

its ability to manage people effectively, which in essence, is exactly what resource management is about.

2. The Union of the Comoros

The Union of the Comoros is situated at the northern end of the Mozambique Channel in between Madagascar and Mozambique (Figure 1). The country comprises the three volcanic islands of Ngazidja, Ndzouani, and Mwali. The islands are surrounded by patch and fringing reefs and are home to endangered green and hawksbill sea turtles, dugongs, and the legendary living marine fossil, the coelacanth (Abdoulhaik, 1998; Granek & Brown, 2005). The marine and coastal environments are diverse on all three islands, consisting of mangroves, extensive seagrass beds, and inshore and offshore reefs. These ecosystems, however, are under threat due to coastal development, habitat degradation, and the unsustainable use of coastal resources (C3-Comores, 2007; Granek & Brown).

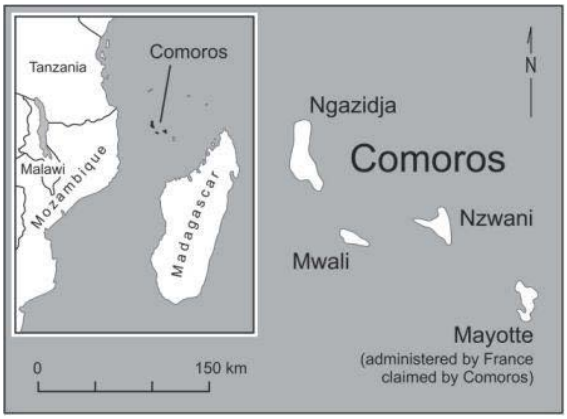

Figure 1 - Union of the Comoros

The Comoros is classified as a small island developing state and one of the poorest countries in the world (UNDP, 2007). According to the 2010 UNDP Human Development Indices, the Comoros ranks 140th among 169 countries. Monetary poverty levels for the country are approximately 37% per household and 45% per individual (Union of the Comoros, 2005). In addition, the Comoros is facing considerable demographic pressure with approximately 42% of the population under 15 years old and one of the highest growth rates in Africa at 2.73% (CIA, 2010). With 88% of the population living on the coast (UNDP, 2007), this pressure will likely result in a serious increase in environmental degradation and poverty unless effective management strategies are employed. Exacerbating this situation is the country's serious political instability. Not only has the Comoros undergone more than 20 coups since their independence in 1975 (Granek & Brown, 2005), but according to Carleton University's *Country Indicators for Foreign Policy* (CIFP), in 2008 the Comoros sat among the top 30 of the world's most fragile states, and ranked worst in terms of capacity[1]. Their rankings have since improved, but it is worth

[1] "Capacity refers to the power of a state to mobilize public resources towards productive ends. . . [i.e.,] a basic competence in political and economic management and administration, with governments capable of regulating domestic affairs and conducting international transactions. They also possess the basic infrastructure required of a modern state, including functional transportation and communication networks" (CIFP, 2008).

mentioning simply to draw attention to the complex situation within which the citizens and government are attempting to progress, and to further emphasize the need to include local grassroots organizations in the management of natural resources.

3. Research Objectives

The overall goal of this research is to improve understanding of the dynamics and effectiveness of community-based management of marine resources, particularly in data-deficient areas where governments have little capacity to manage fisheries. These questions are examined through a case-study of informal fisheries management on the island of Ngazidja (Figure 2) in the Union of the Comoros. Emphasis is placed on assessing the effectiveness of local management systems and providing some understanding of the underlying characteristics of effectiveness. As baseline fisheries data is not available for the Comoros, the research focuses primarily on social, rather than ecological, systems and their ability to act alongside the national government to manage fisheries. Part of this examination includes taking into account the impacts and contributions of the women's fishing sector which has so far been completely marginalized, as well as assessing the implications of the gradual modernization of the fishing sector. Both of these studies are important for, 1) if developing a sustainable fishery is a goal of the Comorian government then all marine harvesting activities must be considered, and 2) the gradual modernization of the fishing sector (and the corresponding shift in values and beliefs) may affect the ecological sustainability of the fishery and the ability of local fishing associations' to effectively govern fisheries.

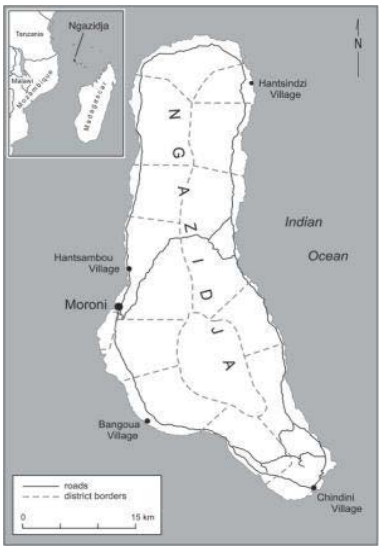

Figure 2 - Ngazidja Island

The main objectives of the study are to:

1. Describe current fishing practices and management structures;
2. Assess the strength and capacity of community-based fisheries management structures;
3. Identify key resource management tools and assess their overall effectiveness;
4. Identify factors which influence fisher behaviour and decision-making patterns;
5. Identify the spatial distribution of fishing grounds and management methods;
6. Examine women's fishing methods, environmental impacts, and contributions to livelihoods;

7. Add to the dearth of information on women who fish.

4. Methodology

A combination of qualitative research methods were used to collect primary data. These included participant observation, key informant interviews, focus group discussions, and GIS mapping of traditional fishing grounds. This multi-methods approach helps verify and validate findings, enables a more thorough understanding of the issues, and ensures a greater likelihood of filling in the gaps of existing data. Study participants included all relevant fisheries stakeholders: male and female fishers, fish vendors, government agents from the Ministry of Environment and Department of Fisheries, presidents of local and national fishing syndicates, and village leaders. Interview topics and questions were based primarily on Berkes et al.'s (2001) work and questionnaire guide on community-based fisheries management, McClanahan's and Cinner's (1996 – 2009) work on fisheries management in Eastern Africa, Ostrom's (1995) principles for successful community management, Bodin and Crona's (2006, 2008, 2009) work on local knowledge and the importance of social capital for effective community management, Johannes' (1998, 2000) work on local fisheries management and knowledge, and Bunce et al's (2000) and Malleret-King et al's (2006) guides for socioeconomic monitoring in Eastern Africa. The study was conducted in consultation with local, national, and international collaborators: the National Ministry of Environment, the National Fisheries Department, the National Fishing Syndicate, community fishing associations, and village chiefs and governing bodies. Two students from the University of the Comoros were also hired and trained to assist with interviews and fieldwork.

5. Organization of thesis

This thesis is organized into three individual papers. The first paper is on artisanal fishing practices on Ngazidja and sets the context for the subsequent two papers. This paper focuses primarily on current fisheries trends and the possible implications of the gradual erosion of customary beliefs and practices. The second paper examines the effectiveness of community-based governance of artisanal fisheries and addresses the main overarching goal of this study. The last paper looks at fisherwomen on Ngazidja and focuses specifically on documenting their practices, livelihood contributions, and management of their sector. Each of these papers provides new baseline information as studies of this kind have never been conducted in the Comoros. Since each paper is meant as an individual publication, there is some overlap between the three papers; e.g., methods and background information. The thesis concludes with a short chapter to summarize the key findings and recommendations of this study.

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"If I told you to climb a coconut tree even though you don't know how, would you be able to? It is the same with fishing"

- Expert fisher from Hantsambou

Paper 1

The implications of modernization on fishers' knowledge, practices, beliefs, and livelihoods Ngazidja island, Comoros

1. Introduction

Artisanal fisheries represent the main livelihood and protein source for approximately 500 million people around the globe (Berkes et al., 2001), most of whom are located within the world's poorest nations (Allison & Ellis, 2001; Berkes, 2003). Artisanal fisheries play a central role in food security, poverty alleviation, and rural development, yet the highly complex nature of these fisheries and the inconsistent reporting of catch numbers means that our knowledge of this sector remains very limited (Andrew et al., 2007; Berkes et al., 2001; Chuenpagdee et al., 2006; Cunningham & Bodiguel, 2005; McClanahan & Mangi, 2004; Zeller, Booth, Craig & Pauly, 2006). As described by Johannes (1998), "no other fisheries involve so many species, such complex and diverse habitats, so many fishers, gear types, landing sites and distribution channels per unit of catch" (p. 243). These conditions are often further complicated in remote and lesser developed regions where governments lack the capacity and funds to adequately collect fisheries information (Berkes et al., 2001; Chuenpagdee et al, 2006; Johannes, 1998). In such cases, fishers and fishing communities are often the only source of information on current and historical fisheries trends (Johannes, Freeman, & Hamilton, 2000; Johannes & Neis, 2007). As such, fishers' local and traditional ecological can play a pivotal role in natural resource management, including producing baseline fisheries information to enhance understanding of local fisheries (Berkes, Colding, & Folke, 2000; Johannes, Freeman, & Hamilton, 2000; Fernandez-Gimenez, 2000).

Traditional ecological knowledge (TEK) is the accumulation of knowledge, practices, and beliefs that have been passed down from one generation to the next. It is a site-specific body of knowledge acquired through observation and experience about the relationships between organisms and their environment. TEK is adapted and revised as new knowledge is gained (Berkes, Colding, & Folke, 2000; Fernandez-Gimenez, 2000). Thus, it is "based not only on what each generation learns from [their] elders, but also on what that generation adds to that knowledge" (Ruddle, 1994, p. 174). While the extent and distribution of TEK varies among individuals within a community, there is often a base knowledge which is shared by all community members and which is embedded in local customs, behaviours, and practices (Berkes, Colding, & Folke; Fernandez-Gimenez). Thus, fishers' understanding

of the local marine environment is often strongly embedded within the local social context. In this way, knowledge is stratified between a general social knowledge (e.g., that shared by either a group of fishers or coastal community) and role-specific knowledge (e.g., that which is held by fishers themselves and varies with expertise) (Ruddle).

Recent literature distinguishes between local ecological knowledge (LEK) and TEK, where LEK is defined as that which is locally generated but not derived from past generations (Berkes et al., 2001; Olsson & Folke, 2001), or knowledge which has been gradually eroded due to modernization and changes in traditional belief and value systems (Crona, 2006). In practice, however, the distinction between "local" and "traditional" is not always clear. Knowledge is not stagnant, it is dynamic; it is constantly being verified, adapted, and built-on. Thus, most knowledge bases will contain both traditional and recent components. Ruddle (1994) aptly describes this when he writes, "modern influences do not necessarily make contemporary local knowledge less traditional, as they are incorporated into a framework of existing knowledge. Inevitably some of the past generations' knowledge is replaced through the present's experience, but the knowledge core remains intact" (p. 175). Although LEK can be instrumental in providing critical information or insight into local resource conditions, caution must sometimes be taken when interpreting results (Johannes, Freeman, & Hamilton, 2000). For instance, while at times logical and sound reasoning may underlie certain explanations, the explanations themselves may be false. Or, while observations of different phenomena may be correct, the understanding of *why* they are occurring may be incorrect. Even so, fishers' observations and local knowledge are invaluable for gaining insight into past and current trends – particularly in situations where conventional scientific data is unavailable (Johannes, Freeman, & Hamilton; Pitcher, 2001).

In these respects, the Union of the Comoros is not unique. Fisheries information for the Comoros is largely unreported and apart from Stobbs' contributions (e.g., Stobbs 1987, 1991; Stobbs & Bruton, 1991) few written accounts of the fishery exist. Available fisheries data is scarce and inconsistent, and past and current fisheries trends remain largely unknown. The purpose of this study, therefore, is to contribute to this data deficiency and lack of understanding of Comorian fisheries by documenting fisheries information based on fishers' local and traditional knowledge. The results presented in this paper are part of a larger study which looked at the effectiveness of community-based artisanal fisheries management on the island of Ngazidja. The objectives of this paper are to 1) provide a detailed account of fishing practices and beliefs in the Comoros, with a specific focus on Ngazidja; 2)

document current resource trends based on fishers' ecological knowledge; and 3) examine some of the possible social, cultural, and ecological implications of the recent influences of modernization. The paper begins with a background on the Comoros islands and fishery sector to set the context for the study. Results are then presented according to the key findings which emerged from the study, including fishing practices, effort, and beliefs, markets and livelihoods, and resource status trends. Particular attention is paid to how local knowledge and customary beliefs relate to and influence fisher behavior. The final discussion centers on the implications of changes in beliefs and practices as a result of modernization.

2. Background

2.1. Union of the Comoros

The Union of the Comoros is a remote, small-island developing state located at the northern end of the Mozambique Channel in between Madagascar and Mozambique (Figure 1). The country is comprised of three volcanic islands, Ngazidja, Ndzouani, and Mwali[2], and numerous uninhabited islets, all hosting a rich marine and terrestrial biodiversity. The islands are surrounded by patch and fringing reefs, mangroves, and extensive seagrass beds which stretch across 340km of coastline. The Comoros are home to endangered green (*Chelonia mydas)* and hawksbill (*Eretmochelys imbricate)* sea turtles, dugongs (*Dugong dugon)*, and the legendary coelacanth (*Latimeria chalumnae*) (Abdoulhaik, 1998; Fricke et al., 1991; Granek & Brown, 2005). The islands also provide important habitats and nursing grounds for migrating humpback whales (*Megaptera novaeangliae)* and numerous other cetacean species (Kiszka, Vely & Breysse, 2010).

The Comoros is classified as one of the poorest nations in the world (UNDP, 2009) and coastal communities in the Comoros rely heavily on marine resources for both economic and subsistence livelihoods. Already one of the most densely populated countries in Africa at approximately 371/km^2 (UNDESA, 2008), the Comoros continues to face considerable demographic pressure with an estimated 42% of the population under 15-years-old and one of the highest growth rates in Africa at 2.73% (CIA, 2010). It has been shown that high human population density is one of the greatest drivers for reef decline (Cinner et al. 2009; Newton, Côté, Pilling, Jennings & Dulvy, 2007), and with 88% of the

[2] The fourth Comorian island, Maoré, has been under French jurisdiction since colonization and was voted an overseas department of France during a referendum in 2009 (IRIN, 2009*a*; 2009*b*).

population living on the coast of the Comoros (UNDP, 2007), this pressure will likely lead to a serious increase in environmental degradation and poverty unless effective management strategies are employed.

2.2. Ngazidja Island

The study area for this research is the island of Ngazidja (Figure 2). Ngazidja is the largest (1,148 km²) and geologically youngest island in the archipelago (Guébourg, 1995). It rises steeply from the ocean floor at a depth of more than 3000m (Dossar, 1997; Stobbs & Bruton, 1991) and is the only island with a highly active volcano, Mt. Kartala (2361m). Approximately 60% of the island, or 100km of the 170km coast, is bordered by coral reefs, covering an area of 31km^2 (Guébourg). The continental shelf is very narrow, varying between 200 - 1200m (Dossar). Ngazidja is the second most populous island. The most recent (2003) census recorded the population at 296,177 with a density of 258/km^2. Estimates suggested that by 2011, the island population density would increase to 316/km^2 (Union of the Comoros, 2005). Apart from the capital city and closely surrounding communities, infrastructure on the island is highly limited by poor road conditions, unreliable power and water supplies, and negligible health and education facilities. Many rural communities remain entirely cut off from basic infrastructure. Likewise, food security is low in these isolated communities, and fish remains the most accessible and affordable form of protein in an already very nutrient-poor diet. Nevertheless, as a result of this isolation, communities are very resourceful and adaptable, leading to strong social networks and cohesion (personal observation).

2.3. Fisheries Sector

Fishing in the Comoros is exclusively artisanal[3] and catches are used for subsistence purposes or sold at local markets. Until 1985 fishing in the Comoros was purely traditional; i.e., comprised of dugout canoes, called *galawas*, and handcrafted traditional gear. Since then, the sector has "modernized" through international aid from development projects. This led to the provision of small (5 -7m) fiberglass boats with outboard motors (15–40HP), modern gear (e.g., metal hooks, plastic bait, and monofilament fishing line), and freezers (Union of the Comoros, 2005). Traditional canoe fishers, however, still comprise a significant portion of the sector (Table 1). There are also four commercial fleets (9 meters in

[3] Artisanal fisheries are characterized by low-technology, low-investment, and low-energy. Most artisanal fishers use gears such as traps, nets, lines, and spears in coastal waters. The term 'artisanal' is often used synonymously with 'traditional' or 'small-scale'. Artisanal fisheries are the main fishery in tropical developing nations (Berkes et al., 2001; Chuenpagdee et al, 2006; McClanahan & Castilla, 2007).

length with a maximum capacity of 200 tones) which are used to fish near the Mozambique coast. As these boats are limited in size and technology, they are still considered artisanal.

Fisheries production in the Comoros is limited by a lack of storage facilities and processing abilities (Meyer et al., 2006). A variety of processing methods were attempted (e.g., drying, salting, smoking), but it was found to be much cheaper to import processed fish from Madagascar. In addition, due to frequent power cuts and poor maintenance, few of the provisioned freezers are in working condition. In 2010, the National Fishing Syndicate opened a small cold storage unit in the capital city, Moroni, from which they sell fish at a fixed and slightly discounted price. A few of the village fishing cooperatives have also collectively purchased cold storage chambers for use in their villages. Fishers without access to these facilities are obliged to sell or give away their entire catch each day to avoid wastage. Households cope with excess fish by frying all of it immediately and storing it until the following day. During the high season it is not uncommon for fish to be wasted, and during the low or windy season, families go for days or weeks without fish.

The national government's outlook for the fishing sector is one of growth, expansion, and modernization. The government's 2009 targets were to increase fisheries production by more than 50%, to create 5,000 new jobs, and to increase contribution to GDP by more than 13% (Union of the Comoros, 2005). These goals have yet to be achieved, but the government contends that development can occur through the expansion of the Exclusive Economic Zone (EEZ) and the exploitation of unexploited resources (e.g., shrimp, lobster, cephalopods) – all in light of the high global demand for seafood in an era of overexploited fisheries stocks. The growth and development of the industry is appealing for many, however, it also raises concerns regarding the uncontrolled expansion of fishing and a need to better understand the current situation before such measures are taken.

Very little reliable scientific data exists on fisheries in the Comoros. The only systematic collection of fisheries data occurred in 1994 and all statistics before and after this date are based on estimates derived from this data and other small, isolated studies. The commonly quoted statistics are often contradictory, out of date, or clearly guesswork. For instance, the number of fishers is reported as 8,500 (e.g., Meyer et al., 2006; Union of the Comoros, 2005), yet the FAO (1999) *Fisheries Circular* shows that fisher numbers have been recorded as such since 1970. Information on catch numbers is much the same. Potential fisheries production rates are estimated at 33,000 metric tons annually of which 64% are said to be exploited, yet these numbers are based on an estimate derived in the 1970's which used

calculations from studies conducted in other "somewhat similar" tropical waters (Union of the Comoros, 2005; n.d.). The Department of Fisheries acknowledges these limitations but is so limited by staff, resources, expertise, and funding that they can only attend to immediate administrative tasks.

3. Methodology

3.1. Study Design

Data-collection took place between July and December 2009, though insights into results are also informed by extensive experience in the country since 2006. Although women throughout the islands fish, this paper focuses specifically on results from the male fishery on Ngazidja. A case-study on the fisherwomen of Ngazidja is available in a separate paper (Hauzer, 2011).

Prior to commencing field research, preliminary discussions were held with the National Fisheries Department[4], the National Fishing Syndicate[5], and local fishing associations in seven potential study sites. The purpose of the meetings was to present the research interests and objectives, receive feedback, and explain the research process and dissemination of results. Potential participants had the opportunity to ask questions, express concerns, and decide whether they were interested in participating. Baseline information was gathered to help guide questionnaire design and decide on study site selection. The preliminary meetings were also critical for building trust between the community and researcher. Permission to conduct interviews and take photos in each of the villages was granted by the participants and village leaders.

A variety of methods were used to collect data, including key informant interviews, focus group discussions, participant observation, and GIS mapping. Key informants (i.e., local experts) were the primary study participants as they are generally those with extensive knowledge and experience, and have the ability to provide greater insights on certain issues. The island dialect of Comorian, ShiNgazidja, is not a written language so questionnaires were written in French and then orally translated into ShiNgazidja. Local experts were sought to translate key words and concepts (e.g., scientific and religious terms) from French into ShiNgazidja and vice-versa. To ensure consistency in translation and interviews, a two-day training workshop was held for the research team prior to commencing interviews. The team

[4] State government

[5] Non-governmental association acting as a representative umbrella organization for local fishing associations

also convened after each day of fieldwork to discuss any issues or concerns. Data was entered at the end of each field-day in case any discrepancies arose so that they could be addressed immediately.

A pilot study was conducted with members of the National Fishing Syndicate to assess key informant questionnaires in terms of comprehension, flow and order of the questions, relevance, and length of time. This was the most practical and cost-effective means to conduct a pilot and avoided taking up the time of fishers in villages which were outside the study sites. Upon completion of the fieldwork, a preliminary results meeting was held and each village was invited to participate, along with the National Fisheries Department, the Ministry of Environment, the National Fishing Syndicate, and anyone with an interest in the study. Preliminary results were presented and the next steps in the research process were explained. It also provided an opportunity for participants from different villages to meet and comment on the research and discuss any issues of interest or concern.

3.2. Study Sites

Four large fishing communities were chosen as study sites: Chindini, Bangoua, Hantsambou, and Hantsindzi (Figure 3). Selection was based on geographical distribution, the importance of fishing within the community (i.e., percentage of fishers and reputation as a major fishing community), recommendations made by the National Fishing Syndicate and National Fisheries Department, and community interest in participation.

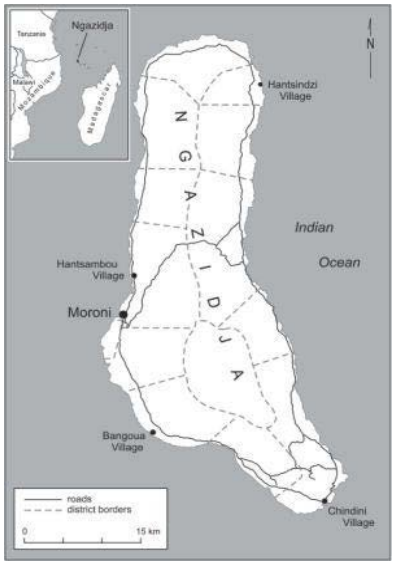

Figure 3 - Study sites of the male fishery on Ngazidja island

There are approximately 44 landing sites on Ngazidja, though many of these are quite small (e.g., 1 -10 fishers/village), particularly on the central east coast. Chindini and Bangoua are two of the three main fishing communities on the island. Each of the study sites is the main fishing village within their region and fishing is the main livelihood (economic and subsistence) activity. Estimated fisher and boat numbers for each study site are shown in Table 1 and are based on estimates provided in consensus by the fishers in each community.

Table 1 - Estimated fisher and boat numbers per study site

	Hantsindzi	Hantsambou	Bangoua	Chindini
# of male fishers	150	260	600	1700
# of traditional canoes	55	160	90	70
# of powerboats	13	50	60	100
% of traditional fishers	50%	35%	15%	20%
% of modern fishers	50%	65%	85%	80%
% of fishers in village	80%	85-90%	90%	90%

3.3. Key Informant Interviews

Semi-structured key informant interviews were the main data collection method. A mix of open- and closed- ended questions was used to provide both quantitative and qualitative information. Questionnaires were structured to allow for comparison of results within and between villages, and to provide consistency when being used by multiple interviewers; yet, their semi-structured nature allowed the interviewer the flexibility when needed to follow new lines of questions.

Seventy-five interviews were conducted with expert male and elder fishers. As part of the study sought to document whether changes had occurred over time (e.g., fishing practices, marine resource conditions, beliefs and perceptions), a distinction was made between current (i.e., younger) and elder fishers. This distinction is based on both fishing methods and age. Elder fishers only fish from traditional canoes while younger generations may fish from traditional canoes and/or powerboats. Ages ranged from 20 to 65 for current fishers and 50 to 100 for elder fishers. The overlap in ages is a result of some elders being physically or mentally older than others, and because many do not know their exact age. Most of the elder fishers interviewed continue to fish, though not with the same intensity as their younger days. The goal was to have a minimum of ten expert fisher interviews and 5 elder fisher interviews per village. However, the guideline followed was that interviews could stop once answers became repetitive (Bunce et al., 2000). There was also an attempt to have equal representation of powerboat versus traditional canoe fishers as they use different methods, gears, and fishing locations.

Fishers were defined as experts according to their own communities; i.e., those with a local reputation as “great fishers” – usually based on their extensive fishing knowledge, abilities, and experience. Expert fishers interviewed had a minimum of 7 years’ experience (n=3), a maximum of 50 years’ experience (n=1), and an average of 21.3 years’ experience; elder fishers had a minimum of 27 years’ experience (n = 1), a maximum of 90 years’ experience (n=1), and an average of 55.4 years’

experience. Experts were initially identified during the preliminary meetings in which a minimum of 20 fishermen and ten community members per village participated; it also became clear during fieldwork that expert fishers are well-known throughout their villages and are quickly identified by community members. Interview participants were thus selected using a snowball sampling technique whereby both communities and fishers identified local experts. Reliable and well-respected local informants assisted in locating fishers within the village.

Interview questions for expert fishers focused on local fisheries knowledge (e.g., fishing techniques, customary beliefs, fishing effort and gear, marine species and habitats) and transmission of this knowledge among fishers from the same community and between generations of fishers. They were also asked questions pertaining to markets, livelihoods and changes in fisheries resource conditions over time. Elder fishers were interviewed on traditional fisheries knowledge, customary beliefs, knowledge distribution, and changes in fishing practices. There was some overlap in questions between expert and elder fishers to verify responses and to note whether differences in perspectives existed between the different generations. Interview times ranged from 30 minutes to 1.5 hours.

3.4. Focus Group Discussion

Fourteen focus group discussions were conducted, including the preliminary meetings. Preliminary results from the key informant interviews were used to guide discussion questions for focus groups; this allowed certain issues to be explored in greater depth, to cross-check information, and to gather additional information. As key informant interviews were comprehensive in their coverage of topics, focus group discussions were kept relatively informal and were tailored to each village. Six to eight key fishing leaders; i.e., experts, elders, and management committee members, were invited to participate in the discussions. Topics included clarification and confirmation of information, ideas and solutions on specific issues, and lists of target species specific to each traditional fishing ground. The discussions lasted from 1 – 2 hours. Short group interviews with fish vendors also took place in each study site to gather information on fisheries pathways; e.g., where fish is sold and why, and for how much.

3.5. Fishing Grounds Mapping

Maps of traditional fishing areas were made for each village. A local fishing expert was hired in each village and asked to navigate the perimeter of each fishing ground while GPS points were taken

every 10 – 20 seconds. The fisher was asked to list the target species in each zone, the water depth, and the landmarks used to identify boundaries. Published maps showing a rough outline of the island's features, including reef area, were used with ground truthing points to create a map of the study area (Figure 2) and maps of traditional fishing grounds for each study site (Figure 4). Fishing grounds for powerboats were not documented as they simply encompass the open waters far offshore.

3.6. Participant Observation

To better understand local fishing practices, six fishing trips were made with expert fishers. The trips proved to be extremely useful as a means situate results from the study and to gain insight into the issues and descriptions that emerged from the interviews.

4. Results and Discussion

Results were analyzed using a mix of content, discourse, and narrative analysis and have been organized according to the main themes which emerged from analysis. Although sample sizes are too small to be statistically accurate, given the extensive experience and expertise of those interviewed (section 3.3), the results provide important insight into fishing practices and trends based on fishers' local and traditional fisheries knowledge.

4.1. Local and traditional fisheries knowledge

Understanding the local knowledge base in a fishing community is crucial; not only does it provide critical information on the natural environment, but it also provides insight into fisher decision-making patterns. Fishers' understanding of how the marine environment works will profoundly influence how, why, and where they harvest resources. In the Comoros, local and traditional fisheries knowledge is paramount to a fishers' existence. It is the lens through which a fisher understands the world and is pivotal to his or her success as a fisher. The local knowledge of marine species, fishing grounds, seasonal cycles, and weather patterns act in lieu of technologically advanced gear. Fishers' knowledge base also works alongside local cultural beliefs and traditions to govern their behavior.

Coastal fishing communities in the Comoros are highly interconnected and dependent on fishing. Fisheries knowledge is therefore widely shared among community members. Knowledge transmission begins informally at an early age, often via the direct exposure of living in a fishing village. It is very common, for instance, for young children to imitate their older siblings or parents by fishing off

the coast with a handline. Children also demonstrate surprisingly extensive knowledge of local folk taxonomy of fish species. Formal knowledge transfer of aspiring fishers begins during teenage or young adult years. Knowledge transmission on Ngazidja is not as formally structured as those described in other societies (e.g., Ohmagari & Berkes, 1997; Ruddle, 1994), but young fishers generally learn to fish via similar mechanisms where the emphasis is placed on learning-by-doing.

Most young fishers learn to fish by accompanying an experienced fisher to sea, often a family member (e.g., father or uncle) or an expert fishing elder from their village. In contrast to the fisherwomen's sector which transmits knowledge and skills more informally (Hauzer, 2011), male fishers on Ngazidja participate in semi-formal apprenticeships that can last from weeks to months. Traditionally, a novice fisher will learn to fish by sitting at the back of an outrigger canoe and learning through observation and instruction. The experienced fisher passes on his knowledge and skill regarding fishing and navigation techniques - including the craftsmanship of traditional gear and canoes, marine species and habitats, weather conditions, and the geography of local fishing grounds. It is through this daily repetition of observation, instruction, and practice that young fishers grasp the skills they need. Once they have acquired satisfactory knowledge and skill levels, they gradually begin to fish on their own until their mentor feels they are ready. Today, some young fishers move on to fish from motorized boats, while others will remain in canoes, or use both. As they continue to fish on their own, their knowledge is enhanced through their own observations and experience, and by sharing information with their peers. If fishers encounter difficulties or have questions, they will often discuss with other fishers or seek expert or elder fishers for answers. Experienced fishers act as mentors for other fishers and occasionally hold gatherings to teach certain skills or share knowledge and experiences. Thus, there is a strong intra-community support network among fishers which helps to continually verify and adapt local knowledge, and simultaneously reinforces feelings of solidarity among fishers.

Fishers' knowledge on Ngazidja is extensive, ranging from fish behaviour (e.g., feeding, reproduction, migration, and aggregation patterns) to detailed folk taxonomy, including different names for species according to their different life stages and taxonomic groups (e.g., sharks, tunas), to knowledge of the marine physical environment (e.g., seabed topography, weather and associated sea conditions, seasonal patterns, and lunar and tidal cycles). Fishers' knowledge on Ngazidja is primarily founded in practical and empirical information (e.g., specialized fishing techniques and species knowledge), though astronomy (i.e., observations of the night sky) is also used to predict changes in weather patterns and seasons. Even though this knowledge is broadly shared among fishers, the depth

of each fisher's knowledge base is not uniform - often attributable to both personal experience and whether they had been taught by reputable, experienced fishers. This distinction was made clear by fishers during interviews, and was also made apparent through responses to questions concerning how fishers had acquired certain information or skills. In any case, a fisher's knowledge is essential for productive fishing. Knowledge of fish habitat and movement patterns, for instance, is used to judge the time, method, and location required to catch certain species. Thus, it is widely agreed among fishers that the more knowledgeable the fisher, the more successful his catches and the safer he remains at sea.

4.2. Customary Belief Systems

Traditional beliefs and practices related to fishing are still used on Ngazidja, but are gradually being replaced by Islam. Local history has it that Islam was first introduced to the Comoros in 650 A.D. (Ottenheimer & Ottenheimer, 1994), though Islam did not really take hold until the 13th century (Union of the Comoros, 2005), and it is only really during the past 20 years that a more orthodox adherence to Islam has spread among the wider population. According to local communities, this is because young Comorians were given an increasing number of opportunities to study abroad in Islamic regions (e.g., Sudan, Saudi-Arabia, Pakistan) from which they returned with a different interpretation of their religion, and brought these interpretations home to their communities. Prior to this contact, the majority of communities in the Comoros practiced a much milder form of their faith intermingled with traditional shamanistic and animist beliefs (Union of the Comoros, 2005). By contrast, this newer, more orthodox, Islamic philosophy prohibits traditional practices and beliefs. Even though most of those interviewed did not hold particularly strong positions against customary beliefs or practices, fishers who seek the assistance of a shaman today will often do so in hiding for fear of being labeled a non-believer. That said, traditional practices and beliefs in Comorian culture run deep, and thus continue to coexist with those of Islam (Union of the Comoros, 2005). As described by Chanfi, Le Guennec-Coppens & Mery (2002), while the local culture in Comorian society has been strongly influenced by Islam, the local Islam owes much of its development to local culture.

Whether it be shamanism or Islam, fishermen on Ngazidja often seek help and protection from greater spiritual powers. Islam is a central facet in Comorian life and it is common practice to incorporate religious aspects into one's occupation. Islamic rituals related to fishing involve reading the Koran and reciting prayers; e.g., to ask Allah to sustain catch numbers, to keep the sea calm, or to

provide protection against evil spirits found at sea. A typical Islamic ritual involves a spiritual leader reciting verses from the Koran and then blowing onto the fisher as a symbol that the spoken words have now entered into his body and spirit. Fishers also pray to Allah specifically to avoid what they call *ditso*. *Ditso* refers to "the evil eye", a superstitious phenomenon apparent in many cultures and religions (Dundes, 1992). Fishers claim that *ditso* occurs when one has caught a large quantity of fish and a bystander casts their 'evil eye' upon the fisher; i.e., a look of envy and/or disdain which can lead to troubles, illnesses, and even death. This fear of *ditso* is largely responsible for the cultural taboo against greed and wastage which serves to keep fishers' catch numbers in check.

Customary spiritual beliefs and practices are similar to the intentions of Islam, but are far more elaborate and take on many forms. Customary rituals are often undertaken to keep fishers safe at sea, to bless and protect new fishing boats and fishers, and to "call the fish to come", as said by an elder fisher from Hantsambou. Each village on the island has an experienced shaman, some of whom have such great reputations that Comorians will travel from other islands to consult with them. Traditional rites can involve entire villages, a group of fishers, or individuals and/or their families. Village-wide ceremonies with food, drumming, dancing, and gifts to incite and appease spirits were once common, though are becoming increasingly rare since the wider-adoption of Islam. Some examples of shamanistic rituals related to fishing are:

- *Written or spoken incantations*: a shaman writes or speaks incantations onto a piece of tree bark, cow hide, coconut, or a fishing weight. The fisher takes this with him to sea and when he is located underneath a specific star, he attaches it to his boat. Incantations may also be written with coal or sand onto a blackboard. Once completed, the shaman will pour water over the blackboard and funnel it into a vial. The vial is then taken by the fisher to sea and the water is thrown into the ocean.

- *Tam-tam*: a community ceremony involving singing, drumming, and dancing, and where the village prepares food as offering for the spirits. These may last from one to seven days.

- *Masadaka*: traditional foods are prepared and different cloths and objects of the same color (white, red, or black) are laid out in the fisher's home. The shaman will recite incantations while the fisher touches each of the objects.

The above examples are only a small fraction of the rich traditional ceremonies and rituals which exist in Comorian culture - both for fishing and other aspects of life. These practices and beliefs, however, are slowly being eroded by modernization and changes in belief systems - particularly on the island of

Ngazidja. Nevertheless, both Islamic and customary beliefs and practices continue to be incorporated into the daily lives and fishing activities of male fishers.

4.3. Fishing Gear and Methods

Fishermen on Ngazidja fish by traditional outrigger canoes and motorized boats (Table 2). Some also fish by foot at low tide, though this is more common among women and children. Traditional canoes tend to stick to inshore waters (~200m) and target reef fishes and coastal pelagics, while motorized boats travel farther offshore and target oceanic pelagic species. There is generally one fisher per canoe and two fishers per motorized boat. Some fishers use both canoes and motorized boats – either seasonally, since inshore versus offshore species abundance varies, or they use powerboats during the day and canoes at night. Fishers with the economic means may purchase their own motorized boat, but most lease from boat owners in return for a substantial portion of their catch (Section 4.5.2). On Ngazidja, it is equally common for women to be boat owners as it is for men.

Table 2 - Gear characteristics in study sites

	Traditional	Modern	Foot
Boat Specifications	Single-outrigger canoes, 3-5m, hand paddled	Motorized boats, 5-7m, 15-40HP	n/a
Gear	Handlines, spear guns, spears, wooden or iron traps	Handlines	Wooden or iron spears, handlines
Bait	Live and fresh dead bait, plastic baits	Live and fresh dead bait, plastic baits	n/a
Sinkers	Rocks, lead chunks	n/a	n/a
Target species	Reef fish, coastal pelagics, crustaceans, cephalopods	Oceanic pelagics, sometimes deep sea fish (200m)	Juvenile reef fish, cephalopods, bivalves, gastropods

A variety of traditional gears are used for fishing (Table 2), all of which are highly selective in terms of size and species composition. Many fishers still craft their own spears, gaffs, sinkers, and traps, but the relative ease of acquiring modern fishing line and hooks means that few fishers continue to make their own[6]. The most common gear type used by fishers in the study sites are monofilament handlines. Handlines are used by traditional canoe fishers to target deep water reef species or to troll for coastal pelagics. As fishing gear is rudimentary, fishers have developed highly skilled and unique fishing methods. For example, canoe fishers troll by trailing the fishing line over their ear or around their big toe while they paddle so that they will feel the tug of a fish when it bites. Instead of using fixed

[6] See Stobbs & Burton (1991) for a rich and detailed account of Comorian fishing gear craftsmanship

sinkers, the line, hook, and bait are wrapped multiple times around two fist-sized rocks and lightly secured; when the line reaches the desired depth (up to 300m), a quick jerk frees it from the rocks and the tackle remains at depth. Many variations on bait also exist, e.g., baiting a sardine through the eyes so that it remains alive and swims behind the canoe, or cutting up fish (e.g., skipjack tuna) and placing it inside a small woven basket attached to the canoe's outrigger so that small bits drift out and attract fish. Powerboat fishers, on the other hand, tend to use simpler techniques and target fewer species. A high skill set, however, is still required as apart from having a motor, fishers' gear greatly limits how much they can catch. Powerboat fishers commonly fish by trolling a handline with 1 – 3 hooks. As they target oceanic pelagics, they often locate fish by looking for birds, following currents, or simply trolling until they find fish. If fishers are having little success in capturing pelagics, they may rotate between stationary deep-water fishing and trolling.

4.3.1.Night fishing

Night fishing is common in the Comoros and only done via traditional canoe. Night fishing grounds and techniques are much more species-specific than during the day, and fewer species tend to be targeted at night. Species found at night are often categorized between those that may be caught during full moon and those during no moon. Some fishers use lanterns during periods of no moon, though this technique has been banned by a number of villages on the island for fear that it is too effective at catching fish. Those who fish with spears dive with an underwater flashlight and mask, and target fish and lobster. Most night fishers, however, use handlines, and Ngazidja fishers are particularly well-known for their deep-water nighttime handline fishing – a technique, according to Stobbs and Bruton (1991), that is practiced nowhere else in the Indian Ocean. One specific method called *Mazé* is used to capture the oilfish (*Ruvettus pretiosus*, locally known as *Nessa*) found at 300m depths. It is likely while fishing for this species that Comorian fishers first caught the coelacanth as it is located at similar depths (Stobbs & Bruton, 1991).

4.3.2.Fishing Grounds

Coastal fishing communities all have a number of local fishing areas adjacent to their shorelines that coincide with habitats for certain species. Fishers are intimately connected to their village's fishing grounds and know the underwater terrain as well as their own backyard; e.g., habitat locations of specific species, water depth, and seabed topography. Each fishing ground is identified according to landmarks on the island (e.g., specific coconut trees) and distance from the island (e.g., when two hills

on the horizon merge to become one at a certain distance). All fishing grounds adhere to the land boundaries of each village. Maps of these traditional fishing grounds were produced for each of the study sites (Figure 4) and provide insight into fisher distribution and activity patterns.

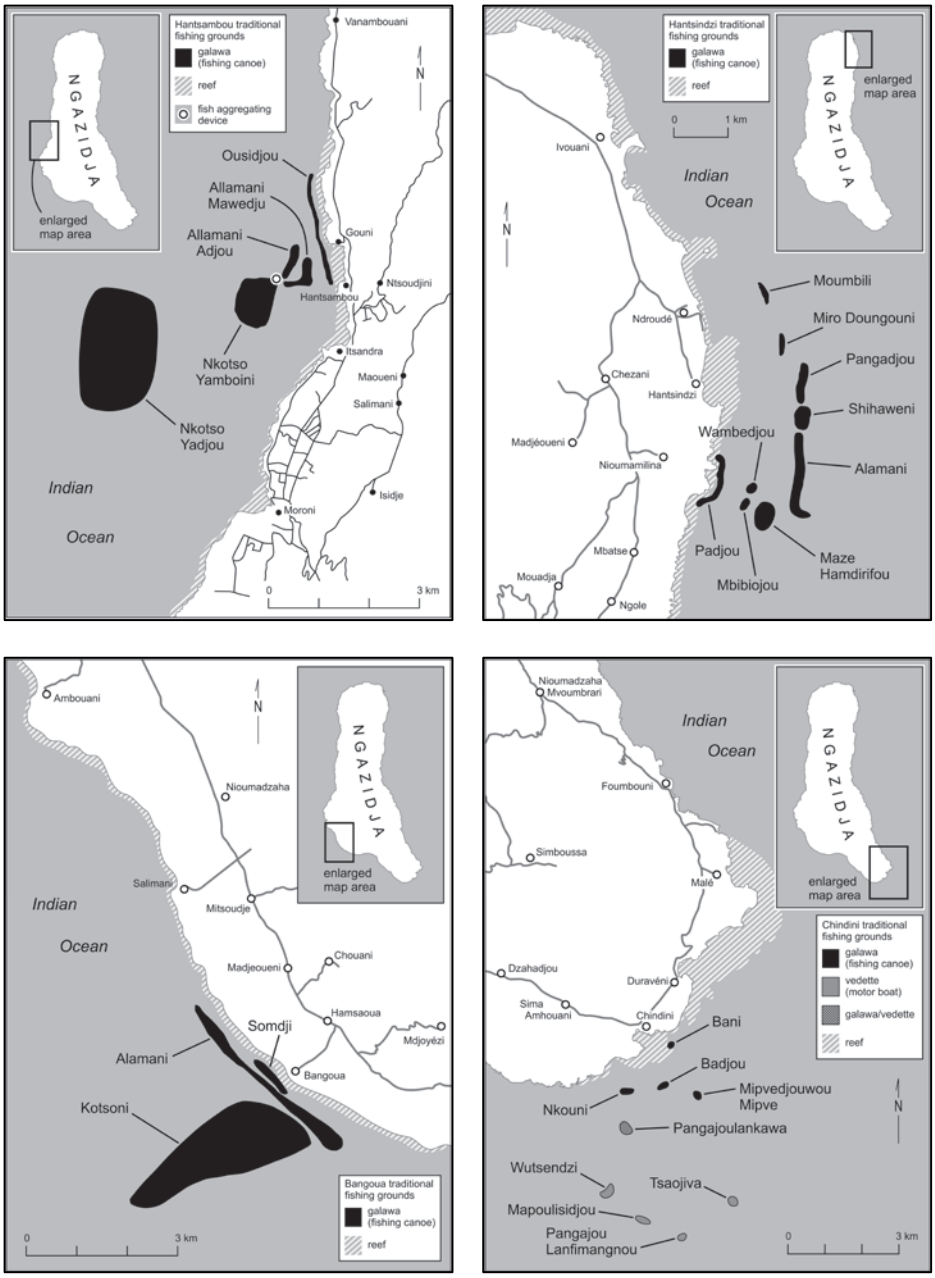

Figure 4 - Maps of the traditional fishing grounds of canoe fishers: Hantsambou (top left), Hantsindzi (top right), Bangoua (bottom left), and Chindini (bottom right). Powerboat fishing areas extend offshore from the last marked boundaries of the traditional canoe fishing areas.

4.4. Fishing Effort

4.4.1.Daily and seasonal fishing patterns

Most of the fishers interviewed fish fulltime: 6 – 7 days a week and between 9 – 10 hours a day (though fishing hours ranged from 4 – 17 hours/day). Canoe fishers tend to be at sea for one hour longer than powerboats. Most fishers depart at 6am for the day, while some – mostly canoe fishers – will fish again at night or alternate between days and nights.

There are three main seasons recognized by fishers in the Comoros: *Hasihazi* (Nov – Apr), *Husi* (May – Aug), and *Mbeni* (Sept – Oct). *Hasihazi* is characterized by heavy rains and weak and variable winds. *Husi* is a dry season, with strong winds and rough seas. *Mbeni* is a transitional season, when the seas begin to calm and the winds subside. While weather and wind patterns differ slightly on the east and west coasts of Ngazidja, *Hasihazi* is generally the best season for fishing for both traditional canoes and motorized boats as the seas are calm and there is an abundance of large pelagic species. Fishing during *Husi* is poor for powerboats due to the strong winds and rough seas, though navigable for traditional canoes that can stick to inshore waters. During *Mbeni*, fishing begins to pick-up for powerboat fishers and dwindles for canoe fishers. As such, those that rotate between boat types will often do so in terms of the seasonal abundance of different species and weather patterns. Fishers that only use one vessel type primarily fish for eight months of the year, six of which are during the most productive *Hasihazi* season.

4.4.2.Catch rates

Fishers were asked to estimate their average catch per day or per season – depending on whether they experienced seasonal fluctuations in catch numbers. Responses that were provided per fish unit (i.e., quantity of fish caught), were calculated into weight (kg) based on an estimated per unit fish weight provided by the fisher. Catch rates per traditional canoe (with one fisher on board) ranged from 4.5kg/day to 80kg/day, and averaged at 22kg/day. Seasonal variation was less prominent with traditional canoes as they tend to stick to inshore waters and target reef species. Nevertheless, responses confirmed that catch numbers during *Mbeni* were half of those during *Hasihazi* and *Husi*. Catch rates per powerboat (with two fishers on board) ranged from 30kg/day to 300kg/day, and averaged at 110kg/day. The average catch per day was 120kg during *Hasihazi*, 80kg during *Husi*, and 100kg during *Mbeni*. Powerboat fishers catch composition consisted primarily of six commonly caught

and preferred oceanic pelagic species while canoe fishers listed 15 commonly caught and preferred reef species. Only species considered inedible (i.e., poisonous) are discarded.

4.5. Markets and Livelihoods

Fisheries are one of the most vulnerable and impoverished livelihoods in the Comoros. While some households subsist solely from fishing, it is often carried out in conjunction with agricultural activities (Union of the Comoros, 2005; Meyer et al., 2006) in order for families to meet their economic and subsistence needs. According to the FAO (2007), in many lower-income countries where the main staples consist of foods such as rice, maize, and cassava, fish provides essential nutrients in an otherwise poor diet. Likewise, fish continues to be the main source of protein for the majority of families in the Comoros, as other meat sources are more difficult to obtain and more expensive. In the concurrent study conducted with female fishers, it was found that most families in coastal villages consume seafood 2 - 3 meals a day, 7 days a week (Hauzer, 2011).

4.5.1.Markets

Large fishing villages on Ngazidja sell the majority of their fish in one of two street markets located in the capital city, Moroni, or in neighbouring non-coastal villages. As fishing in these study sites comprises the majority of the male employment sector, there is only a small local market for fish as fishers generally supply their family and friends with a portion of their catch. In smaller fishing communities, most of the fish is sold within the village and/or used for household subsistence. Fish prices generally fluctuate within a 50% margin depending on the season and/or abundance of certain species. Higher sale prices are usually found in Moroni where, on average, 1kg of fish is sold for ~2.65€[7]. For those fishers fortunate enough to obtain a contract as a lobster supplier with one of the few hotels or restaurants in Moroni, they may obtain ~5.82€/kg of lobster.

Fisheries in the Comoros are centred on small-scale, family-based activities with few resellers, enabling fishers to earn between 80% - 100% of the final retail price. By comparison, in developed countries fishers generally receive 20-25%, and in other developing countries, 30-40% (Lawson, 1984 in: Charles, 2001). Fishing is commonly a family practice whereby a fisher's wife or other female relative will sell the fish, though some will also sell to female vendors outside their family. Price is negotiated based

[7] By comparison, market costs of other commonly purchased items are: chicken wings = 2.03€/kg; beef = 2.85€ – 3.56€/kg; tomatoes = 1.02€ – 2.03€/kg

on weight (kg), size, species, or quantity of fish. A vendor generally makes 20% of the profits; e.g., a fisher will sell 1kg to a vendor for 2.12€ and the vendor will earn the subsequent 0.53€ per kilo.

4.5.2.Average Daily Income

Fishers' daily income and expenses are highly dependent on catch numbers and composition, seasons, market prices, and weather. Nevertheless, fishers were asked to provide an estimated daily average income to give an idea of how much they earn. It is important to bear in mind that most of those interviewed were experts, and thus, their wages and catch numbers (section 4.4.2) are likely higher than the average fisher. Powerboat fishers interviewed earned on average 62.71€/day; the minimum cited earning was 21.19€/day and the maximum was 211.86€/day. Average daily earnings for canoe fishers were similar at 53.67€/day, though the minimum cited earning was 5.29€/day and maximum was 211.86€/day. Fishers using both powerboats and canoes earned an average of 25€/day. Even though powerboat fishers have the capacity to catch much more than canoe fishers (section 4.4.2), they are also required to divide their catch in three parts: 1/3 is for the fuel, 1/3 is for the boat owner, and 1/3 is split between the two fishers. Nevertheless, of those interviewed, 83% stated they were satisfied with the amount earned from fishing. Many expressed how fishing enabled them to house and feed their families, and put their children through school. However, it is important to note that although profit margins and income can be high, catch rates can fluctuate significantly and fishing is only in abundance for about 6 months of the year. Thus, income from fishing is sporadic and unstable. In addition, it is customary in the Comoros for the head of a household to provide the main support for not only their own immediate family, but their extended family as well. As such, earnings can be spread quite thin.

4.5.3.*Expenses: Fuel, repairs, boats*

Powerboats use on average about 70L of combined fuel (kerosene, gasoline, and oil) per day which amounts to about 55€ – a cost which is typically deducted from the amount of fish caught each day (or at the end of each month) and shared between the two fishers and boat owner. Based on average catch numbers for motorized boats (section 4.4.2), fishers catch 1.57kg of fish per litre of fuel - however, this ranges from 0.43kg - 4.28kg per litre of fuel. To put this within a global context, annual estimates for small-scale versus industrial- fisheries fuel oil consumption are 5 million tonnes of fuel per 4 - 8 tonnes caught and 37 million tonnes of fuel per 1 - 2 tonnes caught, respectively (Jacquet & Pauly, 2008).

The cost of maintenance and repairs per powerboat is around 300€/year, though costs were reported as low as 50€/year to as high as 1,225€/year, depending on the severity of the repairs. These costs are commonly born by the boat owner, though may also be shared between both fishers and the boat owner. The maintenance expenses for traditional canoes are much less as there are no fuel costs or motor repairs. Instead, their major expense is the initial investment. Fishers generally buy the wood and build the canoe themselves or have it built, which can take between 2 weeks to 3 months (see Stobbs, 1991, for detailed descriptions of Comorian *galawas*). If a fisher is unable to build the canoe himself, the average cost per boat is generally 115€ which includes the purchase of the tree and the labour costs. Depending on the quality of wood and maintenance, *galawa*s can last from 2 - 10 years.

4.6. Changes in the abundance, composition, and location of harvested species

To gain insight into the current status of fisheries resources, fishers were asked whether they had observed any changes in the quantity, size, species composition, or location of fish caught. They were asked to provide an estimated timeframe for when they first noticed these changes occurring, ideas for the possible causes behind the changes, and solutions when declines were noticed. Fishers were asked to comment specifically on their own personal experiences; however, as they work alongside other fishers every day, their perceptions are also likely influenced by observations of catch landings within their village.

Results on changes in catch abundance, fish size, species composition, and location are presented per fisher group (Figure 5). Reponses from elders (who only fish from traditional outrigger canoes) have been grouped separately to draw out any temporal changes or changes related to shifts in fishing gear and practices. Differences between study sites are noted when significant. Timeframes of observed changes were grouped into ranges of 1 – 10 years, 11 – 20 years, 21 – 30 years, and >31 years. For current fishers, the majority of changes were observed within the 1 – 10 year range and responses occurred in a downward cascading sequence (e.g., 50% of fishers noted changes in the 1 – 10 year range, 40% in the 11 – 20 year range, etc.) – regardless of whether they had noticed increases or decreases in fisheries. Responses from elders, on the other hand, were clumped primarily into the 11 – 20 year range, with up to 33% of their responses falling into the >31 year range. This is likely reflective of the different career lengths of the user groups. It is also interesting to note that ~17% of respondents specifically mentioned “the arrival of powerboats” as the time for when they began to notice declines in catches. For some fishers, this marked the onset of when fisheries resources began to change. For

others, it was simply a landmark time in their career history; i.e., before and after modernization, and was used as their main reference point.

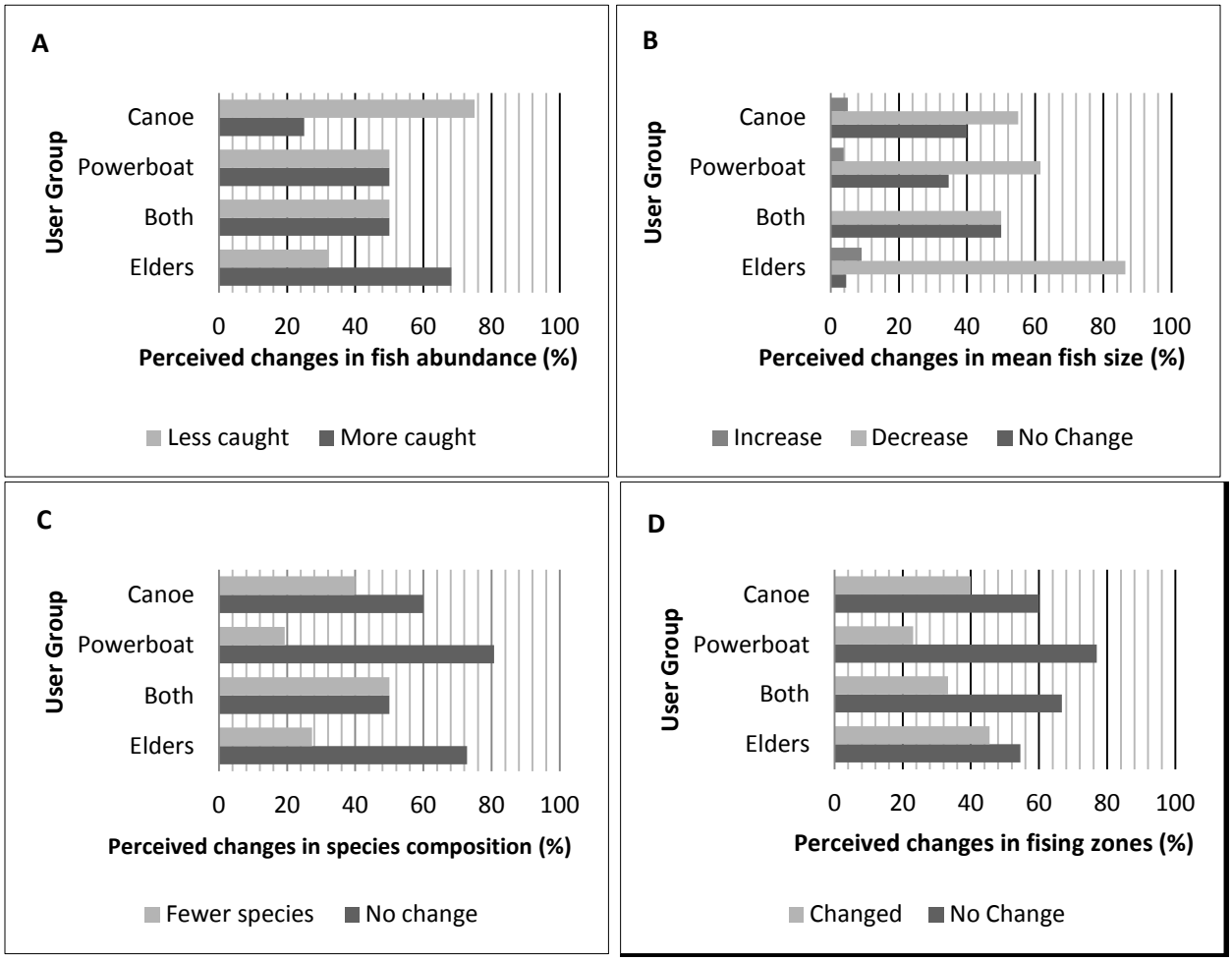

Figure 5 - Expert fishers' observations of changes in resource conditions
Results showing expert fishers' observations of changes in mean fish size (A), fish abundance (B), catch composition (C), and fishing zones (D). Results are categorized into user groups according to fishers who use traditional outrigger canoes (n = 20), powerboats (n = 26), both canoes and powerboats (n = 6), and elder fishers (n = 22) - all of whom use traditional canoes.

4.6.1.*Changes in fish abundance*

Responses regarding changes in the quantity of fish caught diverge relatively equally between those who claim there has been an increase in the amount caught and those who claim there has been a decrease (Figure 5, Panel A). Conflicting responses among user groups do not necessarily indicate poor observations; they are more likely a result of variances in individual experiences and perceptions. They also provide important insight into trends which may be occurring in different fishing zones and with different user groups. For example, elder fishers have a much longer timeframe from which to draw

reference and therefore, within their lifetime, have witnessed an increase in catch landings as the sector became mechanized by powerboats with a greater capacity for catching larger quantities of fish. By contrast, results from the majority of canoe fishers who experienced decreased catch rates may indicate declines in fish abundance in coastal areas as canoe fishers tend to stick to inland waters. This analysis is also supported by inter-village results where overall, fishers in Hantsambou (63%) and Hantsindzi (61%) – villages with a greater reef area and number of traditional canoe fishers - noticed more significant declines in catch abundance than Chindini (43%) and Bangoua (37%).

4.6.2.Changes in the mean size of fish caught

The majority of fishers interviewed observed a decrease in the mean size of fish caught, though a significant portion also stated that fish size has not changed (Figure 5, panel B). Proportionally more elders noted a decrease in the size of fish which may provide greater evidence of decline since elders have a longer time reference than current fishers. However, this could also be the result of changing fishing practices which have shifted pressure to smaller species. Similar to the results on fish abundance, fishers in Hantsambou and Hantsindzi observed much greater decreases in fish size than Bangoua or Chindini; i.e., 50% of fishers in Bangoua and 57% in Chindini noted that fish size has decreased, while 68% in Hantsambou and 89% in Hantsindzi noted a decrease.

4.6.3.Changes in species composition

The majority of fishers (70%) interviewed had not observed any changes in the species composition of their catches (Figure 5, panel C). Nevertheless, the remaining 30% of fishers who have observed decreases in catch diversity should not be overlooked. Apart from Chindini, where no fisher interviewed had observed any changes, 31% of fishers interviewed in Bangoua, 32% in Hantsambou, and 61% in Hantsinzdi had experienced a decrease in catch diversity. Notably, a total of 23 fish species were listed as either having become rare or disappeared. This homogenization of catch composition could be due to changes in fishing methods and target species, or actual declines in diversity.

4.6.4.Changes in fishing zones

Most fishers have not experienced changes in fishing locations; i.e., the areas where they commonly find fish (Figure 5, panel D), but those who have experienced changes, specifically noted a decrease in fish abundance in coastal waters. These fishers were required to either shift fishing zones or fish for longer hours. These results correlate with responses regarding the decrease in fish abundance

noted by canoe fishers (Figure 5, panel A). These findings are not altogether surprising as prime fishing grounds such as reefs are especially vulnerable to fishing pressure because they are easy to find and host a variety of harvestable species.

4.6.5.Summary of current fisheries trends

According to results, it appears that the most common trends are, 1) a decrease in mean fish size, 2) a decrease in fish abundance in coastal waters, and 3) a decrease in catch composition diversity – all of which may be an indication of overfishing and/or serial depletion. These results correspond with responses from a concurrent study in Chindini and Hantsindzi where 88% of the fisherwomen interviewed noted significant declines in species abundance, diversity, and habitat in coastal areas (Hauzer, 2011). Moreover, the higher percentage of declines in fish size and abundance observed in Hantsambou and Hantsindzi provide further evidence for the trend in coastal declines as the two villages have a more significant reef area and a greater number of traditional canoe fishers (Table 1), resulting in a larger portion of fishers more apt to be affected by declines in nearshore species. As fishers' observations and experiences vary considerably, both within and between fisher groups, it would be easy to attribute the changes in catch composition (particularly perceived declines) to the recent shift in fishing practices. However, although this shift may account for observations of motorized vessels landing relatively homogenous catches of smaller, pelagic fish; it does not account for the female and traditional canoe fishers who have experienced declines in catch abundance and composition.

The risk in assuming that declines are simply attributed to changes in fishing practices, or to the misperceptions of those opposed to modernization, is that accounts of earlier abundance are undermined as anecdotal, mythical, or simply exaggerated, when in fact, they represent a time when little effort brought in large catches, bigger fish, and more species (Pauly, 1995; Pitcher, 2001). This perception is a result of what Pauly (1995) calls the 'shifting baseline syndrome'. This syndrome is a result of each generation of fishers (or scientists, or resource managers) adopting new baselines for appropriate stock abundance and composition based on that which was the norm at the beginning of their career. Changes are thus evaluated against what is perceived to be the baseline in accordance with that generation. However, with each new generation, new baselines are created. The result is a gradual shift in baselines, a steady decline in species, and false reference points for assessing change. Although the shifting baseline syndrome may not yet be symptomatic of Ngazidja fishers, as elder fishers pass on

and fewer youth spend time being trained by experienced fishers and elders, this knowledge may begin to erode with each new generation.

4.7. Reasons for changes in resources

Fishers' perceptions of the possible reasons for the changes in catch abundance, composition, and location are presented in Table 3 and Table 4. Apart from elder fishers whose responses are shown separately, no significant difference exists between fishers of different boat types. Those fishers who noted positive changes in the fishing sector, i.e., increases in catch numbers, attribute these changes primarily to improvements in gear technology and experience (Table 3). Ironically, many of the reasons provided for declines in fisheries resources (Table 4) are also linked to modernization. Fishers' suggestions for possible solutions to the declines are also provided (Table 5).

Table 3 - Reasons attributed to the increase in catch numbers

Reason	Expert Fishers (%)	Elder Fishers (%)*
1 More efficient technology	53	73
2 More fish in the sea	28	11
3 More experience fishing	11	0
4 More fishers = more catch	8	16

*The % is derived from total number of reasons stated for increase. Experts: n=36 ; Elders: n=19. Those who responded "I don't know" are not included.

1. There has been an increase in motorized boats, access to fuel, and better equipment. Fishers are able to go farther, catch greater quantities, and carry more and larger fish than previously. This has also led to a shift in target species and fishing zones.
2. Fishers attributed the perceived increase in the quantity of fish at sea to the fact that the number of fishers has increased, yet they are still catching large quantities of fish; therefore, there must be more fish.
3. Individual fishers noted that their catch numbers have increased as they are now more experienced and knowledgeable fishers.
4. There has been an increase in fishing vessels and fishers which has resulted in an overall increase in the amount caught.

Table 4 - Reasons attributed to the decline in catch abundance, fish size, species composition, and fishing locations

Reason for declines	Expert Fishers (%)	Elder Fishers (%)*	Explanations
1 Overfishing	31	18	The arrival of powerboats has led to an increase in fishers and fishing pressure. Fishers do not allow fish to mature; instead they catch them while they are juveniles. In some regions, the disappearance of certain species (e.g., sardines) has meant a disruption of the entire food chain and caused larger fish to also disappear.
2 Motorized boats	23	52	Motorized boats scare the fish away, particularly juvenile fish from coastal areas, which in turn results in the larger fish losing their food source and no longer coming near the coast to feed.
3 Environmental degradation	21	4	a) Destructive gear (i.e., gillnets, spearguns, dynamite, and fishing with a lantern at night) used by neighbouring communities degrades fish habitat and/or takes large quantities of juvenile fish; i.e., non-selective gear. b) Environmental degradation; e.g., pollution from household waste and garbage being dumped into the ocean kills fish and degrades coral reefs and fish habitat. c) Fishers in Hantsindzi remarked that the use of kerosene, which is mixed with oil, as boat fuel has led to a decline in juvenile fish and seagrass species in the bay where boats are moored. Fishers claim that the evaporation speed of this fuel is much slower than gasoline.
4 Limited technology of traditional fishers	11	4	Traditional fishers remarked that those using motorized boats are better equipped to go farther out to sea where they are able to catch greater quantities of fish. Older fishers have less strength and stamina to fish the same quantities as before, and their gear restricts them to using methods which require much strength.
5 Religious and other observations	9	13	This category represents responses which associate resource declines to God's will or observations about environmental changes (e.g., there is less rain now, there has been an increase in water levels, and a large fish is consuming all the smaller fish).
6 Foreign boats	5	0	The decline in fish is related to foreign boats fishing in Comorian waters with large nets.
7 Youth are less knowledgeable	0	9	Elders believe that there is less specialization among fishers today. There are no longer any experts and youth are less knowledgeable about what, where, and how to fish. Some do not know which fish to keep or release and therefore take too many juveniles.

* The % is derived from total number of reasons stated for fisheries declines. Experts: n=59; Elders: n=23. Those who responded "I don't know" or "there are no solutions" are not included.

It is evident from the results presented in Tables 3 and 4 that the gradual mechanization of the fisheries sector has left fishers with mixed views of the overall merits of modernization. Some perceive it to be the main driver for fisheries declines, while others attribute it to an improvement in fishing and livelihoods. Either way, the modernization and mechanization of the fishing sector seem to be the root of greatest concern for fishers, particularly regarding the impacts on local ecosystems. Historical trends for global fisheries show how biodiversity and stock abundance fell as fisheries moved from simple gears such as handlines, traps, and spears to more sophisticated gears such as seine and drift nets (Pitcher, 2001). Thus, advancements in gear technology were always paired by subsequent declines in marine resources. On Ngazidja, as fishing is only used for domestic markets and subsistence, hypothetically, the increased efficiency of fishing (e.g., outboard motors, larger vessels) and the shift away from nearshore benthic species to offshore pelagic fish would result in a reduction in fishing effort and reduced pressure on inshore habitats. This may very well be the case, however, the widespread use of powerboats is only very recent (i.e., last 10 years), and so, if reef stocks and habitats were previously degraded due to fishing pressure, they will take time to regenerate. It is also interesting to note that many fishers expressed concerns that factors such as waste, pollution, and destructive fishing techniques are also contributing to declines. Fishers' suggested solutions in response to these issues are listed in Table 5. Not only do these solutions provide an excellent starting point for elaborating effective management strategies, but they also provide important insight into fishers' perceptions of their own ability to reverse or manage resource declines.

Table 5 - Fishers' suggested solutions to the observed declines

Reasons for declines	Solutions
1 Overfishing	▪ Ban destructive fishing techniques used in other villages; e.g., gillnets, dynamite, spearguns ▪ Impose zoning restrictions, size restrictions, species restrictions, or seasonal / temporary closures to allow stocks and habitats to regenerate ▪ Increase the number of FAD's (fish aggregating devices) to attract fish and reduce pressure on reef habitats ▪ Reduce boat numbers or designate days when only certain boats are allowed to fish ▪ Build storage facilities (e.g., freezers). This will reduce spoilage and overfishing as fishers will not be required to fish as much each day. Also, during temporary/seasonal closures there would still be fish to eat.
2 Motorized boats	Implement FAD's (to reduce motor use), impose zoning restrictions, reduce boat numbers
3 Environmental degradation	▪ Environmental monitoring and protection ▪ Use gasoline rather than kerosene engines ▪ Use of chemicals in agricultural plantations needs to stop. During the rainy season these chemicals are drained into the sea and degrade intertidal habitats ▪ Community awareness-raising to reduce the amount of waste and pollutants being disposed into the sea
4 Limited technology of traditional fishers	Training in new techniques to increase fishing efficiency, provision of modern gear, installation of FAD's
5 Religious and other observations	There are no solutions. It is God's will.
6 Foreign boats	The government must stop foreign vessels from fishing in Comorian waters; they use large nets that take all the fish.
7 Youth are less knowledgeable	Train powerboat fishers in techniques other than trolling

4.8. The implications of change in values, practices, knowledge, and beliefs

This trend of modernization and shifting belief systems is common throughout coastal communities in many parts of the globe (e.g., Hickey, 2007; Ruddle, 1994, 1998; McClanahan, Glaesel, Rubens, & Kiambo, 1997). Changes in societal values and ways of doing things are inevitable, particularly as isolated societies gain increasing contact with a more modern 'outside world'. For most communities, this exposure brings changes not only in fishing methods and equipment, but also in values and belief systems. For this study, change in beliefs and practices was explored to provide greater insight into the potential current and future effects this could have on fishers' harvesting methods and attitudes towards fishing, thereby affecting the use and condition of marine resources. Evidence from some case-studies shows how the erosion of traditional practices can lead to declines in marine resources as a result of increased harvesting pressure and unsustainable new technologies or practices (e.g., Hickey,

2007; Kalikoski & Vasconcellos, 1997; Ruddle, 1994, 1996, 1998). Elder fishers were interviewed regarding their perceptions of whether and how changes in the fishing sector have been occurring over their lifetime; this included changes in fishing methods and equipment, local knowledge, and traditional belief systems. Questions for younger, expert fishers focused on traditional and Islamic belief systems, though responses for other questions also reveal shifts in value and belief systems. Results show that changes in fishing practices and traditional knowledge have begun to occur only recently (i.e., over the past couple generations), and these changes do not yet appear to be substantial, or having an overly negative impact on the status of marine resources. However, it is worth noting that the changes in practices and beliefs coincide within the same timeframe as declines in catch abundance and composition. Thus, even though overall resource declines are not drastic, there may be a link between the loss of traditional knowledge and practices and the degradation of marine resources.

The most noticeable changes in the fishing sector on Ngazidja are those in fishing equipment and techniques. Powerboats, 'modern' equipment, and newer techniques that target different species are common throughout the island. This modernization, albeit very minimal, seems to be having an overall positive impact on the livelihoods of fishers and those living in coastal communities; e.g., increased village infrastructure, fishing equipment, and economic development. However, many elders expressed concerns about the simultaneous loss of traditional knowledge and skills, and the recent decline in coastal species - both of which they attribute to the impacts of modernization. All but one elder stated without hesitation that fishers today possess far less traditional knowledge, technique, and seamanship than did those of previous generations. An elder from Hantsambou noted, "young fishers today only use power and speed. They have no knowledge or ability to think as the old fishers. They have not cultivated their mind for fishing. . .". Likewise, another elder from the same village remarked that young fishers today do not know how ". . . to entice a fish to come to them. Rather than using brute force, you must use patience, knowledge, and technique. In this way, you preserve your strength, equipment and expenses . . .". Thus, for the elders, not only do they perceive a loss in traditional knowledge and practices, but a change in attitudes towards fishing. As such, it is not simply the erosion of traditional practices and knowledge, but how this change in attitudes and values can alter how a fisher views his role within the marine environment. In many traditional communities, a group's local knowledge and beliefs shape their attitudes towards how resources are used and managed (Sherry & Myers, 2002).

The trend in traditional knowledge loss is not only apparent in the new fishing practices of youth today, but also in that fewer are choosing to become fishers. The majority (91%) of fishers interviewed had parents, uncles, older brothers, and/or grandparents who were fishers, demonstrating the highly-hereditary nature of their profession and the greater likelihood of knowledge transfer from one generation to the next (Berkes et al., 2001). By contrast, few of the expert fishers' children had become fishers and most expert fishers wished for their children to become educated and choose other lines of work. They believed that fishers in the Comoros endure too many hardships and their profession is not respected by the State or society, so many wished for their children to build a better life. Reasons given for why current fishers decided to become a fisher are starkly different from previous generations. The majority of elders became fishers as it was a livelihood they had inherited from their ancestors, i.e., they were born from a family line of fishers and it was "in their hearts" to become a fisher. Moreover, during that time, fishing was a highly respected and valued occupation. By contrast, many of the current fishers began fishing as a result of poverty, including limited access to school or the money to pay for it, and the need to support family members.

Most of the elders interviewed lament the loss of traditional knowledge and practices for cultural reasons, and believe that expertise in fishing no longer exists among younger generations. For instance, an elder from Hantsindzi said that knowledge transfer was important as "it is part of our heritage: it is important to know what our ancestors did. But even my own son does not want to learn from me about how to fish from a galawa". Likewise, an elder from Hantsambou noted that "youth today think that having a motor on their boat means they do not have to learn these things". Many such elders claimed that youth no longer had a desire to learn from their elders, and with new fishing techniques and boats, they no longer had use for traditional practices and knowledge. This is evident in the growing number of young fishers who learn their skills from their friends with powerboats, and not through the traditional method of being taught by an experienced fisher in a galawa. This contrast between generations makes evident that not only have fishing methods begun to change, but so have values surrounding fishing as a profession and a way of life. Thus, the concern remains that as the sector continues to modernize and fishers turn to newer, more efficient technologies, not only will impacts on marine resources and ecological losses begin to rise, but so will the loss in cultural richness and knowledge. As written by Ohmagari and Berkes (1997), traditional practice "sustains social relationships and [the] distinctive cultural characteristics of a society" (p. 218).

It should be made clear that the above discussion does not portend to a culture in imminent danger of massive resource declines and cultural loss; this is by no means a rapid modernization. This is simply evidence of a culture moving slowly away from subsistence livelihoods and towards economic development and modernization. This discussion is nonetheless of particular relevance and importance as modernization of the fishing sector is only beginning to occur, and thus, there is still opportunity to learn from the successes and mistakes of other regions which have already been down a similar path. In a world filled with over-exploited and depleted fisheries (Newton et al., 2007; Pauly et al., 2002), the Comoros still have a chance to choose the path they wish to take. Coastal communities will need to decide their own fate; however, ideally a balance would be sought between maintaining traditional values and knowledge, and adopting new technologies, practices, and information which help to sustain livelihoods while improving fishing conditions and marine resource management.

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Question: So how do you think this traditional knowledge may be passed on to future generations?

Response: *"Take your kid, throw him in the boat, and teach him how to fish"*

- Elder fisher from Hantsindzi

Paper 2

The effectiveness of community-based governance of artisanal fisheries Ngazidja island, Comoros

1. Introduction

Tropical small-scale fisheries represent the main livelihood and protein source for a substantial portion of the global population. Growing pressures on marine resources, however, have left many fishing communities faced with declining catches and increased environmental degradation. It is now widely agreed that the current crisis is primarily a result of overfishing and poor management (Berkes et al., 2001; Botsford et al., 1997; Defeo et al., 2007). Effective governance institutions are thus critically important for ensuring sustainable livelihoods, food security, and marine conservation in these communities.

In natural resource management, institutions were traditionally devised to deal with the two underlying problems inherent to all common-property resources: controlling access to the resource and establishing rules which regulate users' ability to potentially extract more than their 'fair share' (Berkes & Folke, 1998). Such institutions are often characterized by the formal (e.g., laws, statutes, regulations) and informal (e.g., social and cultural norms) rules used to govern user behaviour (North, 1990; Ostrom, 2005). In traditional and artisanal fisheries, customary forms of informal management are common and may involve practices such as territorial user rights (TURF's), temporary closures, gear restrictions, religious taboos, and community catch quotas (Cinner & Aswani, 2007). Such approaches bear many similarities with conventional fisheries management as they both use "limits on effort, time, space, species, size, and gear" (McClanahan & Castilla 2007, p. 305). The difference, however, is in how they are adopted and implemented. In customary management systems, emphasis tends to be placed on *how* fishing is done, rather than *how much* is being caught (Achenson et al. 1998). As such, fisheries institutions play a significant role in shaping user behaviour, and can be paramount to the success or failure of a fishery system. Not only do institutions have the power to create or destroy user incentives to abide by regulations, but without an effective and sustainable governance institution, management practices are futile. As noted by Charles (2001), "no amount of attention to management tools is likely to make them effective within a dysfunctional institutional environment" (p. 317).

To date, much of the research on artisanal fisheries management has taken a prescriptive approach and focused on the successes and challenges of management regimes that have been imposed

on fishing communities (e.g., gear restrictions, MPA's, no-take zones, co-management). Few documented case-studies, however, have aimed to work within existing social structures and with existing fisher knowledge to develop effective management strategies. Chuenpagdee and Jentoft (2009) also note that the assessment of governing institutions seems to have centered on achieving the ideal, rather than what is realistic – resulting too often in the failure to reach unattainable objectives. In reality, they argue, "most organizations do whatever they can do, given the circumstances that they find themselves in" (p. 110). As such, this case-study of artisanal fisheries in the Comoros examines how effective local fishing institutions are at managing common fisheries resources, and provides some understanding of the underlying characteristics of effectiveness. Emphasis is placed on assessing governance according to measures appropriate within the given context, and on suggesting ways to enhance (rather than restructure) local institutional strength and capacity to manage resources effectively.

2. Background on Ngazidja case-study

This study took place on the island of Ngazidja in the Union of the Comoros. The Comoros is situated at the northern end of the Mozambique Channel in between Madagascar and Mozambique (Figure 1). The country comprises the three volcanic islands of Ngazidja, Ndzouani, and Mwali, each of which is surrounded by patch and fringing reefs supporting a rich marine biodiversity. The Comoros is classified as a small island developing state and one of the poorest nations in the world (UNDP, 2009). Coastal communities in the Comoros rely heavily on marine resources for both economic and subsistence livelihoods. However, the country is currently facing considerable demographic growth and with 88% of the population living on the coast (Union of the Comoros, 2005; UNDP, 2007), there will likely be a serious increase in environmental degradation and poverty unless effective management strategies are employed.

The focus of this paper is on governance structures and processes, though some discussion of fishers' observations of resource conditions is included to provide insight into the ecological sustainability of fishing and management practices. Understanding fishers' perceptions is important as perceptions can strongly influence behaviour and decision-making, thereby shaping the type of management strategies employed. The paper begins with a background on the fisheries sector in the Comoros and provides an overview of the study design and methodology. The results are then

presented and discussed in reference to some of the key concepts on governance institutions found in the common-property literature. Recommendations are provided based on practical, low-cost solutions to the core governance challenges facing fisheries on Ngazidja.

2.1. Fisheries sector of the Comoros

The fisheries sector in the Comoros is entirely artisanal (i.e., small-scale) and catches are used for household subsistence or sold at local markets. Until 1985 fishing in the Comoros was comprised of dugout canoes and handcrafted traditional gear. Since then, the sector has modernized through international aid from development projects. This led to the provision of small (5 -7m) fiberglass boats with outboard motors (15–40HP) and more modern gear (e.g., metal hooks, plastic bait and fishing lines) (Union of the Comoros, 2005). Nevertheless, fishing gears remain simple and low cost (Table 6).

Table 6 - Most common gear and target species per fisher group in the study sites

Fisher Group	Boat Specifications	Gear	Target species
Male and elder fishers	Single-outrigger canoes, 3-5m, hand paddled	Handlines, spear guns, spears, traps	Reef fish, coastal pelagics, crustaceans
Male fishers	Motorized boats, 5-7m, 15-40HP	Handlines	Oceanic pelagics
Female fishers	By foot at low tide	Mosquito nets, sheets, spears, traps	Juvenile reef fish, mollusks, crustaceans

The national government's outlook for the fishing sector is one of growth, expansion, and modernization. The government's 2009 targets were to increase fisheries production by more than 50%, to create 5,000 new jobs, and to increase contribution to GDP by more than 13% (Union of the Comoros, 2005). These goals have yet to be achieved, but the government contends that development can occur through the expansion of the Exclusive Economic Zone (EEZ) and the exploitation of unexploited resources (e.g., shrimp, lobster, cephalopods) – all in light of the high global demand for seafood. The growth and development of the industry is appealing for many, however, it also raises concerns regarding the uncontrolled expansion of fishing, and a need to understand the current situation before such measures are taken.

Little reliable scientific data exists on fisheries in the Comoros. The only systematic collection of fisheries data occurred in 1994, and thus, all statistics before and after this date are based on estimates derived from this data and other small, isolated studies. As such, the commonly quoted statistics are

often contradictory, out of date, or clearly guesswork. This is common in many lesser developed regions as governments often lack the capacity to collect fisheries information. In cases where both current and historical fisheries data are absent, fishers and fishing communities are often the only source of information on fish stocks and marine resource conditions and changes (e.g., Johannes, Freeman & Hamilton, 2000; Johannes & Neis, 2007).

3. Methodology

3.1. Study Design

Fieldwork was conducted between July 2009 and December 2009. The primary data collection methods used were key informant interviews, focus group discussions, GIS mapping, and participant observation. The approach taken for this research was primarily inductive which allowed results to emerge and be examined within their own context, as opposed to being analyzed from a pre-established theoretical basis.

Prior to data-collection, a scoping survey was completed and a variety of fisheries stakeholders were consulted to inform site selection, questionnaire design, and general methodology. A pilot study was also conducted to assess questionnaires. Translators fluent in both French and the island dialect of ShiNgazidja were employed to assist with interviews.

Semi-structured key informant interviews were the main data collection method. A mix of open- and closed- ended questions was used to provide quantitative and qualitative information. Two main questionnaires were employed: one regarding local fisheries knowledge and practices asked to expert current and elder fishers, and one regarding management structures and strategies asked to local village association leaders. Additional questionnaires were created for authorities in the National Fisheries Department, National Fishing Syndicate, and private sector. Focus group discussions were tailored to specific villages and held once key informant interviews were completed. This allowed for certain issues to be explored in greater depth, to cross-check information, and to gather additional information. Participant observation (including eight fishing trips[8]) and GIS mapping of traditional fishing grounds took place at various intervals throughout the field season.

[8] Six with male fishers and two with female fishers

3.2. Study Area

Four large fishing communities on Ngazidja were the primary study sites: Chindini, Bangoua, Hantsambou, and Hantsindzi (Figure 3). Selection was based on geographical distribution, the importance of fishing within the community, recommendations made during interviews, and community interest in participation.

There are approximately 44 landing sites on Ngazidja, though many of these are quite small (e.g., 1 -10 fishers/village), particularly on the central east coast. Each of the study sites is the main fishing village within its region and fishing is the main livelihood (economic and subsistence) activity within the community.

Table 7 - Estimated fisher and boat numbers in study sites

	Hantsindzi	Hantsambou	Bangoua	Chindini
# of male fishers	150	260	600	1700
# of traditional canoes	55	160	90	70
# of powerboats	13	50	60	100
% of traditional canoe fishers	50%	35%	15%	20%
% of powerboat fishers	50%	65%	85%	80%
% of fishers in village	80%	85-90%	90%	90%

3.3. Participant selection

Participant selection was based on the sampling of experts as the study sought to document information on specific issues which would be known by those with extensive knowledge and experience. Purposive sampling was used to select management authorities and snowball sampling was used to identify expert fishers. Expertise was defined by fishers themselves and referred to a fisher with extensive knowledge, skill, and experience. A distinction was made between expert elder fishers and younger experienced fishers to draw out any changes which might have occurred over time (e.g., in fishing practices or regulations) as well as differences in beliefs and perceptions. This distinction is based on fishing methods and age. Elders only fish from traditional canoes while younger fishers may fish from traditional canoes and/or powerboats. Ages ranged from 20 to 65 for current fishers and 50 to 100 for elder fishers.

3.4. Interviews

A total of 75 expert fisher interviews, 17 management authority interviews, and 11 focus group discussions were completed. Expert fishers interviewed had a minimum of 7 yrs experience (n=3) and an average of 21.3 years experience; elders had a minimum of 27 years experience (n = 1) and an average of 55.4 years experience. Management authorities had been employed in their position for a minimum of 1 year and a maximum of 10 years and they had all been involved in the fishing sector for a minimum of 10 years. Interview times ranged from 30 minutes to 1.5 hours.

4. Results

Results were analyzed using a mix of content, discourse, and narrative analysis and have been organized into the dominant themes which emerged from the study. As the structure, organization, and function of cooperatives vary only slightly among the study sites all results are presented together.

4.1. Cross-scale governance structures

Fisheries governance in the Comoros is informally shared among state fisheries departments, national and island fishing syndicates, and village fishing associations (Figure 6). Although the overall development and governance of fisheries is shared among the three levels of authority, the actual implementation of management strategies is largely undertaken at the local level. The national government maintains no formal regulations on fishing and due to limited staff, resources, expertise, and funding, has little capacity for effective management. As a result, local fishing associations have assumed a pivotal role in managing fisheries in their own communities. They function much like cooperatives and collectively design, monitor, and enforce local regulations. Decisions are based on local knowledge and experience, and management strategies are adaptive and based on low-cost practical solutions; e.g., gear restrictions to reduce environmental degradation, user-monitoring and enforcement of regulations, and graduated sanctions for those who violate the rules. Associations, however, have little power or capacity beyond their own villages, and thus work closely with national and island syndicates. The syndicates act as the primary mediator between the local associations and national government - both by intervening on behalf of the associations and by disseminating fisheries information for the government. The state fisheries departments, although somewhat disconnected from actual fisheries and management, are involved in overarching logistical and administrative duties, and serve as the first point of contact with outside donors and organizations. Thus, even though each of

the different levels of fisheries institutions are limited in certain capacities, they tend to complement one another. For example, while local associations demonstrate their ability to function independently, being 'nested' within larger-scale institutions provides associations access to resources (e.g., external funding for projects, diverse management tools) that they may not have had on their own. Likewise, local institutions can provide information on marine resources that the government and syndicates do not have the time or resources to collect; e.g., catch composition and effort, and observations of changes in marine resources and habitats. Thus, although much capacity building is still needed, this polycentric structure provides opportunity for use of a blend of knowledge sources and approaches which provides a strong foundation upon which to build effective and productive fisheries management.

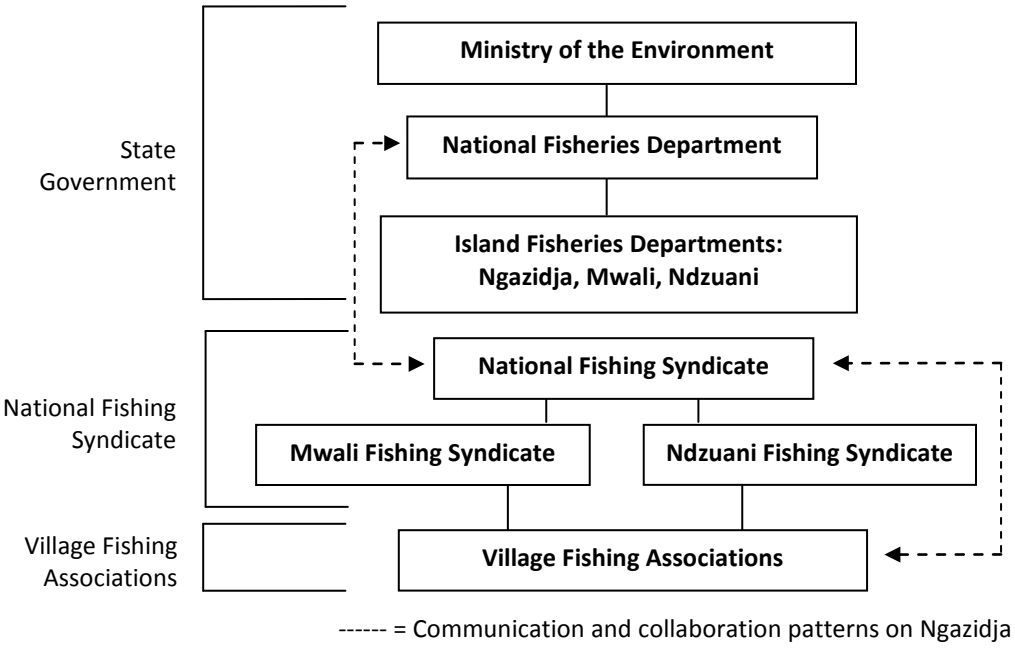

Figure 6 - Fisheries governance structures of the Comoros

4.2. Village fishing associations

The creation of village fishing associations stems from an island custom of creating associations for those of similar interests and occupations (e.g., cultivators, traditional dancers, weddings). It is a means for villagers to pool finances for projects, to elaborate on new ideas, and to share knowledge and skills. The associations also provide a certain safety net as revenues from the association can be redistributed among members or the wider village to help alleviate the acute effects of poverty (Union of the Comoros 2005). Even the national government has acknowledged that the "associations take

initiatives that fill in the gaps left by the State in order to meet the needs of those communities" (UNDP, 2007, p. 24). These associations are thus capable of adapting to the growing and changing needs of the population. For example, an increasingly large percentage of the funds collected during 'big wedding' ceremonies are redistributed to help with community development projects; e.g., installation of water pumps and construction of youth centres.

Each fishing village on Ngazidja has a local fishing association. Initially, the associations were quite informal and acted more as a means for creating feelings of unity among fishers and collectively pooling funds for small projects. Many of these associations, however, have since grown into organized and self-reliant institutions. Each association has a management committee elected by local fishers. Those elected are chosen based on their knowledge, skill, and social status. A president, for example, is often an older, experienced fisher who has earned the respect of others and has strong leadership skills. A secretary, on the other hand, may have little knowledge of fishing but is often formally educated, and therefore, able to perform secretarial duties that may be difficult for others with lower literacy levels. These committees are almost solely responsible for managing fisheries in their communities, including financing the majority of their fisheries development projects. In regards to their legal status, the formation of user groups is allowed under Comorian legislation; however, it does not permit the creation and legal implementation of management regulations. Nevertheless, local fishing regulations are often respected and enforced by island and state authorities.

Membership within fishing associations is mandatory for all fishers using motorized boats and most associations require an entrance fee to become a member (e.g., ~60€/powerboat) and daily or monthly contributions thereafter (e.g., 1 fish/day for every ~15 caught). Powerboat fishers generally rent their boats, so fees and contributions are the responsibility of boat owners, not fishers. Traditional canoe fishers, on the other hand, are not obliged to pay fees as they tend to catch smaller quantities and fish closer to shore. Nonetheless, they are still considered full members and have access to the same benefits of membership (e.g., participation in decision-making, use of site facilities) as powerboat fishers. A substantial portion of the fees are used for the search and rescue of lost powerboat fishers, while the remaining funds contribute to fisheries management and development within respective communities. For example, in some of the study sites, membership fees enabled the construction of a boat ramp and sheds to store equipment, and provided credit to fishers who wished to buy a motor or boat.

4.3. Fishers' perceptions of the current status of fisheries resources

As fisheries data in the Comoros is extremely limited, information gathered from fisher knowledge can provide some indication of overall resource conditions and trends. Understanding fishers' perceptions of the status of their resources can also provide insight into the attitudes and motivations behind their behaviour, including decisions on fishing regulations. Expert and elder fishers were questioned on whether they had noticed any changes in the quantity, size, species, or locations of fish caught. They were asked to provide an estimated timeframe for when they noticed these changes occurring, ideas for the possible causes behind the changes, and solutions when declines were noticed. Although the sample size is not statistically representative, fishers interviewed have extensive local knowledge and experience, and thus, are considered of sufficient authority to report on fisheries observations. Results for this section are presented in a summary format and focus primarily on trends. Detailed descriptions of these results are available in Hauzer (2011*a*).

Based on expert and elder fisher interviews, the status of fisheries resources appears to be relatively stable; however, results also show possible trends towards declines in mean fish size and fish abundance in coastal waters. Among the three fisher groups, 55% of traditional canoe fishers (n=20), 61.5% of motorized boat fishers (n=26), and 86.4% of elder fishers (n=22) noted declines in mean fish size over the last 20 years. The higher percentage of elder fishers noting declines is likely because they have a longer timeframe from which to draw reference, which could also mean greater evidence of size declines. In regards to catch abundance, 31.8% of elders, 50% of motorized boat fishers, and 75% of traditional canoe fishers noted declines in the amount of fish caught over the last 20 years. These trends are also supported by data collected with female fishers in a concurrent study (Hauzer, 2011*b*), where 80% of fisherwomen noted a decrease in the mean size of fish caught and 86% noted a decrease in the quantity of fish caught in intertidal areas. Among fishermen, declines in fish size and catch abundance were attributed to: overfishing, motorized boats (due to engine noise), environmental degradation, and the limited technology of traditional canoe fishers. However, although interviews suggest that some declines are occurring, these declines are not likely drastic, otherwise the vast majority of fishers would have provided the same response. Furthermore, gear choice can be a reliable indicator of how a resource is doing, as most fishers will switch to more efficient (and often, more destructive) gears when they begin to see serious declines (Cinner, 2010; Pomeroy et al., 2007). In the case of the Comoros, most fishers utilize extremely simple gears, yet catch numbers remain considerably high (e.g., they average at 22kg/day per traditional canoe with one fisher on-board and 110kg/day per powerboat with two fishers

on-board). By comparison, studies at multiple sites in Kenya recorded catch numbers per fisher between 2.5 – 4.3kg/day using similar artisanal gears (McClanahan, Hicks, & Darling, 2008), and studies in Tanzania recorded average catch numbers per fishers using handlines as 1.9 – 7.0 kg/day (Jiddawai & Ohman, 2002).

4.4. *Customary fisheries regulations*

Fishing associations employ a variety of customary fishing regulations including gear, spatial, and species restrictions (Table 8). Catch and temporal restrictions also exist but are based on social taboos, rather than actual regulations. Rules are often created on an ad hoc basis as issues arise, and are thus adaptable to changing needs and environments. All fishing regulations are informal and site-specific, though most associations submit their rules regarding fishing gear bans to local and island authorities so that offenders can be punished through the legal system when necessary. Regulations are first proposed by a management committee member or a fisher, and then discussed and voted on by all fishers. It is a highly-participatory process that engages both resource users and managers. As a result, compliance rates with fishing regulations are very high, with intra-village infringements being extremely rare.

Fishing in the Comoros is entirely open-access in the sense that there are no regulations concerning user access-rights, i.e., who may enter the fishery, how much they can harvest, and when they can harvest. Instead, fishers believe very strongly in allowing everyone to fish wherever and whenever they like - primarily in light of maintaining solidarity and reciprocity among Comorian fishers. Although fishers claim that since 'the time of their ancestors' the sea has belonged to everyone, interviews with the National Fishing Syndicate revealed that prior to 1978, fishing villages enforced fishing boundaries much more strictly. At that time, it was viewed as an insult if a fisher from a neigbouring village fished in front of another village. Now, according to the President of the National Fishing Syndicate, while this is still mildly taboo, "fishers have realized that management is best done by stopping destructive techniques, rather than restricting access". Moreover, with the arrival of powerboats, fishing zones and target species have changed significantly, making the enforcement of near-shore fishing boundaries less applicable. Thus, although well-defined fishing boundaries exist in all villages, and fishers monitor and enforce regulations in these areas, they believe equally strongly in the values of reciprocity, including the freedom to fish where one pleases. To restrict the access of others would mean that they would also be restricted from fishing near other villages.

Table 8 - Customary fishing regulations in study sites on Ngazidja

Fishing Regulations	Description
Gear Restrictions	Gillnets, dynamite, and the use of ichthyotoxic plants (*Tephrosia vogelii*) are prohibited in all study sites. The use of lanterns while fishing at night is prohibited in Chindini and Hantsindzi.
Spatial Restrictions	Within community fishing grounds, locally determined gear and species restrictions also apply to outside users.
Species Restrictions	Skipjack tuna (*Katsuwonus pelamis*) and Indian mackerel (*Rastrelliger kanagurta*) are banned for use as bait in Chindini and Hantsindzi.
Catch Restrictions (social taboos)	There are no formal catch restrictions; however, social and cultural norms look unfavourably upon greed and wastage. Harvesting more than can be consumed or sold daily is uncommon.
Temporal restrictions (social taboos)	There are no temporal restrictions in terms or times of day, seasons, etc., though it is generally looked down upon if people fish on Fridays, the day of the Muslim *jumu'ah* prayer.

Most fishing gear bans were adopted as fishers began to notice the negative environmental and social consequences of using certain gears. The prohibitions on dynamite, gillnets, and ichthyotoxic plants, for example, were imposed to reduce environmental destruction (e.g., damage to reefs and declines in fish abundance), while the bans on fishing with a lantern at night and using certain species as bait stem primarily from social taboos against greed and wastage. Many fishers believe that using lanterns at night makes it far too easy to capture fish. They fear that fish will become so drawn to the lights at night that they will no longer feed during daylight hours, making them impossible to catch. The same reasoning is used for the prohibition of using tuna or mackerel as bait. Fishers in Chindini and Hantsindzi believe that fish will become habituated to eating fish meat and no longer take to plastic bait, making it difficult for other fishers. It is also believed that using fish as bait is wasteful. While the logic behind some of these prohibitions may be false, the reasoning stems from a conservation ethic and a drive to regulate harvests so that a certain amount of equity will exist among fishers. All of those interviewed firmly believed that fish stocks and marine habitats have improved since gear prohibitions were implemented.

4.5. User monitoring and enforcement of regulations

Monitoring and enforcement of regulations is conducted by the fishers and the association's management committee. It is the most effective, low-cost, and practical option available. It empowers fishers with being responsible over their own resources and ensures greater compliance. Also, as fishers

participated in the creation of these regulations, they are enforcing rules that they themselves believe are important. Penalties for those who break the rules are very specific and may include one or a combination of: fines, temporal fishing bans, physical assault, destruction of fishing gear, and imprisonment. If the rule violations are repeated, the severity of the penalty increases. Physical assault and the destruction of fishing gear are most often used for infringements of fishing gear bans, and the remainder are more common for infringements of safety and/or administrative regulations. Many fishers passionately expressed their willingness to enforce local fishing gear bans as they believe so adamantly in their importance. A management committee member from Chindini stated, “there is a second government here in the Comoros: the village. If the government does not want to enforce regulations, we will do it ourselves”. Another management committee member from Hantsambou stated, “whoever is found using prohibited fishing methods will be beaten-up and their materials will be destroyed. Even if the police tell us not to do this, we will still do it as we want people to respect the rules”.

4.6. Fisheries Conflicts

Fisheries conflicts on Ngazidja seem to be primarily of short duration and medium- to high-intensity. Using the scale presented in Table 9, most fisheries conflicts in the Comoros can be categorized as level 3 and 4. There have been no conflicts over access-rights or marine resources. Instead, fisheries conflicts are primarily related to management practices and gear prohibitions. Conflicts which go beyond the scope of fisheries (e.g., intra-village conflicts related to historical tensions) tend to last much longer, be less intense, and flare-up from time to time. All of those interviewed believed that their village’s conflict management strategies are effective: they attempt to solve problems within the village - through the fishers association and/or village chief, and only if things get out of hand do they call the gendarmerie or seek intervention from the State.

Table 9 - Conflict intensity scale

Intensity	Level		Description
None	1	Non-violent, latent conflict	A positional difference over definable values
	2	Non-violent, manifest conflict	Verbal pressure, threat of violence, economic sanctions
Moderate	3	Crisis, partly violent	Tense situation in which at least one party uses sporadic violent force
High	4	Serious crisis, repeated and / or organized use of violence	Severe conflict where violent force is organized and used repeatedly
	5	War	Systematically organized violent force using extensive measures

Based on the Heidelberg Institute for International Conflict Research *Conflict Barometer* (2008)

Inter-village conflicts occur primarily over gear restrictions and tend to be more violent than conflicts between fishers of the same village. These conflicts are infrequent, occurring every couple years per village. They are often of high-intensity but short duration, lasting from 1-2 days to one week. A typical conflict involves a group of fishers from one village catching a fisher from another village using prohibited fishing gear within the boundaries of the former fishers' village. Awareness of village-specific fishing gear prohibitions is widespread, so the enforcing fisher(s) tend to resort quickly to violence (i.e., physically assaulting the fisher, sinking his boat, and destroying his gear). If the conflict does not subside here, then more fishers from the village may get involved, and/or the gendarmerie. In a few extreme situations, military intervention is required to restore order.

Intra-village conflicts are uncommon. Solidarity, particularly within a village, is so strong among fishers that conflict tends to be rare. Moreover, as association management practices and structures develop, fishers tend to be more involved in decision-making and management activities, thus increasing compliance and reducing incidents of conflict. Past disputes within villages were most often related to disobeying safety or association regulations; e.g., fishing alone rather than in pairs. However, some more prominent conflicts led to the creation of a second fishing association in two of the study sites. While these disputes became escalated, they eventually resulted in redefining regulations pertaining to management structures and clarifying the rights of fishers and management committees. The conflicts also seemed to bring about productive working relations between the two associations as they now follow the same regulations and often work together on fisheries development projects.

Mild tension between fishers and the state government exists as many fishers do not feel they are supported or respected by the State. During part of the fieldwork for this research (November 2009),

fishers and fish vendors went on strike nationwide. The strike lasted over 2 weeks and sought to bring attention to the lack of governmental support for the fishing sector: one of its main industries and most important food sources. The National Fishing Syndicate and village fishing associations joined forces to request that the government offer subsidized fuel prices for fishers and more capacity development, equipment, and financial support for the sector. The result was a 25KmF/L (~0.05€) reduction in fuel prices and a general agreement to provide increasing support. It remains to be seen specifically how and when this support will take effect. Nevertheless, fishers succeeded in drawing attention to their needs and their ability to unite to incite change.

5. Discussion

When considered within their own context, the results from this study provide clear evidence that the local fishing associations on Ngazidja are capable of effectively and independently managing resource users, and to some extent, the resources themselves. To further substantiate these findings, results were compared with Charles' (2001) and Ostrom's (1992, 2005) work on successful governance institutions; for, although the ultimate measure of success is often context-specific, Charles and Ostrom have identified core underlying characteristics of successful institutions which span across a diversity of case-studies. In drawing on their work, successful resource governance institutions can be defined as those which are both effective and sustainable. It is important to note, however, that effectiveness and sustainability are not mutually inclusive; i.e., simply because an institution is effective does not mean it is also sustainable, and vice versa. As such, an important aspect of successful institutions is also to enhance and maintain diversity. This may include, for example, using multiple management tools and approaches, various knowledge sources, cross-scale decision-making structures, mixed fishing practices, and occupational pluralism (Allison & Ellis, 2001; Charles, 2001; Folke et al., 1998). By increasing diversity, pressure and dependency on the fishery and governance institution are reduced, thereby enhancing resilience and sustainability.

Ostrom's (1992, 2005) work on robust and sustainable institutions has been very influential in the common-property literature, particularly in identifying the key attributes of successful resource management institutions. In particular, her eight design principles of robust institutions (listed in Table 11) provide a practical and theoretical context from which to assess the effectiveness of an institution's ability to manage resources. Likewise, Charles' (2001) work integrates many of the core concepts of successful institutions and applies them to fisheries systems as a means to examine their ecological,

institutional, social, and political sustainability. A list of these key conditions inherent to most successful resource management institutions is provided in Table 10.

Table 10 - Conditions for effective and sustainable institutions

	Conditions	**Description**
Charles (2001)	Management Effectiveness	Existing management structures control exploitation levels and regulate resource users
	Use of Traditional Methods	Traditional resource and environmental management methods are utilized
	Incorporating local input	Management activities incorporate local socio-cultural factors (e.g., tradition, community decision-making, LEK)
	Capacity-building	Capacity-building occurs within relevant organizations
	Institutional viability	Management organizations have long-term financial viability and political will exists to support local structures
Ostrom (1992)	Simple, key rules	Resource access and use are regulated by a small number of agreed upon rules
	Dual Enforcement	Rule enforcement is shared by all users and backed by officials
	Adaptability	Institution must be able to adapt to changes by restructuring and/or changing rules
	Ownership	Users have legal claims as owners over the resource
	Nested institutions	Institutions are nested within larger organizations
	Change is moderate	Changes external to the institution are moderate

The conditions outlined in Table 10 can be used as a framework for understanding why some institutions are more likely to succeed than others. They can also be applied at a local context, making them highly relevant to assessing customary, community-based management institutions. To illustrate this, Table 11 presents some of the key characteristics of local fishing associations alongside Ostrom's and Charles' conditions. When comparing the attributes of the fishing associations on Ngazidja to the conditions outlined by Ostrom and Charles, it is apparent that the local governance institutions on Ngazidja fulfill most of the criteria suggested as critical for effective and sustainable governance of common-property resources.

Local fishing associations on Ngazidja are characterized by qualities which empower and engage resource users and local managers, resulting in high compliance rates, social capital, and ultimately, effective governance processes. The success of local governance systems is achieved not only through robust institutions, but also through the shared values of reciprocity, trust, invested interests, and solidarity - all of which provide the ultimate incentive not to overexploit or disobey the rules. While these values (or user characteristics) extend beyond the conditions listed by Charles (2001) and Ostrom (1992, 2005), they are prominent among fisher communities on Ngazidja and contribute to the success of local management systems. Likewise, the highly-participatory nature of governance structures has fishers directly involved in decision-making and monitoring, which enhances their sense of responsibility and invested-interests. Thus, it is clear that these local associations have the ability to regulate resource users and control exploitation levels; however, it is also important to ensure that management strategies are effective not only at managing people, but also at conserving marine ecosystems.

Current management strategies, and in particular, gear prohibitions, are reflective of fishers' invested interests in ensuring the long-term health and viability of their fishery. These concerns stem from both a moral standpoint, whereby fishers genuinely believe in the importance of all fishers (including future generations) having access to common resources, and a conservation viewpoint where fishers fear the negative effects of destructive activities on the marine environment. Such attitudes have been able to grow and foster in fishers on Ngazidja because they have had the luxury of having almost complete control over the use and management of their own resources. As such, they assert a strong sense of responsibility over maintaining and protecting their livelihood. However, although fisheries regulations address concerns of direct habitat and resource degradation, they may not be adequately addressing other issues, such as the declines noted by expert fishers. More importantly, until regular monitoring of fisheries resources occurs, the status of resource conditions and subsequent

Table 11 – Key characteristics of effective and sustainable local governance institutions on Ngazidja

Key characteristics of local institutions on Ngazidja	Effectiveness & Sustainability Conditions (Charles, 2001; Ostrom, 1992)										Eight design principles (Ostrom, 2005)							
	Management Effectiveness	Use of traditional methods	Incorporates local input	Capacity-building	Institutional viability	Simple, key rules	Dual enforcement	Adaptability	Ownership	Change is moderate	Clearly defined boundaries	Costs & benefits	Collective-choice agreements	Monitoring of rules	Graduated Sanctions	Conflict resolution	Right to organize	Nested Enterprises
High compliance rates to local regulations	√	√	√			√	√	√	√*			√	√	√	√		√	
Direct involvement of fishers in management, decision-making, monitoring, and enforcement	√	√	√	√		√	√	√	√		√		√	√		√		
Funding for local projects is largely obtained through fisher contributions			√	√	√			√	√									
Association leaders are respected and electoral procedures abide by local customs	√	√	√	√				√	√				√				√	
Resource conflicts are relatively infrequent and quickly resolved via culturally appropriate mechanisms							√								√	√		
Cross-scale linkages exist between the three levels of governance	√		√	√	√		√						√			√	√	√
National Fishing Syndicate acts on behalf of fisher needs and interests																		√
Use of traditional knowledge and methods		√	√							√		√						
Government and enforcement authorities respect fishers' right to organize and create local regulations	√		√		√				√		√		√				√	
Comorian society remains significantly isolated from outside influences										√								

*Users do not have actual legal ownership over the resource, however, they feel and act as if they do, leading to behaviours which promote sustainable use

management strategies can only really be based on speculations; and, unless regular, systematic observations take-place, certain issues may be overlooked. Fishers do not need to engage in complex data collection, however, frequent monitoring and recording of key ecological information can provide enough of a basis for fishers to better understand, predict, and address resource changes overtime.

In order for the long-term sustainability of fisheries and marine ecosystems to be achieved, broader socioeconomic issues must also be considered. With such a high population density, particularly along the coast, controlling fisher behaviour and harvests may not be enough to achieve sustainable use and conservation of marine resources. Coasts and reefs around the Comoros are under serious threat from household waste and pollution, coastal development, and other destructive activities. In addition, although the village fishing associations in this study are well-organized and effective, not all fishing associations are the same. Thus, a long-term goal should be to incorporate a broader set of objectives and stakeholders in coastal and marine management to address issues outside the scope of fisheries. While the structure and foundation for effective and sustainable multi-layered governance is in place, additional research and capacity building are needed in several key areas to strengthen each institution's ability to manage fisheries.

6. Conclusion and Recommendations

The results presented in this paper show that fisheries governance structures on Ngazidja provide a sound platform from which to build effective management strategies. Specifically, the study demonstrates how collective governance of common pool resources can be achieved within communities, and how feelings of empowerment and shared responsibility among resource users can lead to effective management practices. Thus, in light of the current limited capacity and resources of the national government, the answer to enhancing effective fisheries management on Ngazidja may lie in strengthening the capacity of existing local organizations so that they may play a larger role in managing their own resources; e.g., enhancing the capacity of fishing associations to monitor marine resources to ensure regulations are appropriate and practices are sustainable. The ultimate goal is to transform effective institutional structures and processes into effective practices for the future. The following recommendations focus on low-cost, practical solutions that would be easy to implement and maintain in the context of unstable political and financial situations. Solutions concentrate on working

with the limited resources and current capacity of each of the organizations. Imposing new structures or projects which require increased funding and/or expertise are not a sustainable solution at this time.

1. Enhance linkages between the National Fisheries Department, National Fishing Syndicate, and village fishing associations. An increase in cooperation and information sharing among the three levels of governance will enhance the capacity of each organization to manage fisheries.

2. Build capacity within the three main governing bodies; e.g., village fishing associations should be better informed of the diversity of management options available to them so that they may improve and adapt management practices when necessary. Likewise, government officials need increased training in alternative fisheries management approaches; e.g., ecosystem-based management and adaptive management, as they are somewhat constrained by their training in conventional Western fisheries management paradigms. The combination of local knowledge with more modern skills and approaches will likely enhance their ability to monitor resources effectively and adapt their management methods accordingly.

3. Train expert fishers and local association authorities to gather baseline data on fishing effort and marine resources in their communities.

4. Experiment with alternative management tools (e.g., seasonal or area closures, minimum allowable hook sizes, size and/or species restrictions) as pilot projects in select villages. These may help to address concerns of decreases in fish size, species diversity, and fish abundance in coastal waters.

5. Address external local threats to marine and coastal ecosystems need to be addressed; e.g., household waste, pollution, sand mining. Until these threats are also addressed, fisheries and conservation objectives will never be fully realized.

6. Conduct a 'futures scenarios' workshop where groups of fisheries stakeholders work together to agree on desired fisheries outcomes and how to best achieve them. This can help stakeholders and managers to jointly investigate opportunities, mitigate risks by addressing potential threats, and develop a shared vision of prospective futures (see: Andrew, 2007; Pauly et al., 2003).

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"In the uruva*, there are satanic spirits and if you use it a lot, these spirits will come out and make the fishermen disappear"*

- Fisher from Hantsambou

Paper 3

Fisheries livelihoods, impacts, and implications for management: A case-study of the fisherwomen of Ngazidja island, Comoros

1. Introduction

Studies on women in fisheries in lesser-developed regions tend to focus on their roles as processors and vendors, but rarely on their direct engagement in fishing (Chapman, 1987; Chuenpagdee, Liguori, Palomares, & Pauly, 2006; Ruddle, 1994; Williams, 2002). Consequently, the contributions of fisherwomen to coastal livelihoods, including household income and food security, are often overlooked (Bennett, 2005; Verebalavu, 2009). This study contributes to this gap by examining the harvesting activities and livelihood contributions of artisanal fisherwomen in three communities on Ngazidja island, Comoros. Though women on Ngazidja have fished for generations, local fisheries authorities have recently attempted to ban them from fishing as their practices are considered destructive to near-shore reefs and juvenile fish populations. The purpose of this study is thus twofold: first, to examine women's fishing methods, impacts, and contributions to livelihoods in light of the push to stop their fishery, and second, to make recommendations on potential management interventions. This study also aims to add to the dearth of published information on women who fish, as this lack of information is yet another symptom of their marginalization. Acknowledging that women *do* fish (and making an effort to understand how, what, where they fish) is a first step towards granting fisherwomen with greater recognition so that so that they may be included in resource management and policy decisions.

The Union of the Comoros is situated at the northern end of the Mozambique Channel between Madagascar and Mozambique. The Comoros is classified as a small island developing state and one of the poorest nations in the world (UNDP, 2009). Food insecurity is a critical issue in many communities and is reflected in the high number of stunted, wasted, and underweight[9] persons (Meyer, Nelson, & Black, 2006). Households and communities with diverse livelihoods and income sources are less vulnerable to poverty and food insecurity. Women in particular play a central role in obtaining household food security through the provision and preparation of food (FAO, 1997). A national study

[9] Stunting is a result of long-term chronic food insecurity, wasting is related to acute recent nutritional shortfalls, and underweight is a composite of the two *(Union des Comores, 2005; Meyer, Nelson & Black, 2006)*.

found that on all three islands, homes where women were the head of the household were less vulnerable to poverty than those run by men (Union of the Comoros, 2005). This is likely due to women's willingness to work in a range of income- and subsistence- generating activities and a greater tendency for women to redirect income back into the household (FAO, 1997).

Worldwide, the critical role of artisanal fishing in terms of nutritional contributions, informal employment generation, and the development of coastal economies has been well-documented (FAO, 2007; Sowman & Cardoso, 2010). Not only does fish as a subsistence product provide an important source of food security through the direct access to high-quality animal protein, but the wages earned from fishing also enhance a household's food-purchasing power. Moreover, in rural communities with little access to alternative employment opportunities, the harvesting, processing, and marketing of marine resources provides important local livelihoods (FAO, 2007). Thus, small-scale fisheries have the potential to contribute directly and indirectly to food, livelihood, and economic security – each of which are closely linked and together contribute to poverty alleviation. Similarly, fisheries in the Comoros represent one of the most important employment and subsistence activities for coastal communities around the islands, and in some villages, fisherwomen comprise a significant portion of the fisheries sector. As such, fisherwomen contribute substantially to the subsistence economy by filling in the gaps of household income and food supply, and in some cases, are the primary protein and/or income supplier for their household. Yet, to date, the female fishery sector has been largely ignored by local and national fisheries authorities. As a result, fisherwomen remain excluded from management decisions and development strategies. Over the last 20 years, a number of fisheries development projects have been implemented in the Comoros, yet only male fishers benefited from the associated training, capacity building, and fishing technology improvements. Moreover, because women's practices remain unrecognized and undocumented, little can be done to improve their management or sustainability. Thus, if the development of a sustainable fishery is a goal of the Comorian government and fisheries authorities, then the activities of fisherwomen must also be considered.

2. Methodology

2.1. *Study Design*

Data-collection for this study took place from July – December 2009, and June – August 2010 and was part of a larger study on artisanal fisheries management and practices on Ngazidja. An initial

scoping survey was conducted to identify potential study sites, determine interest in participation, and gather baseline information to inform questionnaire design. The scoping survey involved interviewing authorities from the state fisheries department and the national fishing syndicate, and visiting four communities to meet with fisherwomen. Permission to conduct interviews and take photos in each of the villages was granted by the research participants and village leaders. Qualitative methods were used to collect data, including key informant interviews, focus group discussions, and participant observation. Some overlap in questions existed so that findings could be validated through the use of multiple survey tools. Study participants included expert fisherwomen, leaders of fisherwomen's cooperatives or working groups, and authorities from the national fisheries department and national fishing syndicate.

2.2. *Study Sites*

Three large fishing communities were chosen as study sites: Chindini, Mitsamiouli, and Hantsindzi[10] (Figure 7). Selection was based on geographical distribution, importance of the women's fishery (e.g., number of fisherwomen and fishing intensity), and interest in participation. Most women fish by foot on reef flats at low tide; and thus, the existence of a female fishery within a community depends on both the local traditions of that community and its biophysical features. There are approximately 44 landing sites on Ngazidja, though of these sites women only fish in approximately seven communities in the north and three in the south as reef flats are unevenly distributed across the island and are most prominent in the north and south. Table 12 shows the approximate number of fisherwomen per study site, including those who fish full-time (i.e., year-round) and those who fish part-time (i.e., seasonally and/or occasionally).

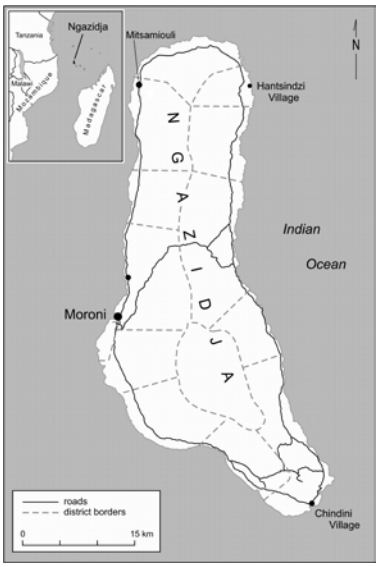

Figure 7 - Study sites of the female fishery on Ngazidja island

[10] The fourth site, Ouellah, participated in the initial scoping study but was not chosen as only 10 women fish there.

Table 11 - Estimated number of full- and part- time fisherwomen per study site[11]

	Hantsindzi	Mitsamiouli	Chindini
Full-time fisherwomen	50	60	10
Part-time fisherwomen	30	20	70
Total	80	80	80

2.3. *Interviews and focus group discussions*

Thirty-nine key informant interviews and two focus group discussions were conducted with fisherwomen in the three study sites. Fisheries authorities from the national fisheries department and national fishing syndicate also participated in three key informant interviews and one focus group discussion which focused in part on their perspectives of the female fishery. Snowball sampling was used to identify fisherwomen and purposive sampling was used to select national fisheries management authorities. Interviews with fisherwomen were conducted in the island dialect, ShiNgazidja, with the assistance of a translator, and interviews with national fisheries authorities were conducted directly in French. Interviews lasted from 40 minutes to 1.5 hours. Redundancy in responses was used to guide when enough interviews had been held.

Two semi-structured questionnaires were used for interviews with fisherwomen. The first was designed for expert fisherwomen and focused on fishing practices and effort, changes in marine resources over time, and markets and livelihoods. Ultimately, questions sought to determine both the impact women's fishing practices were having on marine resources and the importance of their harvests to household income and food supply. Expertise was defined by their own communities and was characterized as those who have extensive knowledge of fishing grounds and techniques, species' behaviour, and the marine environment. The second questionnaire was directed at the leaders of fisherwomen's working groups and cooperatives and focused on fisheries management to gain insight into how the women's fishery currently operates and the potential for women to participate in management activities. These latter interviews were only conducted in Hantsinzdi and Mitsamiouli as fisherwomen in Chindini have not formed any working groups or cooperatives. Focus group discussions on key fisheries and management issues were also held in Hantsindzi and Mitsamiouli. Fisherwomen

[11] See section 3.2 for a full description of the distinction between part- and full- time fishers

ranged in age from 25 to 70 years old, with the average age being 43 years old. All of the women interviewed continue to fish, and of those interviewed, there was a minimum of 5 years fishing experience and a maximum of 60 years' experience.

2.4. *Participant observation*

Along with household and market visits, several fishing trips were made in each of the villages to better understand women's traditional fishing practices. The fishing trips were not arranged for the sake of the researcher and, therefore, provided authentic insight into women's fishing methods and culture. Different methods and gears were used on each trip and group size varied from a few individuals to more than 30 women and children. The trips were extremely useful in gaining insight into traditional fishing techniques and complex activities which can be difficult to describe during interviews. They also proved critical for building trust between the fisherwomen and researcher. Although initially hesitant, the women were very proud to share their knowledge and skills, and appreciated that an outsider took genuine interest in learning and sharing their work. Participant observation was especially important for documenting female fishers' techniques as no written information exists on their practices, and as they tend to be diverse and unique, they are more thoroughly understood when observed.

3. Results

Data were analyzed using a mix of content analysis and coding to extract key findings. Although interview numbers are not high, women often fish in groups and, therefore, expert fishers are considered of sufficient authority to report on information which is common within their working group. Moreover, as this is largely an exploratory study, some of the more quantitative results are simply intended to reveal possible trends and to provide working baselines for future research.

3.1. *Fishing practices and gears*

Throughout the islands, reef gleaning and harvesting of inter-tidal zones are activities primarily undertaken by women and children. Fisherwomen use a variety of methods, depending on whether they target certain species or fish alone or in groups. Fisherwomen's activities are spatially restricted as their gear confines them to fishing in reef flats, so they very rarely enter into the deeper waters beyond the reef. As such, there is very little overlap between male and female fisheries.

Fisherwomen on Ngazidja fish for both household subsistence (food and income) and pleasure. While most women fish by necessity, many also spoke of the cultural and social importance of partaking in an activity they inherited from their grandmothers. As most women have been fishing since they were children and were taught by their elders, they maintain significant local expertise on fishing techniques, gear fabrication, marine weather conditions, and marine species and habitats, including a detailed folk taxonomy and impressive knowledge of species' behaviour. The transfer of knowledge between generations of fisherwomen occurs in a more informal manner than it does in the male fishing sector (see Hauzer, 2011*a*). Young girls learn to fish by accompanying their elders to sea and learning-by-doing, rather than through a more structured apprenticeship as occurs among male fishers. While male fishers tend to design step-by-step lessons, elder fisherwomen demonstrate fishing skills and pass on their knowledge through oral instruction as they fish. Another difference is that unlike their male counterparts who engage in a variety of traditional and/or religious fishing rituals, women's practices are primarily secular.

3.1.1. *Cloth sheets, mosquito nets, gillnets*

Women who fish in groups most often use bedsheets, mosquito nets, or gillnets[12] to catch fish. They go to sea as the tide level is still fairly high (e.g., neck level or higher) to maximize fishing time, and then work outwards and inwards from shore along with the ebbing and flooding tide. Group size varies significantly, e.g., from 10 - 50 fisherwomen. Once in deeper waters, two to four women position themselves with the nets (or sheets) so that the current flows into them. Rocks are placed on the bottom of the net and each woman holds a top corner so that the net forms an open mouth for the fish to swim into. The rest of the women create a large circle and work in a uniform fashion to chase the fish into the nets. They smack the water with their sticks to scare the fish into the centre of their circle while slowly walking inwards. As the circle closes, the fisherwomen quicken their pace and stab at the ground with their sticks to chase the fish into the nets. The catch is placed into rice sacks and the inedible fish are discarded. This process is done 4 - 5 times in different areas of the reef flat, depending on tide levels. Once back at land, the group leader sorts the catch according to species and divides it equally among all group members. The women rinse and clean most of the fish on site. Some women head directly into the village market to sell or trade their catch, while others take it home.

[12] Gillnets are only used in Mitsamiouli as they have been locally banned in Hantsindzi and Chindini by the fishermen's cooperatives.

3.1.2. *Baskets and cages*

Women who fish in pairs often use handmade baskets or cages. There are a variety of designs made from different materials; e.g., palms from coconut tree leaves, tree roots or branches, or iron. Women may use one large basket (or cage) or several (>5) small baskets at once. The baskets are placed against the current and fish are chased into the baskets either by a stick or throwing small rocks.

3.1.3. *Pipes and spears*

A number of fisherwomen specialize in catching octopus and often use a combination of iron pipes (~3m) and iron or wooden spears (~2m). The iron pipe is used to pry open coral or rocks when an octopus is spotted inside while the spear is used to stab and extract the octopus. In deeper waters, women habitually use their foot to catch octopus by provoking the octopus to wrap itself around the fisherwoman's ankle and then lifting it up to her hand. In some regions (outside the study sites) where environmental awareness raising has led to the informal prohibition of iron rods and spears, women will use wooden spears with the tips daubed in lime to kill octopus. Spearing is also used to capture large fish at low tide and is commonly employed while night fishing.

3.1.4.*Handlines*

Though less common among women, some use a hook and line to fish at low tide – either during the day or at night. While even rarer, a small number of women (>5) in the study area occasionally fish from traditional canoes using handlines in nearshore areas.

3.1.5. *Ichthyotoxic plants*

The plant *Tephrosia vogelii*, locally known as *uruva*, is traditionally used by female fishers. As with most ichthyotoxic plants, *uruva* functions by poisoning fish so that they rise to the surface for air and can be easily captured. On Ngazidja, the leaves of the *uruva* plant are normally prepared by pounding them into a paste with lime or tobacco and then rolling the paste into small balls which are then wrapped in fresh leaves (e.g., from the taro plant). Oftentimes, however, fisherwomen will simply crush and sprinkle the *uruva* directly over the fishing area as this seems to be equally effective (Bourgois, 1989). The use of *uruva* for fishing has been locally banned by a number of villages due to its widespread, non-selective killing effects (e.g., Bourgois notes that during a 3 hour fishing trip, 50 - 60kg

of fish may be obtained via this method). While *uruva* is still used throughout the three islands, it is not currently used in any of the study sites, either because it was banned or does not grow in those areas.

3.2. *Fishing Effort*

Most women fish only during spring tides (as these are periods with the lowest tides), which equates to approximately 3 - 5 days twice a month; some, however, fish as often as 6 - 7 days a week. Of the women interviewed, the average number of fishing days was 12 days/month. Fisherwomen's activities are highly opportunistic; therefore, if the tide level, sea, and resource productivity conditions are good, then most fisherwomen will be at sea. The most productive fishing season for women is from November – April (locally known as the season of *Hasihazi*) when juvenile fish are found in abundance in the seagrass habitats and shallow reefs of intertidal areas. Most part-time fisherwomen (Table 1) fish only during this season.

The majority of women fish during the day, though at times they may also fish at night, again depending on tide levels and fish productivity. Women in Chindini and Hantsindzi fish an average of 2.5 hours/day, whereas women in Mitsamiouli fish for an average of 4 hours/day. The difference in fishing time is likely due to Mitsamiouli's much larger reef flat and seagrass bed, leading to a greater area being exposed for longer periods at low tide. As harvesting is primarily opportunistic, fisherwomen using nets or cages take whatever is edible and lands in their gear, regardless of size or species. Inedible fish are released at sea and consist only of fish considered poisonous for consumption (e.g., puffer fish). As such, catch composition is primarily composed of small and juvenile reef fishes, though some women also manage to catch larger fish that get trapped inside the reef flat when the tide goes out. Only mollusks (e.g., octopus, squid, and various bivalves) are targeted at an individual species level, mostly by women using spears as their gear is highly selective. During interviews, fisherwomen listed a total of 30 most frequently caught fish species and categorized their importance according to taste, nutritional value, and market value.

Accurate catch numbers for fisherwomen were difficult to obtain as weight scales are not available and women either stated catch numbers per kilogram (kg), per number of 25kg or 50kg rice sacks of fish obtained, or per number of fish. Some women noted how much they catch as a group while others stated how much they obtain on their own. For analysis, all catch data was standardized to

reflect the weighted amount (kg) caught per person. When numbers of fish were provided (as opposed to weight), size and species were also given, and a total catch weight was then estimated. For rice sacks, the weight of juvenile reef fish was calculated to be 1.3 times the weight of rice[13]. Therefore, for this study, a 25kg sack of rice is equivalent to 32.5kg of fish, while a 50kg sack of rice is equivalent to 65kg of fish. To provide as accurate an estimate as possible, these calculations take into account that rice sacks of fish would not be completely full; e.g., to allow women to close and carry the sacks with relative ease.

Average catch numbers for fisherwomen in Chindini were 6.21kg/day per person and 6.38 kg/day per person in Hantsindzi; however, this fluctuated from 0.5 - 20kg/day depending on effort, season, and gear. By contrast, the average catch number per person in Mitsamiouli was 9.8kg/day and ranged from about 2 – 15kg/day. The greater average catch number in Mitsamiouli is likely because women in Mitsamouli fish for almost twice as long as the women in the other two villages and have access to a larger fishing area. Moreover, women in Mitsamiouli tend to fish in much larger groups, resulting in larger catch numbers. Catch rates were also broken down per gear type for Chindini and Hantsindzi (Table 13) and were calculated based on the amount caught per number of women using each gear type. Mitsamiouli is not included as those interviewed use only one fishing method and gear type (sheets and gillnets). Results suggest that women are able to catch more per person using sheets and nets than other gears (Table 13). However, the catch ranges also show that a skilled fisherwoman using gears other than nets can obtain relatively high catch numbers. To contextualize these results, a study from the island of Zanzibar in Tanzania showed that fisherwomen obtained similar catch numbers per person (2 - 17kg/day) when using mosquito nets at low tide (Jiddawi & Öhman, 2002).

Table 12 - Estimated individual catch numbers per gear type in Chindini and Hantsinzidi

Fishing method	Average catch per person	Catch range per person
Mosquito Nets or Sheets	7.97kg	3– 20kg
Baskets and Cages	3.66kg	2kg – 10kg
Iron rods	3.75kg	0.5 – 10kg
Line and hook	7.5kg	5 – 10kg

[13] Rice sacks filled with similar sized fish were weighed in order to provide weight estimations for this study.

By taking the estimated average catch per person per study site and a conservative average of 10 fishing days/month and multiplying this by the number of full-time versus part-time fisherwomen (Table 12), rough estimates of the amount being harvested per community can be calculated (Table 14).

Table 13 - Estimated average catch numbers (kg) per study site

	Chindini	Hantsindzi	Mitsamiouli
Average per person / month	62.1	63.8	98
1 month in high season	4968	5104	7840
High season (Nov-Apr)	29,808	30,624	47,040
1 month in low season*	621	3190	5880
Low season (May-Oct)	3726	19,140	35,280
Year Total	**33,543**	**49,764**	**82,320**

*There are 10 full-time fisherwomen in Chindini, 50 in Hantsindzi, and 60 in Mitsamiouli. These calculations are based on the assumption that only these women will fish during the low season, while all 80 women will fish during the high season.

The catch rates provided in Table 14 are rough estimates and only reflect seasonal variations in terms of the number of women fishing; however, they do provide a general idea of what monthly, seasonal, and yearly catch numbers may look like. Moreover, as this is the first time an attempt has been made to quantify fisherwomen's catch rates for the Comoros, the estimates will be useful as a working baseline.

3.3. *Resource status trends*

In addition to documenting women's fishing practices and effort, the study gathered information on the overall condition of the marine resources and habitats harvested by women. This was of particular importance considering the push to close the female fishery. For this section, women were asked whether they had observed any changes in the abundance, size, diversity, or locations of their catch[14]. Interestingly, consistency in responses to these questions was very high – both within and between villages, providing reasonable evidence to suggest that resources and habitats in inter-tidal

[14] Responses from fisherwomen in Mistamiouli have been omitted from section 3.3 as there were misunderstandings regarding the questions being asked and responses may therefore not be accurate.

areas in the study sites have declined significantly. Of the women interviewed, 100% stated that there has been a decline in catch abundance, 80% stated that mean fish size has become smaller, 86% noted declines in the diversity of species composition (notably, 32 species were listed as either having become rare or disappeared), and 86% noted declines in the habitats in which species are now found. All of these declines were observed within the last 10 years. These findings correspond with results from the larger study where 75% of the traditional canoe fishermen interviewed in four villages noted declines in the quantity of nearshore species (Hauzer, 2011*a*).

Fisherwomen attributed these declines to an increase in the number of fisherwomen (i.e., overfishing), the use of destructive fishing methods (i.e., mosquito nets and dynamite[15]), environmental destruction (e.g., pollution and dredging which has caused the disappearance of seagrass and reef habitats), and capturing juvenile fish species. As possible solutions to the declines, women suggested: periodic fishing closures to allow resources and habitats to regenerate, prohibiting the use of destructive gears and techniques, and allowing juvenile fish to mature before capturing them.

3.4. *Livelihood contributions*

3.4.1.*Household subsistence*

The vast majority of families in coastal fishing communities consume fish every day, and when available, with every meal. In Chindini and Hantsindzi, women maintained that fish is their main source of protein and vitamins, partially because they can seldom afford other forms of protein, but also because they believe fish to be much higher in calcium and nutrients than meat or poultry. Households in Mitsamiouli, on the other hand, tend to consume fish 3 - 5 days a week and alternate between consuming fish and poultry or beef. This is likely due to Chindini and Hantsindzi being remote villages centered predominantly on fishing, making fish constantly available. Moreover, Mitsamiouli is a larger and more developed town than the other two study sites, and fishing within the community is less prominent than other major fishing villages. Being a larger community, livelihoods in Mitsamiouli are also more diverse and average monetary wealth is higher, making other meat sources more accessible.

[15] Dynamite was used by fishermen years ago; however, some believe that certain areas (e.g., reefs) have yet to recover.

Of the fish caught by women, 40% - 100% is used for household consumption while the rest is either sold or traded for other foods such as bananas or cassava. Fish may be sold individually, as a pile, or per kilogram. Individual fish prices range from 50KmF - 1000KmF [16] depending on the size of the fish. A small pile of fish usually sells for 500KmF, or a kilo of fish may be sold for 500 - 1500KmF depending on the species and general availability and abundance of fish. An octopus may be sold for 200KmF - 1000KmF, depending on its size. Other cephalopods and crustaceans are generally reserved for household consumption. Fish is most often sold at either the local village market or taken to inland villages where it can be sold quickly and at a higher price.

Women who sell a portion of their fish earn between 500KmF/day - 15,000KmF/day depending on the season and catch effort. The average income was 2,900KmF/day. Fishing was the main or only source of income for the majority of the women, and most were very satisfied with the amount they received, even though it is mostly periodic. Fisherwomen's earnings are primarily used for household needs such as purchasing food and household goods. Some women were able to furnish their entire home with basic necessities (e.g., pots, plates, mattresses) from the income earned through fishing. Other women fish to earn a small amount of supplementary spending money (e.g., 500KmF/day) to enable them to purchase simple items they could not normally afford. In households where both the wife and husband are fishers, the husband's catch is often sold while the wife's catch is used for consumption. This allows the family to generate additional income as without the wife's catch, the husband would be required to keep a portion of his catch for the household. Moreover, most Comorians prefer the taste of reef fishes and believe them to be of superior quality and nutritious value compared to the oceanic pelagic species often caught by men. Thus, the fish brought in by women are greatly appreciated within a household.

3.5. *Informal management systems*

3.5.1.*Structure and Organization*

Fisherwomen participate in informal fisheries management through village-based working groups or cooperatives. Working groups tend to be very informal and created among friends to share labour and fishing gear. They are often quite small, comprising from 2 - 10 fisherwomen. Cooperatives,

[16] KmF = Comorian Franc. 492KmF = 1€

on the other hand, can have more than thirty members and are more formal in structure and function. For example, they often have managerial roles (e.g., president, vice-president, secretary) and rules regarding member contributions. Most of the working groups and cooperatives have been in operation for 5 - 10 years and were created as a means to share the work and increase harvests, collectively pool money to purchase equipment, and to unite and empower fisherwomen through collective organization. The organizations also act as an important forum for sharing skills and passing on knowledge to younger generations. Villages may have multiple combinations of working groups and cooperatives. Hantsindzi and Mitsamiouli, for example, have groups and cooperatives greatly varying in size, structure, and management. Chinidini, on the other hand, has no organized working groups or cooperatives; women simply arrange to fish together when so desired, while others fish alone.

3.5.2.*Member contributions*

Although each cooperative has its own specific rules regarding member contributions, they all require that a member donate a portion of their daily catch. The amount is often based on whether the group leader(s) personally purchased all the fishing equipment or whether the equipment was purchased by the group. In general, the daily catch is divided equally among members and one or two parts will go towards the fishing materials. Individual members usually decide whether to keep or sell their own portion. When there is a particularly large harvest, fisherwomen take a portion for household consumption and the rest is sold as a group. In some cooperatives the money from fish sales is immediately divided among members, while in other cooperatives the money is used to buy new fishing materials or accumulated until the end of the month (e.g., once they have 50,000 - 100,000KmF) when it is distributed equally among members. The division of catch can be a bit confusing as multiple working groups and/or individual fishers may fish with another cooperative. So, for example, a group of fifty women may fish together, but within that group there may be separate working groups as well as fisherwomen who are not a part of any group. In these situations, those who are not members of the cooperative simply take their portion of the catch and do not contribute towards the cooperative.

3.5.3. *Fishing regulations*

The fisherwomen in Hantsindzi and Chindini maintain a small number of informal fishing regulations; i.e., gear and spatial restrictions. These rules, however, were not necessarily implemented by women as a means to better manage their fishery; it was more a result of adhering to community

regulations set out by male fishers or due to other extraneous affairs. For example, in Chindini and Hantsindzi a gillnet ban was imposed by the local fishermen, as was the use of *uruva* in Chindini. Both regulations are respected by the fisherwomen of these villages. Similarly, in Hantsindzi, the fisherwomen have strict regulations on fishing boundaries and do not allow women from the neighbouring village, Ndroudé, to fish in what they claim as their territory. Conflict over these disputed boundaries has been occurring for years and remains unresolved; however, the conflict (and subsequent regulation) seems to be more a symptom of historical tension between the two villages, rather than specifically related to fisheries. Even so, the regulations are strictly enforced; e.g., when the fisherwomen from Ndroudé set gillnets in the disputed fishing area, the Hantsindzi fisherwomen will destroy their nets and take all the fish.

4. Discussion

4.1. *Destructive fishing practices*

Although determining the ecological impacts of women's fishing methods was beyond the scope of this study, the documentation of their practices does provide some indication that women's gear choice and methods could be contributing to the perceived declines in nearshore marine resources and habitats. The use of sheets and mosquito nets is especially likely to have direct impacts on the composition and abundance of species found in intertidal zones as the catch is primarily composed of immature fishes. This can lead to cascading effects such as species declines, or changes in habitat structure and species composition (Campbell & Pardede, 2006). Although the presence of juvenile fish in catches does not necessarily indicate recruitment overfishing (Mahon & Hunte, 2001; Mangi & Roberts, 2006), future management strategies should err on the side of caution. The challenge is that even though catch rates for women's other methods are relatively sizeable, mosquito nets and sheets are by far the most effective gear (Table 13). Thus, management interventions which ban or restrict the use of sheets or nets could be difficult to implement unless comparably profitable alternatives are available. Moreover, further studies are needed to determine the extent and severity of the impacts of women's fishing gears and techniques. Even so, it is clear that some gears and practices are more destructive than others. The use of iron rods and spears for octopus fishing, for instance, is less widespread than sheets or mosquito nets, though damage can be intense as coral is sometimes smashed to capture hiding octopus. Educating women not to smash coral and providing them with alternative techniques,

however, would be relatively simple to implement. Of the different gear types and techniques, cages seem to have the least impact on either habitat or resources as they capture few species and remain stationary in the water for a short period of time.

The trampling of seagrass beds and reef flats is also a concern. Seagrass beds are one of the most productive ecosystems on the planet, particularly in the tropical Indo-Pacific region (Björk, Short, Mcleod & Beer, 2006; Duarte, 2002). They provide important shelter and nursery grounds for a variety of fish and invertebrates (Nagelkerken, van der Velde, Gorissen, Meijer, van't Hof & den Hartog, 2000), and their importance in terms of carbon sequestration is being increasingly documented (Duarte et al., 2010; Kennedy & Björk, 2009). Seagrass beds tend to be highly susceptible to disturbances from trampling and can take a long time to recover (Eckrich & Holmquist, 2000; Milazzo, Chemello, Badalamenti, Camarda, & Riggio, 2002). Likewise, walking on reef flats can also result in the direct breakage of live corals which can eventually lead to a reduction in live coral cover and affect the overall health of reef ecosystems (Eckrich & Holmquist; Hawkins & Roberts, 1993; Mangi & Roberts, 2006). Women are likely to have direct contact with corals and seagrasses as their methods involve walking in large groups on reef flats and seagrass beds at low tide. Personal observations[17] of reef flats in the study sites reveal that they are highly degraded, though it is unknown to what degree this is due to fisherwomen's harvesting activities or other factors; e.g., damage caused by boat hulls and engines, or the 1998 coral bleaching (Wilkinson et al., 1999).

A study on the impacts of trampling on seagrass conducted by Eckrich and Holmquist (2000) in Puerto Rico showed that substrate firmness in seagrass habitats can reduce vulnerability to trampling and that in comparison to sessile organisms, fish assemblages were less likely to change significantly. They also found that some species of seagrass are more resistant to damage and tend to recover faster than others. On Ngazidja, there are eight species of seagrass (Blake, 2008) and seagrass beds in the north of the island are very robust; i.e., made of a hard substrate and often raised a few feet off the seafloor. Thus, in light of Eckrich and Holmquist's findings, one could hypothesize that the seagrass beds on Ngazidja are more resistant to disturbance from trampling and have higher recovery rates than seagrass beds with fewer species and softer substrates. In order to reduce degradation, Eckrich and Holmquist suggest that trampling by large groups should be limited and confined to smaller areas with

[17] The author led a number of marine research projects in the Comoros, one of which involved mapping seagrass beds around the island of Ngazidja. Thus, she observed firsthand the condition of reefs and coastal habitats around the islands.

hard substrates - but implementing this for a fishery which targets mobile species would be challenging. Nevertheless, various management strategies which address the above issues need to be explored because the long term effects of continuous trampling could be detrimental to not only valuable and vulnerable ecosystems, but also fisheries.

As seen in section 3.3, responses to questions regarding changes in resource conditions were extremely consistent. As such, it is likely that fisherwomen will be open to management strategies which promote conservation measures since they already recognize that there is a problem, and some even admitted that it is due in part to destructive fishing methods. Moreover, it is promising that many of the women themselves suggested relatively strict management regulations to help reverse declines; e.g., gear bans, seasonal closures, size restrictions. Also, considering the high compliance rate to the gillnet and *uruva* ban, it appears that fisherwomen are highly receptive to, and respect, the regulations set out by fishermen. Including fishermen in discussions with fisherwomen regarding conservation measures or changes in fishing techniques could be an effective approach. It would also provide legitimacy to the fisherwomen's otherwise marginalized sector, likely leading them to be more amenable to incorporating management strategies into their fishery. That said, it is also important to acknowledge that other factors (e.g., pollution, erosion, sand extraction, dredging) may also be contributing to the perceived local declines in marine resources and habitats. Thus, while avoiding destructive fishing practices is an important step, it alone may not result in substantial improvements in marine ecosystem health. The ultimate goal should eventually be a more holistic approach to marine resource management and conservation.

4.2. *Livelihood contributions*

The contribution of fisherwomen's subsistence activities to the economic and social well-being of households in coastal communities should not be overlooked. Food security is a serious issue for many households in coastal villages around the Comoros. The supplementary fish and seafood harvested by women, therefore, supplies important proteins and nutrients for families who might not have otherwise had access to such foods. The critical importance of fish within a diet - both as a source of protein and nutrients - is now widely recognized (FAO, 2007). In addition, because the small fish caught by women are consumed whole, they provide much higher amounts of micronutrients (i.e., calcium, iron, and vitamin A) than large fish (FAO, 2007). The contribution of small fish to food security, therefore, is significant, especially considering the extent of nutritional deficiencies in the Comoros.

However, research is still needed to verify whether harvesting these juvenile species can be sustainable, and whether the contribution of small fish is imperative for local diets.

On all three islands, alternative livelihoods for women located outside the capital city are very limited, consisting primarily of petty trade. Thus, although the income derived from fishing can be relatively little and intermittent, it is nevertheless an important source of revenue. Even the harvests themselves contribute to overall household income by freeing-up money which would have been used to purchase food. Likewise, if a fisherwoman is married to a fisher, it allows for all of his fish to be sold, which generally obtains a higher market price than women's fish. Although poor households in the Comoros consist of 5.2 - 6.6 members (Meyer, Nelson, & Black, 2006), it is common for one person or family to assist a number of additional dependents, either for subsistence (i.e., meals, shelter) or economic support. The supplementary food and income provided by women helps to alleviate the stress placed on the household provider(s). An end to this food and income supply could mean the difference between being able to provide for one's family or not. For some families, stopping fisherwomen's harvesting activities could mean eliminating their only semi-consistent form of protein-intake and food high in nutritional value. As women play a central role in poverty alleviation and food security (FAO, 1997), effort should be made to maintain and improve their ability to participate in subsistence livelihoods and income generating activities - not eliminate the only one they have.

4.3. *Cultural and social importance*

Fishing is an important social activity which facilitates the sharing of knowledge and experiences, and reinforces women's collective bond and connection to the sea. Fishing is part of their cultural identity and their role within communities. For example, expert fisherwomen are often highly respected within their villages and frequently sought to answer questions related to fishing techniques or the marine environment. As such, they play an important role as educators of new generations. Moreover, as fisherwomen contain very place-specific knowledge, the information they hold could be useful for future research or management projects. To take away their fishery altogether would be a great loss of knowledge, history, culture, and future potential. Thus, a balance must be sought between ensuring cultural and livelihood rights, and improving marine conservation.

4.4. *Informal cooperatives and fisheries management*

Concerns regarding the negative environmental impacts of the women's fishery are not unfounded. The combination of fishing gears, techniques, catch composition, and recent fisheries trends all suggest that if things continue unchanged, women may soon find themselves with fewer and fewer resources to harvest. The most appropriate means to improving the overall sustainability of the fishery is to focus on suitable management interventions which alleviate pressure on the marine environment. The existence of informal working groups and cooperatives provides substantial potential for achieving these goals. For one, the organizations provide an easy mechanism for communication of information, and second, since fisherwomen are already collectively organized and engaged in their fishery, it is likely they will also be willing to participate in developing effective management strategies.

As most fisherwomen's working groups and cooperatives function primarily on an *ad hoc* basis, the first step to improving management would be to reinforce and strengthen their organizations. Rather than asking women to merge working groups and cooperatives into one large village-wide cooperative (as is the case with fishermen), it may be more productive to simply establish a small local governing body to oversee the female fishery within the village. The governing body could be elected by fisherwomen and would be directly involved in fisheries management and responsible for the dissemination of information. Such an approach would involve less change to the current structure and be less likely to provoke conflict; it would also hopefully unify and empower fisherwomen to take further responsibility over their fishery. Nevertheless, it is ultimately the fisherwomen in each village who need to decide on how they wish to proceed.

Following the suggestions provided by the women themselves, villages could engage in pilot studies to assess the viability of different fishing regulations and management tools. Results from the male fishery showed that compliance rates to locally created and adopted regulations are extremely high, again suggesting that similar results may occur in the female fishery (Hauzer, 2011*b*). Moreover, lessons learned from successful fisheries management practices in the region may encourage fisherwomen to test different management tools. For example, studies on the octopus fishery in Andavadoaka, Madagascar (Humber, Harris, Raberinary & Nadon, 2006) have shown strong community support for seasonal closures (i.e., temporary no-take zones) as they resulted in significant increases in the weight and abundance of octopus once the fishery re-opened. It would need to be determined

whether seasonal closures (or other management strategies) could provide similar incentives for fisherwomen in the Comoros. Thus, pilot projects could be undertaken in communities where the fisherwomen themselves suggested various management interventions.

5. Conclusions

This study has found that women's fishing and harvesting activities are of significant social, cultural, and livelihood importance to coastal communities on Ngazidja. The fisherwomen in these villages are respected leaders and knowledge-bearers who continue to provide for their families and pass on their skills to younger generations. However, there are also clear and worrying signs that the fishery may be unsustainable and may have a detrimental impact on other fisheries through juvenile capture. Nonetheless, closing the female fishery is not a recommended solution at this time. Fisheries authorities in the Comoros do not have the capacity to enforce laws, and instating a ban would create conflict and discontent. Instead, authorities should work to empower fisherwomen with the tools necessary to manage their fishery sustainably. Marine conservation and sustainable fisheries systems are facilitated when all user groups are recognized and engaged in management and policy decisions.

Following are some recommendations for management interventions and further research:

1. Reinforce and strengthen fisherwomen's cooperatives.
2. Empower fisherwomen by providing them with fisheries information and management tools.
3. Conduct pilot studies in select villages to test management tools, e.g., seasonal closures, size and/or species restrictions, gear restrictions.
4. Experiment with low-cost harvesting methods which are both sustainable and do not drastically reduce catch rates.
5. Determine the possible economic, social, cultural, and biological implications if women were to restrict or permanently close their fishery.
6. Assess the overall sustainability of the women's fishery; e.g., whether in fact their practices are detrimental to the marine biodiversity of intertidal zones.
7. Build alternative income strategies to reduce pressure and dependency on the fishery.

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Concluding Chapter

Artisanal fisheries management on Ngazidja island: Summary of key findings, lessons learned and recommendations

The overall goal of this study was to improve understanding of the dynamics and effectiveness of community-based management of marine resources, particularly in data-deficient areas where governments have little capacity to manage fisheries. As shown in the introductory chapter, the global fisheries crisis is largely purported to be a result of mis-management; i.e., of using the wrong management tools and adopting the wrong goals (Berkes et al., 2001; Jentoft, 2000; Pitcher, 2001). The challenges of establishing appropriate management strategies for small-scale fisheries in lesser developed regions was emphasized, particularly in light of the complexity of these fisheries and the limited ability for managers to consistently collect basic fisheries information (Abernethy et al., 2007; Johannes, 1998). The critical importance of small-scale fisheries in terms of their contributions to food security, livelihood security, and poverty reduction was also highlighted (FA0, 2010). In light of these issues, this study provided an example of small-scale, community-based fisheries which demonstrate clear evidence of their ability to effectively govern fisheries. As discussed in the papers, the local governing institutions on Ngazidja still need significant capacity development; however, they have create a sound platform upon which to build effective management strategies. As such, there are lessons learned from this case-study which may be applicable to other small-scale fisheries.

1. Summary of key findings

The main findings for this study are briefly summarized in correspondence with the research objectives which were outlined in the Introduction Chapter.

1.1. Describe current fishing practices and management structures

Prior to this study, fisheries descriptions for the Comoros were incomplete; e.g., fisheries management systems have never been documented, no description of female fishers exists, and records of fishing effort and gear and boat characteristics were severely outdated. This study thus sought to contribute to this gap by recording information on how fisheries are conducted and managed on Ngazidja island. This fits into the overall goal of this research as it is the first step to understanding how and why a fishery functions as it does. Paper 1 and 3 provided descriptions of fishing gears and practices

in male and female fisheries, while Paper 2 focused primarily on describing governance structures and processes.

1.2. Assess the strength and capacity of community-based fisheries governance structures and processes

This objective sought to assess the strength of fisheries management systems in terms of their ability to manage fisheries (e.g., compliance and enforcement, conflict resolution, community leadership) and the barriers to effective management. The aim was also to establish if and how village fishing associations could play a role within the framework of formal management. The results for this portion of the study were analyzed in comparison to Ostrom's (1992, 2005) and Charles' (2001) work on effective and sustainable resource management institutions and were presented in Paper 2. This paper showed how local fishing associations are characterized by qualities which empower and engage fishers and local managers, resulting in high compliance rates, social capital, and ultimately, effective governance processes. Some of the key factors to their success are:

i. Strong feelings of solidarity, trust, and reciprocity

These values (or user characteristics) are prominent among fisher communities and greatly influence behaviour. Ultimately, it is these underlying values, or feelings, which provide users with the incentive to comply with regulations.

ii. User participation in management

Fishers are directly involved in decision-making and monitoring. This results in users feeling they have a direct stake within their fishery, greatly enhancing their sense of responsibility and invested-interests.

iii. Nested enterprises

Nested enterprises are a key characteristic of both effective and sustainable institutions. Although local fishing associations demonstrate their ability to function independently, being 'nested' within larger-scale organizations provides local institutions with assistance resolving problems or conflicts when necessary. Larger organizations also have access to resources (e.g., external funding for projects, diverse management tools) that local associations may not have access to on their own. Likewise, local institutions can provide current information on marine resources that larger organizations do not have the time or resources to collect (e.g., catch composition and effort). This polycentric structure thus provides opportunity for use of a blend of knowledge sources and approaches which enhances the overall adaptability and resilience of the fishery system.

By contrast, some of the challenges being faced by local fishing associations are:

i. Limited access to scientific knowledge and a diversity of management tools

Fishers in the Comoros demonstrate extensive local and traditional knowledge of marine resources and have always managed fisheries from this framework. However, with increasing local and external pressures on marine ecosystems, fishers and local managers may need a wider range of management tools at their disposal in order to continue to adapt effectively to changing environments. The combination of local knowledge with more modern skills and approaches would likely enhance their ability to monitor resources effectively and adapt their management methods accordingly.

ii. External threats

With a high coastal population density, controlling fisher behaviour and harvests may not be enough to achieve sustainable use and conservation of marine resources. Coasts and reefs around the Comoros are under serious threat from household waste, pollution and coastal development.

1.3. Identify key resource management tools and assess their overall effectiveness

This objective sought to identify the management tools used by community-fishing associations and the effectiveness of these strategies. Community-based fisheries management tools on Ngazidja include: gear, spatial, species, temporal, and catch restrictions. Gear restrictions are the primary management tool employed, followed by spatial and species restrictions, while catch and temporal restrictions are primarily based on social taboos. Compliance rates to local regulations are very high. This is due in part to fishers' perception of the critical importance of these regulations, as well as their commitment to ensuring trust, solidarity, and reciprocity among fishers. Thus, although the results from this study do not provide extensive insight into whether regulations are effective at ensuring the ecological sustainability of the fishery, knowing that fishers perceive the regulations to be both essential and effective is critical to understanding how to approach the implementation of future regulations; i.e., these regulations are enforced and obeyed because the governing process which implemented them is effective. Thus, if future management goals are to be successful, fishers must continue to be involved throughout the process.

1.4. Identify factors which influence fisher behaviour and decision-making patterns

This objective sought to understand the factors which influence fishers' decisions on where, what, and how they fish. Although there are numerous influences on fisher behavior, the main influences can be categorized as those related to culture, perceptions, and poverty. Cultural influences

include factors such as the social taboos against greed and wastage, and the importance placed on community values such as group cohesiveness, trust and reciprocity. Understanding how fishers' view themselves, their role, and their fishery also provides significant insight into how these perceptions influence their attitudes and behaviours towards fishing. For instance, the majority of the fishers in the study sites perceived gears such as gillnets and dynamite to have been responsible for the degradation of the marine environment and previous declines in fish abundance. Many also believe that habitats and species abundance have "bounced back" since the prohibition of these gears. Thus, although it is possible that neither of these observations is accurate, these perceptions strongly dictate gear-choice, community fisheries regulations, and fishers' willingness to personally enforce these rules. Lastly, although not discussed in great detail in the papers, poverty is another major influence on fisher behaviour and decision-making patterns. The Comoros is one of the poorest and least developed nations in the world, and fisheries are one of the most vulnerable sectors. Thus, fishers are driven by a need to support and feed their families. Interestingly, however, one might assume that this drive would also lead to illegal fishing, conflicts over access-rights, and ultimately, a sort of 'tragedy of the commons'. Instead, cultural influences and effective governing processes seem to supersede these needs, leading Comorian fishers to place more value in ensuring a strong sense of community and relative equality among fellow fishers.

1.5. Identify the spatial distribution of fishing grounds and management methods

This objective sought to map community fishing grounds and the spatial distribution of fishing methods and/or management regulations. Maps of these fishing grounds were made for each village (Figure 4). The maps provided the study with a visual representation and richer understanding of the spatial distribution of fishing effort according to gear and fisher type. Understanding the spatial distribution of fishing effort will also be useful for future management regulations which may control gear types in certain fishing zones, or seek to protect certain species or habitats.

2. Lessons learned and study limitations

2.1. Fieldwork successes and challenges

Working in a remote, developing nation such as the Comoros can be challenging – infrastructure is poor, language and cultural barriers abound, and expectations (of both the researcher and research participants) are high. As such, a number of challenges were encountered along the way; e.g., keeping

communities engaged in the research and motivated to participate, ensuring effective data-recording and accurate interpretations when translating through three languages, and attempting to complete data-collection within a reasonable timeframe given unforeseen events (e.g., a nationwide fishers' strike). Nonetheless, the field research was successful, much of which is owed to preemptive and thorough planning prior to beginning data-collection. Some of the key factors which helped ensure this success were:

- Building trust with individuals and communities; e.g.,
    - Inclusion of communities and study participants in the research process
    - Continuous presence in villages
    - Research feedback mechanisms (presentations, meetings, photos)
- Working with local partners
- Having a well-known, well-liked, and unbiased local informant in each village
- Being continually transparent and honest about the research objectives, process, and goals

2.2. Study limitations

There were several key limitations to the study. The first was related to the sample size of the study. The sample size was relatively small given that the results intended to be somewhat representative of the four study sites, and even the island as a whole. The sampling of the study population itself, i.e., expert fishers, was high; however, the findings cannot be said to be statistically representative of the wider fishing communities in each study site. This leads to the second limitation which was the sample population. The sample population consisted primarily of expert fishers which may have provided skewed results for certain aspects of the study. For example, catch rates and income were likely much higher among expert fishers than would have been among average fishers. As such, these results cannot be generalized to the wider population. To address these limitations, additional data-collection methods (e.g., short, random interview surveys) could have been explored as a means to augment the information gathered for the study. However, that said, this study also sought to avoid using surveys as a study method since interview fatigue is becoming increasingly common in coastal communities in the Comoros. Thus, in the end, the two sample limitations were not detrimental as they were recognized at the outset of the research and were acknowledged within the papers. They also did not greatly detract from the purpose and final outcome of the study.

The greatest limitation of this study was probably the lack of significant ecological parameters within the scope of the study. The absence of an ecological focus left the assessment of the effectiveness of fisheries governance institutions based solely their ability to manage people, not resources. The inclusion of simple measures to assess the ecological sustainability and effectiveness of various management tools (e.g., gear restrictions) and fishing practices would have greatly strengthened the study and ensured wider applicability in terms of addressing global research gaps. The inclusion of such measures could have included, for example, systematically collecting detailed information on catch data per gear type. These results could have then been compared between villages which have implemented gear restrictions with those which have not.

3. Future research priorities and management recommendations

Based on the study's findings and lessons learned, the following is a summary of future research priorities and management recommendations. One of the core principles of this study was to conduct research of significance and relevance to fishing communities in the Comoros, and to generate low-cost, practical recommendations which would be feasible to implement by community and government fisheries authorities.

3.1. Future research priorities:

i. Assessment of the ecological sustainability of the fishery; e.g., catch effort and the impacts of gear types and fishing methods.

ii. Assessment of the ecological effectiveness of management tools. The study makes clear that governance processes and structures are robust; however, it still needs to be determined whether management methods are helping improve the ecological sustainability of the fishery.

iii. Experiment with alternative management tools; e.g., seasonal closures, size and/or species restrictions, gear restrictions, etc. in both the male and female fishery.

iv. Investigate the viability of alternative income strategies to reduce dependency and pressure on the fishery.

3.2. Recommendations for management interventions:

i. Build linkages between the National Fisheries Department, National Fishing Syndicate, and village fishing associations. An increase in cooperation and information sharing among the three levels of governance will enhance the capacity of each organization to manage fisheries.

ii. Capacity building for the three main governing bodies; e.g., village fishing associations should be better informed of the diversity of management options available to them so that they may improve and adapt management practices when necessary. Likewise, government officials need increased training in alternative fisheries management approaches; e.g., ecosystem-based management and adaptive management, as they are somewhat constrained by their training in conventional Western fisheries management paradigms. The combination of local knowledge with more modern skills and approaches will likely enhance their ability to monitor resources effectively and adapt their management methods accordingly.

iii. Increase the participation and capacity of male and female community fishing associations in fisheries management by empowering them with more knowledge and tools. This may include, for example, training expert fishers and local association authorities to gather baseline data on fisheries in their communities.

iv. Special attention needs to be paid to acknowledging, including, and working with female fishers to better understand their fishery, their needs, and their potential to be involved in improving the sustainability and management of their sector.

v. Local threats to marine and coastal ecosystems need to be addressed; e.g., household waste, pollution, sand mining.

vi. Conduct a 'futures scenarios' workshop where groups of fisheries stakeholders work together to agree on desired fisheries outcomes and how to best achieve them (see: Andrew, 2007; Pauly et al., 2002).

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Appendix A: Participant Consent Forms

1. Research Description and Verbal Consent Form

My name is Melissa and I am doing research on traditional fisheries management in the Comoros as part of my Masters at a university in Canada. I am interested in understanding how different villages on Ngazidja manage their fisheries. The research will take place over 4 months in [village 1],[village 2], [village 3], and [village 4] on a continuous basis. Part of the research involves asking fishers and villagers about their experience and knowledge of fisheries management in their own villages.

Unless you wish to be identified, I will not be using any names in this research. You are also free to withdraw from participating at any time. If you withdraw from doing an interview, the information will be destroyed. However, the information collected during focus group interviews will be grouped together, and thus, it will be difficult to omit your personal responses. Also, it is important to realize that in participating in this study, there are limits to our ability to maintain confidentiality. For example, in focus group interviews the other participants will know who you are. In addition, as I am selecting some participants upon the recommendations of others, your identity will be known by those who recommend you. Furthermore, it may be possible for your identity to be known due to the small number of participants involved in this study.

Once all the information is collected and analyzed, I hope to create a summary document to send to the Comoros to be distributed. I will also be holding a workshop at the end of October once all the information is collected so that participants will have the opportunity to discuss the preliminary findings and provide feedback. I hope that the information that I gather will be of use to your village and other villages in the Comoros, and I fully recognize that the information that I am collecting is *your* knowledge.

During the research, I will be taking digital photographs to use during presentations and possibly in reports. Do you have any objections to your photograph being taken and used in a presentation or report? If I do use your photograph, would you like me to use your name or do you prefer to remain anonymous (e.g., fisher from village X)? If at any time you change your mind about the use of your photo, please let me know and it will be erased. I will also to do my best to distribute prints of the pictures to everyone who had their photo taken.

Do you have any questions or concerns about anything?

Would you mind taking –X– minutes to answer some questions on fisheries management in your village? I may also want to interview you again to follow-up on some of your answers today. Would you be willing to participate on this project again, providing you are available?

2. Written consent form

Principal Investigator: Melissa Hauzer
Email: mhauzer@uvic.ca **Phone**: 321-3470

Title of Study: Traditional Fisheries Management in the Union of the Comoros

The purpose of this letter is to request your permission to participate in an interview on traditional fisheries management on the island of Ngazidja.

The research is part of my Master's thesis which I am undertaking at a university in Canada. For my research, I am interested in understanding how different villages on Ngazidja manage their fisheries. The research will take place over 4 months in [village 1], [village 2], [village 3], and [village 4] on a continuous basis. Part of the research involves asking fishers and villagers about their experience and knowledge of fisheries management in their own villages, as well as relevant government officials such as yourself.

Your participation in this study will be in the form of a 1 – 1.5 hour interview at a time and location of your convenience. Questions will focus on how fisheries are managed in the Comoros and the role of and relationships between government agencies, informal village fishing associations, and the national fishing syndicate. You are free to withdraw from participating at any time, and if you choose to do so, the information you provided will be destroyed.

Unless you wish to be identified, your personal information will remain confidential. However, I may distinguish your responses as either specific to your department (e.g., the Department of Fisheries) or in a more general term (e.g., National Government). Please advise as to whether this is okay.

I will also be taking digital photographs to use during presentations and possibly in reports. Do you have any objections to your photograph being taken and used in a presentation or report? If I use your photograph, would you like me to use your name or do you prefer to remain anonymous (e.g., official from the Department of Fisheries)?

Participants are not being paid to be involved in this study; however, I will be disseminating the results in the form of (1) a workshop to present and discuss the preliminary results of the study; (2) a summary document translated into French; and (3) a final workshop to present the final results once the data has been analyzed. My hope is that the information I gather will be of use to you and your department, and that further research or projects may be conducted based upon the results.

Please do not hesitate to contact me if you have any questions or concerns. My contact information is at the top of this page. Thank you for your time and I look forward to your participation in the study.

Name and Signature of participant:
Date:

Appendix B: Guiding questions for preliminary meetings

The following questions were used as a guide during preliminary meetings to gather basic information about how fisheries were conducted and managed within each community. Responses to these questions helped inform questionnaire and study design.

1. How many fishers are there in your village?
    a. How many powerboats, traditional canoes?
    b. Are there any female fishers? How many?

2. What types of fishing techniques are used?
    a. Powerboat
    b. Traditional canoes

3. Are there any fishing regulations?
    a. Boundaries?
    b. Gear prohibitions?
    c. Are there any seasons / holidays / hours of the day / days of the week / when you are not allowed to fish?
    d. Species forbidden to catch?
    e. Do the rules for fishing change during the month of Ramadan, or any other religious holiday?

4. Do you still practice traditional animistic beliefs/ceremonies in your village for fishing? What about Islamic beliefs / practices?

Appendix C: Semi-structured key-informant questionnaires

1. Interviews with current expert fishers: Local fisheries knowledge and information

Date:_____ Village:_____ Interviewer(s): _____

Name: _____ Name used for quote / photo: **YES / NO**

General

1. How old are you?

2. How old were you when you began fishing?

3. Why did you begin fishing?

4. Were your parents fishers? **YES / NO**

5. Were your grandparents fishers? **YES / NO**

6. Are / do you think your children will become fishers? **YES / NO**
6.1. Why?

7. What makes a good fisher?

8. Who taught you how to fish?

9. What did they teach you?

10. Is this how most people learn to fish? **YES / NO**

Daily Catch & Income

11. How many days do you fish per week?

12. On average, how many hours a day do you fish? (from what time to what time?)

13. What is your average daily income from fishing? _____ KmF
13.1. Is this considered a good income? **YES / NO**

14. Approximately how many kilos do you catch on average each day? _____Kg
14.1. Is this number generally consistent or does it fluctuate frequently? **Consistent / Fluctuates**
14.1.1. How?

15. Do you sell your fish **yourself** or do you **sell** / **give** it to a **vendor** to sell? (*circle answers*)

15.1.1.1. Who do you give / sell it to?

15.1.2. How much do you normally sell it for? _____ KmF per **KILO** or **FISH** or **_____**

15.1.2.1. Where? (village, market, etc.)

16. Powerboats:

16.1. How much fuel to you consume a day?

16.1.1. What is the cost of 1L of this kind of fuel?

Kind of Fuel	Liters consumed / day	Price of Fuel / L (KmF)

16.2. Do you own, rent, or borrow your boat? **OWN / RENT / BORROW**

16.2.1. How much is it to rent? OR Who do you borrow it from?

16.2.2. Who is responsible for maintenance and repairs?

16.2.3. In general, how much do you spend on maintenance and/ or repairs each month (or year)? _____ KmF / month / year

16.3. What are the advantages and disadvantages of using a powerboat rather than a traditional canoe?

Advantages	Disadvantages

17. Traditional Canoes:

17.1. Did you buy, make, or inherit your traditional canoe? **BUY / MAKE / INHERIT / BORROW**
Please explain: (e.g., *the price, where you bought, from whom you inherited it, etc*.)

17.2. How long does it take to build a traditional canoe?

17.3. Where did you get the wood to build it?

17.4. What kind of wood do you use?

17.5. How long do they normally last before you need to make a new one?

17.6. What are the advantages and disadvantages of using a canoe rather than a powerboat?

Advantages	**Disadvantages**

Local Fisheries Knowledge

18. Do you know where to go to catch certain species of fish? **YES / NO** (*explain*)

18.1. Do you know what these different species eat? **YES / NO** (*explain*)

18.2. Do you know when their reproductive season is? **YES / NO** (*explain*)

18.3. Where does this knowledge come from? (e.g., *oral history, experience, etc.*)

18.4. Is this common knowledge among all the fishers in your village? **YES / NO** (*explain*)

19. How do you know when the season is about to change?

20. How do you know when the weather or sea is about to change?

21. If you are lost at sea and can no longer see the island, how do you know how to come back?

22. Since you've been a fisher, have you noticed any changes in the:

22.1. Amount of fish caught

22.2. Size of fish caught

22.3. Species of fish caught

22.4. Areas where fish are caught

Please explain for each and note when you first started noticing these changes:

Changes in:		**Please explain:**	**Since when?**
Amount	YES / NO		
Type	YES / NO		
Size	YES / NO		
Areas	YES / NO		

22.5. What do you think may be the reason for these changes?

22.6. What solutions/actions can you suggest to improve the situation? (*only asked if relevant)*

Traditional & Religious Beliefs

23. Do fishers in your village still maintain traditional practices or beliefs related to fishing? **YES / NO**

23.1. If YES, which ones?

23.2. Why are they important?

23.3. If NOT, why were these stopped?

24. Do fishers in your village (also) practice any Islamic traditions or ceremonies for fishing? **YES / NO**

24.1. If YES, which ones?

24.2. Why are these important?

24.3. IF NOT, why?

25. Any other comments?

2. Interviews with elder fishers: Traditional knowledge & changes in fisheries practices

Date:_____ Village:_____ Interviewer(s): _____

Name: _____ Name used for quote / photo: **YES / NO**

Traditional knowledge & changes in fisheries practices

General

1. How old are you?

2. How old were you when you began fishing?

3. Do you still fish? **YES / NO / Sometimes**

4. Why did you begin fishing?

5. Were your parents fishers? **YES / NO**

6. Were your grandparents fishers? **YES / NO**

7. Are your children fishers? **YES / NO**

8. Are your grandchildren fishers? **YES / NO**

9. What makes a good fisher?

Changes in Fishing Over Time

10. Since you've been a fisher, have you noticed any changes in the:

- 10.1. Amount of fish caught
- 10.2. Size of fish caught
- 10.3. Species of fish caught
- 10.4. Areas where fish are caught

Please explain for each and note when you first started noticing these changes:

Changes in:		**Please explain:**	**Since when?**
Amount	YES / NO		
Type	YES / NO		
Size	YES / NO		
Areas	YES / NO		

10.5. What do you think may be the reason for these changes?

10.6. What solutions/actions can you suggest to improve the situation? (*only asked if relevant)*

11. Have fishing techniques changed since you've been a fisher? **YES / NO** *(explain)*

11.1. When did these changes first start to occur?

11.2. How has this affected fishing in your village?

12. Do you think the current rules on ____(*list gear prohibitions*)___ are important? **YES / NO**
12.1. Why?

13. Are there other fishing rules / prohibitions that were used in the past but are now no longer used? **YES / NO**
13.1. If YES, which ones?

13.2. Why are they no longer used / respected?

14. Are there any traditional practices or beliefs that are / were used for fishing? **YES / NO**
14.1. Which ones?

14.2. Are they still used today? **YES / NO** (*explain*)

15. Are there any Islamic practices that are used for fishing? **YES / NO**

15.1. Which ones?

16. In terms of <u>fishing</u>, what is the difference between traditional and Islamic practices / beliefs?

<u>Knowledge Distribution</u>

17. Do young fishers today possess the same kind of knowledge as you do about fishing? **YES / NO** (*explain*)

18. How will all the knowledge you have be passed on to younger generations?

19. Is it important that this knowledge is maintained and passed on to younger generations? **YES / NO**
19.1. Why?

20. Any other comments?

3. Interviews with local fisheries management authorities

Date:_____ Village:_____ Interviewer(s): _____

Name: _____ Name used for quote / photo: **YES / NO**

Management Body

1. When did your village decide to create a fishing association?
1.1. Why?

2. How does the fishing association in your village function:

2.1. Who is in charge? (*e.g., president, vice president, secretary, etc.*)

2.1.1.How are they elected?

2.1.2.How long their term? _____ years

2.1.3. Are they paid? **YES / NO** _____ KmF / month

2.2. Does your association have an official statute? **YES / NO** (*explain*)

2.3. How do you become a member of the association?

2.4. Is it compulsory for all fishers in your village to become members? **YES / NO**

2.5. Do members have to provide a contribution (monetary or otherwise) to be a member? **YES / NO**
2.5.1.How much?

2.5.2.What do the contributions go towards?

2.6. What about fishers from other islands/villages that live in your village part time, are they a part of your association? **YES / NO**

2.6.1.Is it compulsory? **YES / NO**

2.6.2. Is it the same procedure to become a member? **YES / NO** (*explain*)

3. Does your association work in collaboration with the National Department of Fisheries? **YES / NO**
3.1. How?

4. Does your association work in collaboration with the National Fishing Syndicate? **YES / NO**
4.1. How?

Management Tools Currently in Practice

5. During my initial meeting in your village I was told that __(*list according to village*)__ fishing gear/methods are forbidden.

Is this correct? **YES / NO**

5.1. Are there any other gears or methods that are forbidden? **YES / NO** (*add to list*)

5.2. Why is each one forbidden?

5.3. When was each one forbidden?

Forbidden gear / methods	**Why is it forbidden?**	**When?**

5.4. (*Referring to 5.2*) Where did this knowledge/information come from in order to decide to prohibit these methods / gears? (*e.g., was it the fishers themselves who noticed the consequences, or did the information/idea come from other villages or people?*)

5.5. Have you noticed any changes since your village stopped using these gears / methods? **YES / NO**

5.5.1. Explain:

6. In regards to the local fishing sites which have been named and identified by your village, do fishers from other villages / islands have the right to fish in these areas? **YES / NO** (*please explain*)

6.1. Do fishers from other villages / islands have the right to fish directly in front of your village? **YES / NO** (*explain*)

7. Are there any other rules concerning fishing in your village? **YES / NO**

7.1. Which ones?

Enforcement & Monitoring of Regulations

8. Who makes the rules?

9. How were they agreed upon? (*e.g., by all fishers, association's president, entire village, etc.*)

10. Are the rules written or oral? (*explain*)

11. Are the rules being obeyed? **YES / NO / SOMETIMES** (*please explain*)

12. Who monitors to make sure the rules are obeyed?

12.1. How? (*e.g., formal = regulated hours & personnel, informal = a fisher happens to notice something and informs others*)

13. How would a rule-breaker be punished?

Local Conflict Management

14. Are there any conflicts between fishers within the village? **YES / NO / Sometimes**

14.1. What were the causes of these conflicts?

14.2. What happened?

14.3. How long did the conflict last? / How long has it been going on?

14.4. Was the conflict resolved?

14.4.1. How?

Cause of Conflict	What happened?	Length of Time	Resolved?	How?
			Y / N / Sort of	
			Y / N / Sort of	
			Y / N / Sort of	

15. Are there any conflicts between fishers from your village and other villages? **YES / NO / Sometimes**

15.1. What were the causes of these conflicts?

15.2. What happened?

15.3. How long did the conflict last?

15.4. Was the conflict resolved?

15.4.1. How?

Cause of Conflict	What happened?	Length of Time	Resolved?	How?
			Y / N / Sort of	
			Y / N / Sort of	
			Y / N / Sort of	

16. Do you think conflict management in your village has been effective? **YES / NO** (*please explain*)

16.1. How might it be made more effective?

17. Any other comments?

4. Interviews with expert female fishers: Fishing methods and knowledge

Date:_____ Village:_____ Interviewer(s): _____

Name: _____ Name used for quote: **YES / NO**

General

1. How old are you?

2. How old were you when you began fishing?

3. Was your mother a fisher? **OUI / NON**

4. Were your grandmothers fishers? **OUI / NON**

5. Are / Do you think your daughters will be fishers? **OUI / NON**
5.1. Why? (*only ask if not old*)

6. (*If old*) Are / do you think your granddaughters will be fishers? **OUI / NON**
6.1. Why?

7. Why do you fish?

8. What makes a good fisher?

9. Who taught you how to fish?

10. What did they teach you?

11. Do the majority of fisherwomen in your village learn the same way? **OUI / NON**
Explain:

12. Are you a member of the fisherwomen's association? **OUI / NON**
12.1. If NO, why not?

12.2. If YES, what are the benefits to being a member of an association, as opposed to fishing on your own?

Fishing Techniques

13. What fishing equipment do you use?

14. How do you use each one?

15. Do you buy or make or ___ your equipment? (*e.g., inherit, trade, etc.*)

Equipment	How is it used?	Bought? Made? Or?

16. In general, do you fish alone or in a group?
- 16.1. If in a group, how many fisherwomen are there usually in your group?
- 16.2. If in a group, how is the catch divided?

17. Where do you fish?

18. Do you fish during low tide or high tide? Or both?

19. Do you fish during the day or at night? Or both?

20. How many days per week _____? Or month _____?
- 20.1. Be specific (*e.g., only during the low tides of full/new moons? etc.*) :

21. How many hours do you fish on average per day? _____ hrs/day

22. During which season(s) do you fish?
Hasihazi **Kusi** **Mbeni** *(circle answers)*

- 22.1. Why?

- 22.2. Have you always fished during this/these season(s)? **YES / NO**

  - 22.2.1. Explain: (*e.g., why do you no longer fish during [season X]? **OR,** Why do you now fish during more seasons*)?

23. What are the main species you are targeting OR which species are preferred?

- 23.1. What is the importance of each one? (*e.g., taste, economic value, etc.*)

- 23.2. Make note of whether they are targeting specific species (e.g., octopus) or whether their catch is simply opportunistic (e.g., taking whatever lands in their nets/cages)

- 23.3. Are the species you are catching generally juveniles or adults?

Species	Importance	Opportunistic or Targeted?	Juveniles or Adults?

Daily Catch & Income

24. How many kilos of fish do you catch on average per day? _____ Kg (*Note whether individual or group catch, and specify amount; e.g., in rice sacs or buckets; e.g., 25kg rice sac or 5L bucket?*)

24.1. How many kilos (or rice sacs) do you generally catch during:

Hasihazi:_____ Mbeni: _____ Kusi: _____

24.2. Do you catch the same amount in each season as you did before? **YES / NO**

24.3. If NO, has this increased or decreased, and in which seasons? *(circle answers)*

Hasihazi: Increase / Decrease / Same

Mbeni: Increase / Decrease / Same

Kusi: Increase / Decrease / Same

25. What do you do with the fish you catch? (*circle all that apply*)

Sell Eat Trade Other:_____

If both eat & sell/trade :

26. What percentage is for your home_____ % what percentage is sold/traded _____% ?

If you sell :

27. Who sells the fish?

27.1. How much is it normally sold for? _____ KmF **FISH** or **KILO** *(circle answer)*

28. On average, what is your income per day? _____ KmF

28.1. Is this considered a good income? **OUI / NON**

28.2. Why?

28.3. What do you use this money for?

Household Importance

29. How many meals of fish/seafood does your family eat per day?_____ / week_____?

29.1. Is this similar for most families in your village? **OUI / NON**

Changes in the resource

30. Since you've been fishing, have you noticed any changes in:

30.1. The quantity of fish caught

30.2. The size of fish caught

30.3. Species which have disappeared or become rare?

30.4. The zones where fish are caught

Please explain for each and specify the reason for these changes, and when you began to notice these changes?

Changes in:		**Explanation:**	**Reason :**	**Since when?**
Quantity	Oui / Non			
Size	Oui / Non			
Species	Oui / Non			
Zones	Oui / Non			

30.5. What solutions can you suggest to improve the situation?

Importance / Sustainability of Activity

31. What would happen if you had to stop fishing?

32. Do you think any of the fishing techniques used in your village (whether your own or others) are having a negative impact on the environment and/or fish stocks? **YES / NO**

32.1. Which techniques:

32.2. How are they having an impact:

32.3. Can you suggest any alternate methods/gears which may be less destructive?

33. Would you be willing to try alternative methods which might help to ensure that women could continue fishing in these areas for years to come? (*e.g., alternate gears, temporary closures of certain areas, etc.*) **YES / NO**

33.1. Explain:

Traditional and Religious Beliefs

34. Do fisherwomen use traditional (animistic) practices for fishing? **OUI / NON**

34.1. If YES, which ones ?

34.2. Why are they important?

34.3. If NOT, why have they stopped?

35. Do fisherwomen use Islamic practices for fishing? **OUI / NON**

35.1. If YES, which ones ?

35.2. Why are they important?

35.3. If NO, why not?

5. Interviews with Leaders of female cooperatives: Local fisheries management initiatives

Date:_____ Village:_____ Interviewer(s): _____

Name: _____ Name used for quote: **YES / NO**

Management Structure

1. When was the fisherwomen's association created?

1.1. Why was it created?

1.2. Who decided to create it?

2. When did you decide to create an official statute for your association?

2.1. Why did you decide to make it official?

2.2. What are the benefits of making your association official?

2.3. Would you recommend to fisherwomen in other villages to make their informal associations official? **YES / NO**

2.3.1. Why?

3. Who is in charge of the association? (e.g., président, vice-président, secrétaire-générale, contrôler, trésorier, etc.)

3.1. How are they elected?

3.2. How long is their term? _____ years

4. Does your association collaborate in any form with the National Fisheries Department? **OUI / NON**

4.1. How?

5. Does your association collaborate in any form with the National Fishing Syndicate? **OUI / NON**

5.1. How?

Membership

6. How does someone become a member of the association?

7. Is it obligatory for all fisherwomen to be a member of the association? **OUI / NON**

7.1. Why?

8. Do fisherwomen provide a contribution (money or otherwise) to become a member? **OUI / NON**
8.1. How much?

9. Are members required to provide contributions (money or otherwise) to remain a member? (*e.g., monthly fees/contributions*)

9.1. How much?

9.2. How often?

10. What are contributions used for?

Fishing Regulations

11. Are there any fishing methods which are prohibited? **OUI / NON**

11.1. Which ones?

11.2. Why are they prohibited?

12. Are there any rules which prohibit women to fish during certain : (*circle all that apply & explain*)

Times of Day Days of the Week Seasons Zones Other:_____

12.1. Explain:

13. Are fisherwomen from other villages allowed to fish directly in front of your village; i.e., in your fishing zones? **OUI / NON**
13.1. Explain:

14. Does your association have any other fishing rules? **OUI / NON**
14.1. Which ones?

15. Who creates the rules?

16. How are the rules created? (*e.g., did everyone vote on the rules or did the president decide on the rules?*)

17. Are the rules oral or written?
17.1. Explain:

18. In general, are the rules respected? **OUI / NON / Sometimes**
18.1. Explain : *(e.g., which ones are most often respected and which ones are most often not respected)*

19. Who enforces the rules?
19.1. How are they enforced?

20. What sorts of punishments are used for someone who does not follow the rules?

21. If there are NO rules, why aren't there any?

Local Conflict Management

22. Are there / have there been any fishing-related conflicts between the fisherwomen of **your village**?
Oui / Non / Sometimes
22.1. What was the cause of the conflict?

22.2. What happened?

22.3. How long did it last / How long has it been going on?

22.4. Was the conflict resolved?
22.4.1. How?

Cause of conflict	What happened?	How long?	Resolved?	How?
			Y / N / Sort of	
			Y / N / Sort of	

23. Are there / have there been any fishing-related conflicts between the fisherwomen of **your village and other villages**? **Oui / Non / Sometimes**
23.1. What was the cause of the conflict?

23.2. What happened?

23.3. How long did it last / How long has it been going on?

23.4. Was the conflict resolved?
23.4.1. How?

Cause of conflict	What happened?	How long?	Resolved?	How?
			Y / N / Sort of	
			Y / N / Sort of	