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The social-ecological dynamics of fisherwomen's behaviour in northern Mozambique.

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Declaration of authorship

This is to certify that that the work contained within has been composed by me and is entirely my own work. No part of this thesis has been submitted for any other degree or professional qualification.

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ABSTRACT

Design of effective interventions that support fisherwomen's livelihoods and fisheries sustainability requires a comprehensive understanding of their behaviour, and the social and ecological context in which fishing takes place. However the tendency to analyse the biological and social components of the system separately has limited our understanding of fisheries as complex social-ecological systems. In addition, knowledge of women's fishing behaviour lags far behind that of their male counterparts even though women are particularly vulnerable to marine resource degradation and global change. This thesis addresses this knowledge gap by studying the social and ecological dynamics of a female intertidal fishery in coastal Mozambique.

Field research was conducted over 18 months on Ibo Island in Cabo Delgado province. Methods used included semi-structured questionnaires, an intertidal catch survey, participatory techniques and ethnographic methods such as observation and informal interviews. The research starts with an analysis of the long-term change of women's fishing behaviour in relation to the developing social, political and economic context in the region. Fisherwomen's daily fishing effort is then analysed using general linear mixed models to demonstrate the combined influence of environmental and socioeconomic drivers in an octopus fishery. Following from this, with the application of a cluster analysis, the thesis explores octopus fishers' relationship to the fishery by challenging common assumptions of homogeneity among fisherwomen. Finally the cultural, social and regulatory norms that structure octopus fishing within the community are assessed via institutional mapping.

The research shows that this social-ecological system is characterised by significant temporal and spatial variation in women's intertidal fishing activities. Fisherwomen are not a homogenous group, and there are clear differences in socioeconomic profiles and fishing effort, linked to characteristics of vulnerability. Although fisherwomen remain limited in the gear types and techniques they use, the fishery has experienced substantial changes in terms of resource availability and access, due to both local use and fishing ground restrictions related to conservation and tourism. A defining feature of this female fishery is the degree to which time constraints and local gender norms influence women's fishing behaviour.

The thesis concludes with a summary of the emergent properties of this social-ecological system, and considerations for socially and gender-sensitive fisheries interventions in the region.

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List of Acronyms

CPUE	Catch Per Unit Effort
SE	Social-ecological
SES	Social-ecological system
SSF	Small-scale fisheries
QNP	Quirimbas National Park
WWF	World Wildlife Fund
IFD	Ideal Free Distribution

Introduction

Chapter 1

Octopus fisherwoman on Ibo Island.

1.1 Introduction

This thesis aims to contribute to knowledge on small-scale fishers in developing country contexts, by exploring the behavioural dynamics of fisherwomen in intertidal fisheries in northern Mozambique. The lack of understanding of fisher behaviour has contributed to what many believe has been a failure of fisheries policies and management approaches to achieve effective and equitable outcomes (Wilen et al. 2002; Salas and Gaertner 2004; Fulton et al. 2011; Jentoft and Eide 2011). Part of the problem with attempts to understand fishers better has been the tendency to study the different components of what is a complex social-ecological system in isolation (McClanahan et al. 2009; Cinner 2009). In addition, in an oversight that represents approximately half of all people involved in small-scale fisheries women's role in SSFs in both theory and practice has largely gone 'unnoticed', 'undocumented' and 'underestimated' (Weeratunge et al. 2010; Fröcklin et al. 2014; FAO 2016; Ogden 2017).

A lack of data on fisherwomen has no doubt exacerbated their marginalisation from management. When women remain marginal to fisheries' management it makes them vulnerable to being disproportionally affected by poorly adapted and inappropriate interventions and policies that have not taken into account their fishing practices and needs. Research has already shown that fishers disproportionately bear the costs of management measures when they are poorly adapted to their livelihood systems, leading to unintended outcomes such as effort displacement or elite capture (Powers and Abeare 2009; Walker and Ronbinson, 2009; Mascia, 2010; MacNeil and Cinner, 2013). It is now widely accepted that such unintended outcomes, particularly for women is detrimental to the overall sustainability of the fishery (Alves Figueiredo 2015; Harper et al. 2013; Williams 2002).

This lack of data and integrated assessment of small-scale fisheries is both a concern for researchers and practitioners, and potentially damaging to the livelihoods of those who are more vulnerable to changes in fisheries' resources. The practical challenge remains to conserve marine resources whilst protecting fishers and fishing communities from unjust or harmful effects of fisheries' decline or the very management interventions designed to prevent this decline. This thesis adopts a

social-ecological systems theory as a framework in which to explore women's intertidal fishery, and contribute to the state of knowledge on fisherwomen and the social drivers of their behaviour.

The chapter continues with a definition of small-scale fisheries, a review of the state of knowledge on fisherwomen in SSFs, previous research on fisher behaviour, and women's intertidal fisheries in the West Indian Ocean (WIO). The latter part of the chapter introduces the theoretical and conceptual framework adopted in the thesis, and lays out the research questions addressed here.

1.2 Small scale fisheries

1.2.1 Small scale fisheries and fishers: a working definition

The Food and Agriculture Organisation of the United Nations (FAO) define a fishery as:

> *"A unit determined by an authority or other entity that is engaged in raising and/or harvesting fish. Typically, the unit is defined in terms of some or all of the following: people involved, species or type of fish, area of water or seabed, method of fishing, class of boats and purpose of the activities"* (FAO 2017[1]).

This research focuses on small-scale fisheries, which are also referred to by a variety of other terms, such as 'artisanal', 'traditional' and 'subsistence' fisheries. SSFs, compared to commercial fisheries, are typically characterised by the low capital investment and low level of technology used by individual fishers or their households (FAO, 2016). Small-scale artisanal coastal fisheries are complex, as they are often multi-gear, multi-species systems, with multiple landing sites (Samoilys et al. 2017). In this thesis the term SSF is used to denote the subsistence and commercial fishing activities conducted by fishers in and around Ibo Island the study site, using a variety of artisanal gear types. Throughout the thesis, women's fisheries

[1] FAO 2017: http://www.fao.org/faoterm/collection/fisheries/en/accessed January 2017.

on Ibo are defined when appropriate by the local names given to the particular activity. For example, 'mingalare' fishing, is a type of net fishing that captures needle fish.

The focus of this research is an intertidal fishery, in which women employ a number of fishing techniques in order to catch a range of species found in intertidal zones. While this allows a clear definition – women's intertidal fisheries – there are further complications in terms of defining and categorising individual fishers. Traditionally fishers are classified based on the fishing gear they use or their target species. Women who capture marine resources with their hands are typically referred to as 'gleaners', and those that use tools that don't have a hook or net tend to be referred to as 'harvesters'. Finally, women using hooks (including spears) or nets are often referred to as 'fishers', although there is some variation between authors on their choice of categories. Branch and Kleiber (2017) advocate for the use of the gender-neutral term 'fisher' in order to promote greater recognition and inclusivity of women in fisheries. In line with this recent thinking, all fishing activities practised by women in this thesis will be referred to as fishing in order to cognitively place women's activities alongside men's.

1.3 Small-scale fisherwomen

The growing literature on SSFs illustrates that women fish throughout the world from Central African communities, where women fish from fresh water lakes or dams using nets or cloth (Bene et al. 2009), to Pacific island fisheries where women are known to fish using rods or from boats (Kronen and Vunisea 2009). However, in coastal fishing communities, the majority of studies show women fishing in the intertidal zone (Williams 2002; Harper et al. 2013, 2017). Hviding provides a comprehensive ethnographic study of the significance of women fishing intertidal areas in a case study of a Melanesian fishing community (Hviding 1996). The author talks of the concept of gendered space/environment relations in governing who does what and where. The less 'wild' domain of the intertidal area is considered a place where women can fish safely. Whereas the more unpredictable and dangerous environment of the sea is considered a male domain (Hviding 1996).

Additionally, women's work in the fisheries sector has primarily been conducted in and around the household space, and in conjunction with a myriad of other household obligations as mothers and carers. The fisheries-related work that women were known to undertake involved tasks such as gear maintenance, fish processing and preparing bait (Biswas 2011). As this work was conducted away from the marketplace and in the household it was not considered an economic activity. In effect this meant that women in fisheries were subsidising the price of marine products in the market place, as their labour was not accounted for in the value of fish sold. In a competing global market, Biswas (2011) argues that this subsidy has played a key role in preventing some SSFs from collapsing.

The consignment of women's roles to the private sphere has meant that the productivity of SSF has not been fully accounted for. The International Collective in Support of fishworkers (ICSF, www.icsf.net) and the Gender in Aquaculture and fisheries network (genderaquafish.org) have been pivotal in documenting and researching women's work in SSFs (ICSF 1997). The work of these organisations and scholars (such as Chandrika Shrama, Jackie Sunde and Rosie Mwaipopo) has been to explicitly incorporate a gender perspective into SSFs work and research. This work has developed the understanding of SSFs to include women's productive roles. Through its focus on women in SSFs, and their role in the household and the community, the work has also highlighted the importance of well-being as a key concept in SSFs (Mwaipopo 2008; Sharma 2011; Sunde 2014).

Although studies show that women play a vital role in small-scale fisheries, the lack of characterization or quantification of women's fishing remains a serious impediment in fisheries' management (Kleiber et al. 2015). (2015: 550) argue for greater inclusion of women's catch and effort statistics in assessments of SSFs,

> "*In fisheries science, questions related to fishing pressure rely on the quantification of catch and effort and these are addressed far less frequently in the gender literature representing a considerable gap in our understanding*".

Jacquet et al. (2010) also make this argument specifically for Mozambique and Tanzania. This suggests that the lack of information on women's fishing, which is covered in more detail in the next section, could be feeding into what Baker-Medard (2017) refers to as the '*institutionalized inequitable access to marine resources along gender lines*' in multiple fisheries projects. This is supported by Matthews (2002) and Bennett (2005) who suggest that there is a lack of information, or poor quality information, on women's fishing feeding into fisheries' management (Matthews 2002; Bennett 2005) The problem is further compounded in 'data-less' or 'data-poor' contexts where baseline data is nearly always absent (Johannes 1998). The authors stress that the omission of women's target species and catch can lead to the status of marine resources being miscalculated or misrepresented and would perpetuate women's marginalisation in SSFs. In this thesis, statistics on catches were collected through both catch surveys and women's local ecological knowledge.

1.3.1 Drivers of fisherwomen's behaviour

It is now widely accepted that fisher behaviour is an under-studied aspect of fisheries yet it is key to addressing the global fisheries' crises (Salas and Gaertner 2004; Fulton et al. 2011). Small-scale fisheries that can incorporate local fishing practices into management design and implementation are key to securing sustainability into the future. Abernathy *et al*. (2007: 1596) suggest that understanding of fisher behaviour is '*at best rudimentary*' however knowledge about fisherwomen's behaviour is even further behind that of their male counterparts. Although data on women's role in fisheries has increased (Harper et al. 2013; Weeratunge et al. 2010), information on women's actual fishing activities is still relatively limited (Williams 2002). Most of the knowledge base that has been generated to understand fisher behaviour is based on studies of male dominated, large-scale commercial fisheries. In spite of this, many lessons from these fisheries are still fed into SSF management approaches, under which women are included. The section that follows presents the background to research on fisher behaviour, and establishes the importance of understanding this from fisherwomen's perspective.

Current approaches to understanding fisher behaviour

The majority of research in this area aims to predict sets of rule-based behaviour - often distinguished between the short and long term - using statistical models. Short and long-term behaviour is often expressed using the concepts tactics and strategies. Salas and Gaertner (2004) explain tactics as "*individual actions designed to meet an immediate challenge*" (Salas and Gaertner 2004: 5), and strategies as "*time-planned action or to achieve a general goal*" (Salas and Gaertner 2004: 5). The rules examined often centre around the relationship between the abundance of the resource targeted, its spatial location, and fishing effort which is most commonly assessed over the short-term (McCluskey and Lewison 2008; Abernethy et al. 2007; Gilmour, et al 2013; Wallace et al. 2015).

However whereas such models are useful in testing hypotheses concerning when and where fishers choose to fish, a shortfall of these deterministic models is their limited explanatory power. Explanatory power is important as unintended behaviour continues to destabilise initiatives to manage marine resources. Human behaviour, in its seeming unpredictability, is often treated as a threat to sustainable use. This is where the role of social science in fisheries issues can be most helpful: in its ability to explain the additional spectrums of human behaviour, which, within the field of small-scale fisheries includes, but is not limited to, context (the broader setting), judgement (also referred to as norms), experience (historical analysis and life histories) and intuition.

Hence a major difference when we include a social science perspective on questions of fisher behaviour is that it is not (primarily) about creating deterministic models – as is done in the natural sciences – but instead is about exploring that which appears to lie outside 'normal' rule-based behaviour. As mentioned above, these behaviours tend to be highly context dependent, value judgments. This is because resource use in rural fishing communities constitutes behaviours that are learnt, originally through basic sets of rules that specify the technicalities of the activity but are practised everyday within livelihoods intuitively. Context and intuition take precedent over predictable rule based behaviour as the most important basis for action. Logically based action is replaced by experimentally based action – logically it may be better

for a resource user to do *x* instead of *y* but experience has shown that *x* does not work (Flyvbjerg 2005). Hence from both the social and natural sciences there is increasing evidence to show that fisher behaviour is more complex than initially imagined and that the factors that determine fisher behaviour may be diverse and sometimes unquantifiable.

Key drivers of fisher behaviour

Research into what influences fishing behaviour has looked both at the drivers themselves, and their influence on fishers' strategies and tactics (Salas et al. 2004; Macusi et al. 2015). However, this has predominantly been conducted in a similar vein to previous small-scale fisheries research. The focus has been on the biological or social component of the system in isolation and at a single scale applying quite narrow concepts of behaviour e.g. as examined at the point of extraction (Guest 2003; Vargas-Yáñez et al. 2009).

Researchers from disciplines in the social sciences have attempted to broaden the remit of fisher behaviour by exploring how social, cultural, institutional and political processes – including fisher's livelihood dynamics, co-operative behaviour, and local belief systems – drive behaviours. These studies include livelihood and wellbeing studies establishing the link between poverty and resource use in various contexts (Van Oostenbrugge et al. 2004; Coulthard et al. 2011); institutional analyses studying accepted modes of behaviour (Fabinyi et al 2010; Wickramasinghe and Bavinck 2015) and ethnographies of fishing cultures (Sather 1997; Alexander 1996; Hviding 1996). Below is a list of the key sets of drivers that have been identified in SSFs (see Bene 1996; Béné and Tewfik 2001; Salas and Gaertner 2004; Lopes and Begossi 2011; Abernethy et al. 2007; Daw 2008 for some examples):

- Bio-physical factors – e.g. resource abundance, weather, season, tide.
- Political factors – e.g. fisheries and conservation policy.
- Governance factors – e.g., institutions governing behaviour, both formal and informal.
- Economic factors – e.g. input costs, unit price of resource. Markets – including prices, accessibility, timing;

- Personal circumstances and fisher motives – e.g. skills and capabilities, socioeconomic context, knowledge of stock.

While it is not feasible here to summarise the findings from all these studies, some key trends are important and relevant to the work in this thesis on a female-dominated fishery. The majority of fisher behaviour studies are framed around conceptualisations of fishers as profit maximisers (Gillis 2003; Smith et al. 2016). The assumption here is that fishers follow the general rule that says they will aim to maximise potential profits (or catch) whilst minimising potential costs (or risks) (Hilborn and Kennedy 1992; Gillis 2003) . Models used to test this assumption derive from a variety of disciplines. Ideal Free Distribution (IFD) is one such model from behavioural ecology that has been applied successfully in a SSF context by Abernethy et al (2007). Abernethy et al applied the IFD theory to show how Anguillian small-scale fishers did not in fact show signs of being profit maximisers in a similar analysis to that presented in chapter 5.

A strand of research, particularly from anthropological science, is challenging the popular assumption of fishers as profit maximisers. Data largely generated from in-depth case studies is showing that fishers use resources in different ways to meet different objectives, which depends on one's personal circumstance (Fulton et al. 2011; Begossi 2014; Fabinyi et al. 2010; Fabinyi et al. 2015; Coulthard et al. 2011). So far, however, there has been little discussion about the sorts of women that fish and why. So whereas we may know that men and women use the resource differently we don't have a deeper understanding of the sorts of women that this information pertains to (Mclean and Al Rashdi 2014). For fisherwomen, there has not been substantial research on linkages between their poverty status and fishing for example by exploring the socioeconomic factors that characterise female fishers or drive their participation in the fishery. Therefore, while women might often be disempowered within the fishery (Salim and Geetha 2013), occupy poorly paid positions or low value positions (Harper *et al*. 2013), and are assumed to have low catch rates and predominantly contribute to subsistence fishing (Kronen and Vunisea, 2009), little is actually known about the links with their personal circumstances (including poverty

attributes). As with male fishers, there are likely no generalisations that can be made, but as Thara (2016: 423) comments on women in a southwest Indian fishery, "*these nuances enable us to see fisherwomen as a complex, heterogeneous group full of contradictions, rather than just poor fisherwomen*". This research explores the links between fishing effort and fishers' personal circumstances, in order to provide additional insight into who fisherwomen are, and present a case study highlighting some of the links women's personal circumstance (such as elements of poverty and vulnerability) have to the fishery.

More recently institutional analyses have brought another dimension of understanding to fisher behaviour. Institutional analysis follows the line of thinking that fishers are embedded in the social-political context in which they live (Jentoft et al. 1998). For example, De la Torre-Castro and Lindstrom (2010) analysed some of the social and cultural institutions surrounding fishing practices in Zanzibar and showed that fishers strategies, such as the type of gear they use and their fishing location, are strongly determined by cultural traditions which differ between villages on Zanzibar. The impact of gendered institutions on fishers have not been studied from the standpoint of fisherwomen's behaviour despite a growing evidence base to show that institutions greatly affect fishing practices (Alonso, Houssa, and Verpoorten 2016). Chapter 7 aims to do this by focusing in on the activity of octopus fishing. It traces all the institutions that women encounter and negotiate in order to access the benefits from octopuses. Such an analytical focus is designed to shine a light on how gendered institutions shape fishing practices.

Fishers are not only embedded in their local context, they are part of a broader social, political and economic setting (Ostrom, 2009). The Setting in social-ecological systems is very similar to the idea of a transforming structures and processes in the livelihood frameworks (de Haan and Zoomers, 2005). These structures and processes can either be supportive (allowing people to maintain or improve their livelihoods) or restrictive (preventing people from having a sustainable livelihood). This is an important element to fisher behaviour that is not always given the attention it deserves in behavioural studies. As most behavioural studies focus on the intentional decisions that fishers' make, an examination of the broader structural

forces operating in and around fishers' livelihoods shows that some behaviours are unintentional and beyond the direct influence of an individual fisher. As fishers and their fisheries are increasingly connected to wider forces through the process of globalisation an analysis of drivers at this scale is pertinent to understanding fishers' capacity to cope with these changes. It is assumed that fisherwomen are particularly vulnerable to change (Nordlund et al. 2010; Hauzer et al. 2013). Chapter 4 aims to highlights the impact a range of drivers have on fishing behaviours and what this ultimately means for fishing as a viable livelihood activity for women.

Finally, it is worth noting the dynamic nature of drivers. It means they often interact directly or indirectly with more than one aspect of behaviour at various spatial and temporal scales. Guest wrote a pertinent paper on the influence of scale on fisher behaviour. He showed that the drivers of fishing effort are also a result of the spatial and temporal scale at which behaviour is measured (Guest 2003). Hence it is possible to observe different types of behaviour e.g. profit maximising and not profit maximising in the same fisher or group of fishers (Guest 2003). Therefore it is important to recognise the scale at which any analysis is conducted and explicitly account for it when interpreting one's results. It also suggests that studies that aim to encompass more than one scale at which behaviour operates will likely produce a more holistic and nuanced understanding of fisher behaviour.

1.3.2 Poverty and vulnerability in small-scale fisheries

As ninety-six percent (116 million) of small-scale fishers live in developing countries that suffer from high levels of poverty (FAO, 2016) it is essential to consider small-scale fisheries together with an understanding of poverty (Coulthard et al., 2011; Bene et al. 2010; Jentoft and Eide 2011). Additionally, research questions regarding fishers participation in the fishery are often framed around concepts of poverty and resource use and have been summarized in a popular maxim in the SSF literature: ‘are fishers poor because they fish, or do they fish because they are poor’? (Bene, 2003: 951).

Previous conceptualisations of fishers as being poor due to dependence on an ever-declining resource relied on an oversimplified Malthusian narrative in which ‘too

many fishers were chasing too few fish' (Bene 2003; Pauly 1990). This perspective focused solely on the income that fishers made from fishing, and did not take into account that poverty extends to social attributes (e.g. literacy rates, levels of malnutrition or access to health care), political dimensions (e.g. level of representation of certain groups in governance and decision making) and cultural norms (e.g. commonly held beliefs, values or accepted modes of behaviour (Macfadyen and Corcoran, 2002).

Research on poverty in small-scale fisheries soon expanded to include the concept of vulnerability. This was because research showed that even when fishers are not among the poorest in the community they may be living with a high risk of experiencing poverty (Bene and Friend 2011). Whereas poverty refers to the state of a person, vulnerability as it relates to poverty, refers to the likelihood of someone experiencing poverty due to a hazard, a shock or a longer-term stress on one's livelihood. Vulnerability has three key components: 1) exposure to some form of risk, be it a stress or a shock, often related to an external factor such as a state policy, a large-scale development programme, or climate-related change in rainfall, for example; 2) sensitivity to this risk – i.e. for those exposed, are they then more likely to be affected by the risk? and 3) adaptive capacity – are people then able to make changes that allow them to maintain or improve their livelihood outcomes in the long-term, even if continual exposure continues (Adger, 2006).

This focus on vulnerability illustrated that wider social, economic and political factors can create situations that place individuals at risk of experiencing the hardships that cause poverty. Illustrating the importance of these broader contextual factors Bene and Friend (2011: 131) explain:

> *For example, persons living in income poverty may be more likely to live in an area where they are exposed to health risks from poor sanitary conditions; likewise, if their nutritional status is poor, they will be more sensitive to infection than well-nourished persons; and if they lack money for treatment or if the state does not provide public health resources, their capacity to cope with, and recover from, infection will be lower than wealthier households who can afford private health services.*

There is, therefore, a structural aspect to vulnerability, and the field of political ecology has been in instrumental in developing understanding of how these broader factors influence resource use. This understanding increasingly challenges the simple Malthusian narrative of fishers and their fishing practices, highlighting that a fisher's situation is not solely determined by the state of the fish stock (Finkbeiner et al. 2017). As Adger contends 'vulnerability to environmental change [such as those that management measures introduce] does not exist in isolation to the wider political economy of resource use' (Adger 2006: 270).

Another important consideration is the degree to which individuals and households can access key resources that can either reduce their vulnerability to poverty or prevent them from experiencing it altogether (Sen, 1981; Ribot 2003). Access theory illustrates that even when resources are abundant not all individuals can access them (Sen 1981; Chambers and Conway 1991; Scoones 1998). Even within the same community individuals often have highly variable access to natural resources, and that this can be structured by social factors e.g. age gender, ethnicity (Fabiniyi et al, 2010). Underlying these social factors are mechanisms that appear to structure peoples' access to resources, namely power relations, which have received relatively little attention in the past. More recently however, critical institutionalism approaches such as those researched by Cote and Nightingale (2012), Cleaver and De Koning (2015) and Nunan (2015) explicitly analyse power among different social groups or individuals as the key organising principle by which access to resources or assets is negotiated. This is explored further in the institutional analyses presented in chapter 7.

In summary, evolving understandings of the complex concepts of poverty and vulnerability in fishing communities have benefited from political ecology approaches and access theory. This work has illustrated that using Malthusian constructs to explain fishing is limited at best. It is increasingly recognised in the literature on SSFs that poverty and vulnerability within fishing communities are intrinsically embedded within the social and political context in which fishers live.

1.4 Intertidal fisheries

The general characteristics of the intertidal zone and fisheries, their use and key threats to these fisheries is presented here prior to introducing the research framework. Intertidal zones are areas of shoreline exposed to air between the tides. These areas are exposed to saline and fresh water, have varying degrees of exposure to air, temperature and wave action and are classified into three different zones, low, middle and high, depending on the degree of exposure to these elements (Brown, 1990).

There are some specific characteristics of intertidal fisheries that are relevant here, and these are:

- *Diversity of habitats and users*. Intertidal zones are home to a wide variety of habitats, including mangroves, sea grass beds, and coral reef flats. Habitats present depend on the substrate, which ranges from soft – such as sand and mudflats – to harder substrates such as rocky shorelines. Therefore they are able to support a wide range of fisheries from mangrove crab fisheries, through to the sea grass fisheries where the majority of invertebrate collection takes place. Along coral reef edges both fin fish and gastropods such as octopus are popular fisheries. Due to its relative safety and proximity to land a wide range of people use these areas including men, women and children.
- *Open access nature*. The intertidal fishery is often characterised as open access, and more open access than other small-scale fisheries, predominantly due to the wide variety of users of the intertidal zone.
- *Data poor*. The lack of data on small scale fisheries, and on women's roles is particularly noticeable for intertidal fisheries. Despite the importance of intertidal fisheries to women (and children) few authors have described them from a social-ecological perspective (deBoer and Longamane 1996; Nordlund et al. 2013; Gell and Whittington 2002; de la Torre-Castro and Ronnback 2004; Cullen-Unsworth et al. 2014)

1.4.1 Use of and threats to intertidal fisheries

The wide range of habitats and species found in intertidal zones, and their relative accessibility enables intertidal areas to provide a number of services to coastal communities such as animal protein, building materials, firewood and employment (deBoer and Longamane 1996; Massingue et al. 2014). Intertidal zones and their fisheries are also important to national economies, bringing in revenue from tourism and municipal fisheries as well as playing a vital role in local subsistence economies (Nordlund et al. 2013). They are unique in the high participation of female fishers in locales such as East Africa (UNEP 1984; Nordlund et al. 2010)., South African (Pearson et al. 1997; Kyle, et. al 1997), the numerous island states in the Indian Ocean (e.g. Seychelles) and Asia (Johannes and Hviding 2000; Siar 2003).

However due to their range of services intertidal areas are subject to a number of intensive use activities, which if left unregulated may pose a threat to their sustainability. Mangroves are often cut down for salt and prawn production and firewood and construction purposes. Coral reef and sea grass habitats found in intertidal areas have been heavily degraded due to destructive fishing practices such as dynamite fishing and seine netting. Mafia Island in Tanzania has suffered significant damage to its coral reefs and many sea grass systems have been degraded due to sustained high fishing pressure and destructive fishing practices such as beach seine nets (Walley 2004; Nordlund et al 2010). More recently tourism both direct (development, swimming, snorkelling) and indirectly (aesthetic value) presents a threat due to the environmental impacts of construction, pollution, direct damage and reduced access to intertidal areas to fishers. The potential impact that degraded systems have on intertidal fishers, particularly women, has been documented by Nordlund et al. 2010 who show declines in fishers income earning potential in Zanznibar.

In the Western Indian Ocean (WIO) region women's fishing activities are centred on the intertidal zone in which the majority of target species are invertebrates[2].

[2]Although net fishing is a significant exception to this.

Tanzania, Kenya, Madagascar and South Africa lead the way on studies of women and intertidal fisheries (Pearson et al. 1997; Kyle et al. 1997; Nordlund et al. 2010; Kleiber et al. 2015; Fröcklin et al. 2014). These studies support earlier work such as Hviding's (1996) that show gender segregation in fisheries place women in intertidal areas whilst men's fishing (technology permitting) extends to the sub-tidal area and open sea. They have also shown that intertidal fisheries provide the conditions that many fisherwomen require, that is the near shore environment, a diversity of sedentary or semi-sedentary resources that are accessible and that require low or no technology inputs. In addition, Kleiber et al (2004) indicate a gendered trend for invertebrate fisheries. The authors observed that fisherwomen were more likely to be associated with invertebrate only fisheries than their male counterparts (Kleiber et al 2004). Studies of women in fisheries have also highlighted the importance of women's ecological knowledge in providing a broader perspective on marine resource use and change particularly in contexts with little pre-existing empirical information. When women's knowledge is specifically incorporated in marine management they are more likely to be active participants (Awani and Weiant, 2003). Nonetheless studies of women's fishing in intertidal areas remain few and far between (de Boer et al 2002; Hauzer et al 2013).

Not only are the intertidal invertebrate fisheries important to women's livelihoods in the WIO, but there is evidence that catches from invertebrate fisheries are on the increase globally (Anderson et al. 2011; FAO, 2016). Compared to other target resources within intertidal fisheries, little is known about invertebrate fisheries in terms of catches and species biology, population status and response to exploitation (Jacquet et al. 2010). A common assumption, that invertebrate fisheries are relatively resilient, is now being questioned due to recent studies using historical data on oyster fisheries, and more recent studies on sea cucumbers (Jackson et al. 2001; Kirby 2004). This is thought to be partly due to fishers worldwide moving from increasingly less profitable fin fisheries into invertebrate fisheries.

In conclusion, the intertidal zone is a space where two issues intersect: an increasingly recognized and valued ecosystem with increasing threats and fishing pressure, and a resource base essential for women in coastal communities in the

West Indian Ocean. In such a context where measures to sustain resources and livelihoods that depend on them are urgently required the study of the dynamics of an intertidal women's fishery is particularly relevant and important.

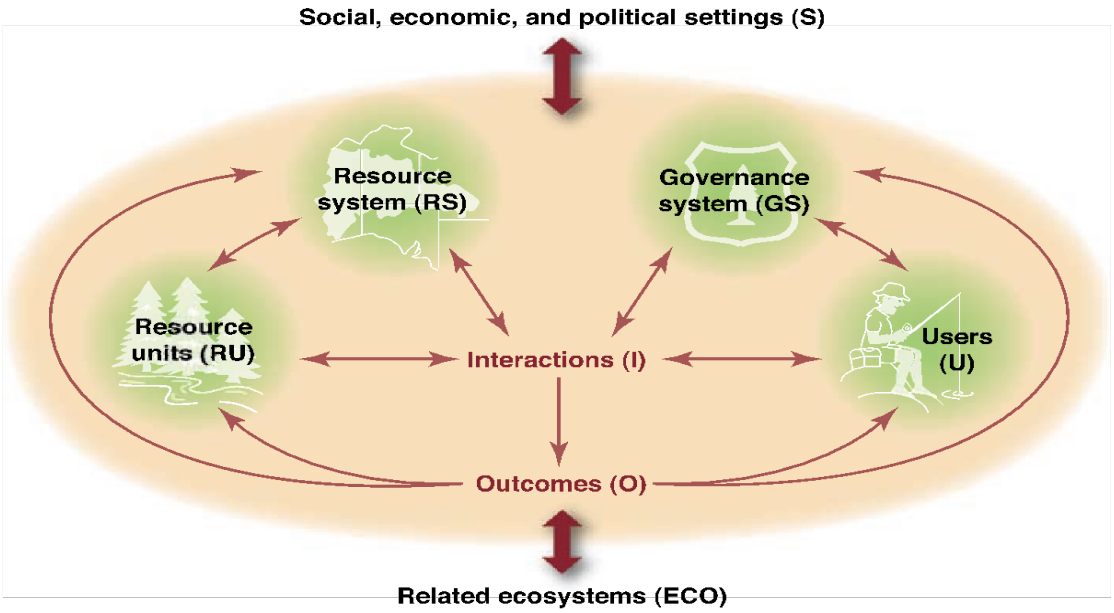
1.5 Conceptual framework and research outline

1.5.1 Social-ecological systems

This thesis uses a social-ecological lens to explore the drivers influencing women's fishing behaviour and the fisheries that they use. The challenge to studying fisher behaviour lies in relating two disparate systems: the human (or social) world with the ecological (or biological) world that interact with each other across a range of spatial and temporal scales creating non-linear links and feedback loops (Berkes and Folke 1998). Current understanding of social-ecological systems recognizes that although the ecological factors in a social-ecological system are diverse, the social variables may be more extensive and have received less research attention (Kittinger et al. 2013). Disproportionate attention paid to the biological realm limits understanding of the whole systems (Berkes et al. 2001; Poe et al. 2014). Hence researchers from multiple disciplines recognise that small-scale fisheries' research would benefit from more evidence of the social elements of social-ecological systems (Fabinyi et al. 2014; Leenhardt et al. 2016).

Ostrom (2009: 419) describes socio-ecological system (SESs) as: 'composed of multiple subsystems and internal variables within these subsystems at multiple levels analogous to organisms composed of organs, organs of tissues, tissues of cells, cells of proteins, etc*'*. In the SES framework Ostrom (2009) illustrates the core systems and subsystems and the links between them, shown in Figure 1.1.

Figure. 1.1: Ostrom's (2009) social-ecological systems framework.



In the context of fisherwomen's intertidal system in northern Mozambique, the core subsystems are: a) intertidal fisheries (the resource system); b) intertidal resources (the resource units); c) fisherwomen (the users/individuals that use or rely on the system and resource units) and d) the institutional context (the governance system designed to regulate how resource users interact with resources). The diagram illustrates that SES are part of broader social ecological and political settings and may also link to other related ecosystems.

The strength of social-ecological systems thinking lies in understanding the interaction between the subsystems and the outcomes they produce. These outcomes can also feed back into the system and influence system operation – this is the idea of reciprocity, expressed by Kittinger *et al* 2013. Reciprocity refers to the interlinked interactions between the social and the ecological, meaning that the state and nature of the ecosystem and services that the ecosystem provides can influence the behaviour and structure of coastal communities. As Kittinger et al. (2013:2) state "*anthropogenic actions alter the structure and function of ecosystems, just as resource pools and ecosystem services can help define the structure and function of coastal societies*".

Social-ecological systems theory also helps to differentiate between 'proximate and ultimate dimensions', which are essentially the direct relationship between the user and the resource (proximate), and the underlying or distal or ultimate driver (Kittinger et al. 2013). This concept is well aligned with the concept of drivers of fisher behaviour introduced above, in which there are direct and indirect drivers of fisher behaviour, and interactions between these (Crona et al. 2015). External and indirect drivers might be disparate, and include market forces, extreme weather events or changing macro-economic policies, while the direct drivers include the ways that fishers have adapted to these ultimate drivers, by using a particular gear type or combining certain activities into a livelihood strategy. The thinking also provides a framework in which to consider the links between fishers' poverty and vulnerability context, and the links to entry, exit and levels of fishing, and the phenomenon of social–ecological traps.

Therefore, for a study into a female-dominated intertidal fishery, the strength of taking a social-ecological systems approach is the ability to: i) investigate the interaction between fishers and resource units; ii) understand how factors interact with each other to produce different social and ecological outcomes, and the implications these outcomes have for sustainability of the system, and finally to; iii) tailor management recommendations to the unique characteristics of the system (Ostrom, 2009).

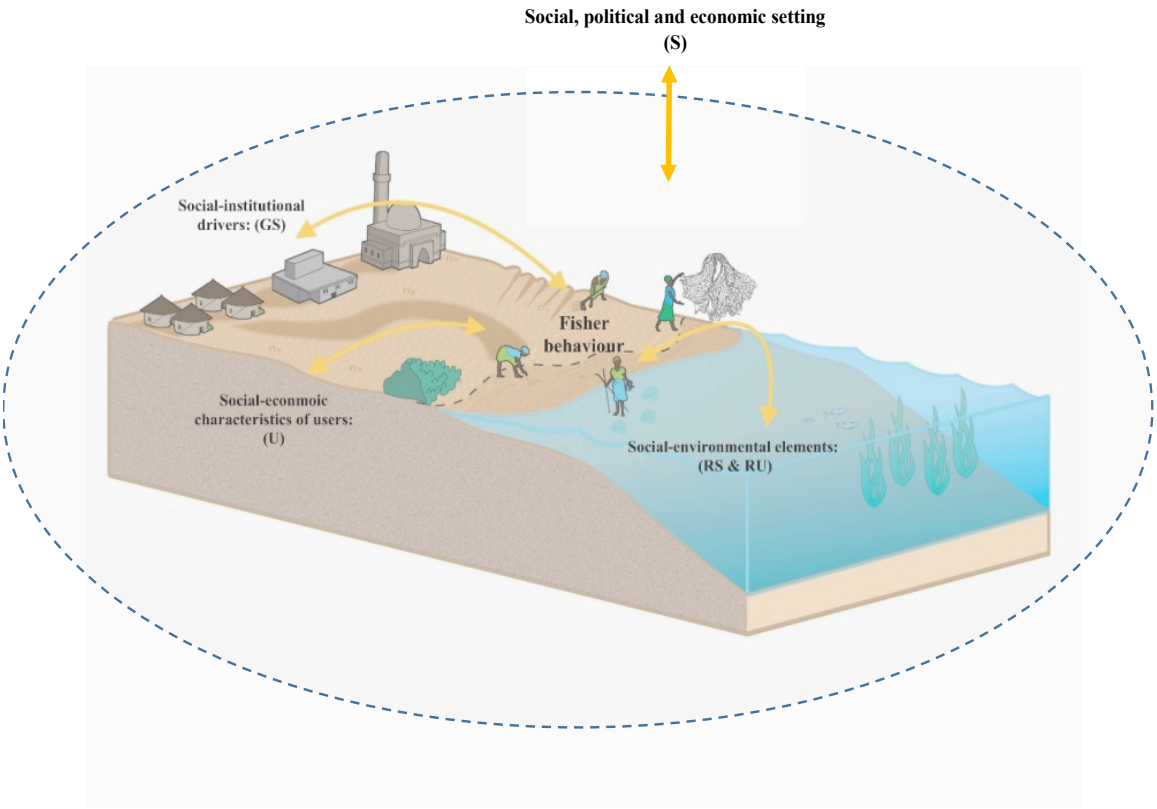
1.5.2 Research outline

This research was designed to explore the political, environmental, socioeconomic and institutional factors that influence small-scale fishers. To do so this thesis systematically focuses on four different elements of the social-ecological system – the 'sub-systems', Ostrom (2009) – represented in each of the four empirical chapters listed below and shown in Figure 1.2. The links between these findings and the research themes introduced in this chapter are discussed in the final chapter (chapter 8).

1. Social, political and economic setting. (Chapter 4).
2. Social-environmental elements of the resource system (Chapter 5).

3. Social-economic characteristics of users (Chapter 6) and,
4. Social-institutional governance (Chapter 7).

Figure 1.2. Social-ecological system studied: A women's intertidal fisheries on Ibo Island



1.5.3 Research aim and objectives

The aim of this thesis is to provide empirical evidence of fisherwomen's behaviour in an intertidal social-ecological system. The thesis looks to illustrate the different drivers that influence behaviour, and provide a basis of information that ensures that management measures can be adapted to the realities and circumstances of fisherwomen's lives.

Without a solid understanding of fisherwomen's behaviour, and what drives this behaviour, then fisheries management measures that are applied in intertidal areas, such as periodically closed zones are likely to produce unintended outcomes.

Questions that remain unanswered are how women's fishing strategies change over time and what drives this change. On a shorter time-scale, it is unknown what factors drive fisherwomen's temporal and spatial fishing effort. 'Fisherwomen' are often classified together as a group with similar characteristics, and an additional question is the degree of variation that exists within this fisher group. Finally, considering the importance of institutional context in determining behaviour and influencing who can benefit from a resource, it is important to understand the degree to which they are able to benefit from fishing as an activity.

Therefore the objectives of this thesis are:

1. To examine changes in women's fishing strategies over the longer-term in relation to broader social, political and economic transformations.
2. To understand how environmental and socioeconomic factors drive octopus fisherwomen's daily temporal and spatial fishing effort.
3. To explore the socioeconomic profiles of octopus fisherwomen and examine links to fishing effort.
4. To investigate the constraining and enabling role of institutions that influence octopus fisherwomen's strategies and their ability to benefit from the fishery.

1.5.4 Thesis structure

The thesis contains an overview of the study site (chapter 2), which hones in on Mozambique's social, economic and political history, fisheries policy, and the role of women in fisheries in Mozambique. This leads onto the methods chapter (chapter 3), which describes the combination of methods used for collection of data, and their theoretical justification. Four empirical chapters representing discreet but inherently connected studies follow (chapters 4–7), with each one intended to address a specific dimension of fisher behaviour, under which a number of questions have been developed. The discussion chapter (chapter 8) then disseminates the findings from these chapters in relation to social-ecological systems theory.

Chapter 4: External drivers of change in female-dominated intertidal fisheries.

Mozambique has experienced exceptional political, economic and social transformations within a single generation. This chapter examines how these transformations have influenced women's fishing behaviour, to which factors they attribute change and how women perceive the significance of this change. It uses questionnaire data to determine changes on five key aspects of fishing behaviour, establishes the drivers of change to which fisherwomen are responding and the local significance of these changes.

Chapter 5: Exploring the drivers of octopus fisherwomen's daily fishing effort**.** Why do fishers fish on certain days and on certain fishing grounds? Researchers argue that knowing the answers to these questions will create spatial-temporal management measures that fit with the spatial and seasonal variability in resources, and fishing patterns thus matching the ecological system (production) with the social (offtake) in a complementary way. This chapter uses data from a 12-month catch survey, semi-structured interview and focus groups to understand why octopus fishers fish where they do, and the factors influencing the number of trips they go on. Generalised linear mixed effects models identify short-term drivers. To understand spatial drivers of fishing effort the ideal free distribution model is compared to current spatial patterns of effort. Deviations from the predictions of ideal free theory are explored qualitatively through semi-structured interviews and focus group data.

Chapter 6: The socioeconomic profiles of octopus fisherwomen and the relationship to the fishery. This chapter examines firstly, how socioeconomic characteristics of octopus fishers correlate with fishing effort and, secondly, how the socioeconomic characteristics measured intersect to create conditions of vulnerability in women's lives. It therefore provides an indication of the profile of individuals that practice octopus fishing and the variation of effort among them.

Chapter 7: The role of institutions in octopus fishing. This chapter presents an analysis of how octopus fisherwomen on Ibo structure their activity within the local institutional context to maintain access to and benefits from octopuses. It does so using Ribot and Peluso's (1998) theory of access to map out the range of institutions involved in octopus fishing to critically assess what influence these behaviours have

on women's ability to benefit from octopus and to highlight the embeddedness of gender norms (and relations) in octopus fishing.

Mozambique, Quirimbas Archipelago and Ibo Island

Chapter 2

Women walking to a local ceremony on Ibo Island.

Chapter 2 – Study site

2.1 Introduction

2.1.1 Site selection

This chapter introduces the social, political and environmental context of the study site. The study site was Ibo Island, which is home to fishermen and fisherwomen who have a long cultural history of fishing and are today living within a context of global change. The island is situated in the southern cluster of islands of the Quirimbas Archipelago. Due to its strategic location and cultural history, the island is a microcosm for some of the broader changes occurring all along the Cabo Delgado coastline. Understanding the context of the study site and the broader region is essential for this study to be able to draw out trends and lessons that are relevant for other coastal fishing communities. Equally relevant is recognising which results might be specific and unique to this site. The island's history and context is described in more detail below in order to highlight the diversity within the Ibo community, presenting an excellent opportunity in which to explore the dynamics of an intertidal fishery. In addition to describing the context of the study site, and relevance of the research for developments in coastal Cabo Delgado, the chapter also aims to illustrate how Mozambique's political history and modern economy have shaped the ubiquitous issues of poverty and gender in the study community and coastal region. This chapter also describes how women are positioned in the wider social context of religious beliefs and national politics. Mozambique today is characterized by the interaction of its internal political history with wider global forces – mainly capitalism.

This chapter not only introduces the study site, but also aims to situate the research in the current issues affecting women and coastal communities in Cabo Delgado. Research on the social-ecological dynamics of an intertidal fishery in coastal Cabo Delgado is particularly relevant given the dearth of knowledge on the social aspects of women's fisheries in the region, and the development of tourism and oil and gas industries in the province. These developments all have the potential to influence the dynamics of the social-ecological system, changing the institutional context and creating competition over space in the coastal zone. Considering the high levels of rural poverty and food insecurity in coastal Cabo Delgado, introduced in this chapter,

these developments could have serious implications for women's livelihoods and the coastal ecosystems themselves.

Finally, it is important to note that, in addition to oil and gas interests and the high levels of rural poverty, the coastal region of Cabo Delgado also has marine sites of conservation interest. Ferreira (2012) documented the coral reefs in the Quirimbas National Park using satellite imagery and noted that they contain "some of the most impressive coral reefs in the western Indian Ocean" (Ferreira 2012: 296). Partly in response to the potential impacts of coastal development, there is increasing attention on the conservation of this unique biodiversity in the Province. The creation of conservation areas such as Quirimbas National Park, in which the study site is situated, is being complemented by more initiatives looking to preserve and maintain the region's biodiversity. Ecological connectivity in the region has been advocated by programmes such as Transmap (Transboundary Networks of Marine Protected Areas). In addition to classic marine protected areas, there are also Locally Managed Marine Areas being established, such as the one on Vamizi Island (Rocliffe et al. 2014a), and the areas being supported by the programme 'Our Sea Our Life', a consortium of international, national and governmental organisations. The selection of a study site within an existing conservation area (QNP) allows for lessons from this research to be applied to other coastal areas of Cabo Delgado where conservation measures are being designed.

2.2 Mozambique country profile

2.2.1 Geography and climate

Mozambique stretches to just over 2,470km from the southern tip of Tanzania to South Africa, and occupies 801,590 square kilometres. On its western edges it borders Malawi, Zambia and Zimbabwe (Figure 2.1). The northern and central regions of Mozambique have tropical to subtropical climate, whereas southern Mozambique's climate has a drier climate and flatter geography (FCO, 2014). There are two distinct seasons, the dry and wet periods, which last approximately from April to September and October to March. Average precipitation during the rainy

season is 1,032mm, however, the northern regions get more rain on average. Data on rainfall available for Pemba, the provincial capital, shows average monthly rain fall to be 84.2 mm during the wet season months January–March, which more than doubles to 179.5 mm (Instituto Nacional de Estatística 2014). It can get incredibly humid in the north during the rains with temperatures exceeding 30˚C and cool and dry over the dry season with the temperature averaging 17˚C (The World Bank, 2014).

Figure 2.1 Map of Mozambique. Source: United Nations, 2016

2.2.2 Politics and economy

The war period (1964-1992)

Mozambique's recent political history has been tumultuous. In the period between 1964 – 1992 the country faced a war for liberation from colonial rule (1964-1974) and a civil war (1976-1992). Mozambicans had to fight for their independence because Portugal refused to follow the decolonisation strategies set out by NATO (The North Atlantic Treaty organisation). The war for liberation ended in victory for Mozambique but the peace did not last long.

Two years later a civil war broke out in the north of the country between Frelimo[3], the newly independent socialist government and Renamo[4] a rebel group born in what was at the time Rhodesia. Hanlon refers to most of the civil war period (1981-1992) as a "Cold War proxy war of destabilisation" because of its links to the cold war (Hanlon 2010: 79). At the height of the cold war, the Reagan administration saw the white South African government as an ally against communism in the region. As such the USA supported attempts by the apartheid government to destabilise Mozambique that was believed to be following a communist agenda. South Africa, Rhodesia (between 1976 – 1980) and the USA heavily influenced the military strategy adopted during the civil war. The main aim of these outside forces was to not to secure a government but to prevent Frelimo - a black, Marxist-Leninist government - from assuming power in the region. Hence the military strategy they adopted was one of terror, designed to destroy civilian resolve and physical and social infrastructures. The war was devastating; it killed over 7% of the population (1 million Mozambicans) and displaced over 5 million from their homes. It left Mozambique bereft of infrastructure from roads and rural shops to schools and health centres. The end of the civil war, in which Frelimo was victorious, resulted in a transition to a multi-party democratic state (Finnegan 1992).

Despite the immense terror the civilian population experienced, and as a true testament to the strength and spirit of the Mozambican people, the country's peace process has been hailed as one of the most successful. This is because it did not require a tribunal or any political initiatives to oversee the peace process. The government adopted the general motto 'to forgive but not to forget' as a guiding principle in rebuilding the parliament which, meant people from both sides were allowed to continue to participate in political life.

Some criticism has been levelled at this approach for not adequately addressing the war crimes that were committed during this period (Igreja 2015). Nonetheless, the effect was that the process of reconciliation was largely informal and conducted at

[3]The Mozambique Liberation Front
[4]The Mozambican National Resistance

the village level. This is significant as the majority of soldiers and guerrilla fighters (almost 90%) returned home after the peace accord was signed (Igreja 2009). The challenge then largely rested with local cultural institutions as to how to deal with returning fighters (some of whom had fought on opposite sides) and how to help heal the social and psychological devastation suffered by all, including children.

Local processes of rehabilitation and peace building varied throughout the country. However curandeiros/as (traditional healers) were key a cultural institution that dealt explicitly with the wounds of the war (Nordstrom 1998; Arnfred 2011; Igreja 2009). Accounts of these various processes show that peace building often involved the whole community and spiritual beliefs that links those that died during the war with present day survivors. Curandeiros/as would perform cleansing and reintegration rituals on people experiencing war trauma. These ceremonies would actively involve members of the community in order to promote a sense of shared experience. They also drew on ancestral spirits as a way to acknowledge common identities or remind those who had been traumatised of their true identity (as a member of a community) in order to rid people of the scars they carried from the war. The process of welcoming returnees back into the community was also aimed to reignite shared cultural identities. For example when teaching returnees how to farm again community members would re-tell stories of their ancestors and the connection to the land (Nordstrom, 1998). Although war atrocities were not forgotten they were forgiven in a safer manner through these rituals.

Economic policy

Mozambique has one of the most impressive GDP growth rates on the African sub-continent. It's GDP is expected to average 6% growth in 2017 (FCO 2014; World Bank Mozambique Overview, 2016). This is driven by an economy that relies on three main industries: services account for 46% of GDP followed by agriculture at 30% (within which mainly industrial fisheries are estimated to contribute 3%) and oil and gas at 24%. Oil and gas extraction is predicted to significantly increase the country's GDP as companies such as Anadarko and ENI move into full production in the north of Mozambique. Despite these high growth rates and trajectories, there is concern that the overall development model is too dependent on international

development assistance and neoliberal economic policies. Foreign Aid accounts for over half of the government's budget and foreign investment is centred on mining, electricity, tourism, construction and telecommunications. In 2013 Foreign Aid was severely restricted when debt was discovered in secret loans which had been taken out: this weakened the economy to such an extent that the currency (meticais) halved by 2016. This also had an impact on foreign investors who pulled back a lot of their planned projects, and the IMF also withdrew a lot of their support. This resulted in the government struggling to pay state salaries and, for Mozambicans, an increase in living costs. One of the major challenges to economic growth that affects the local population is the lack of an educated workforce that industries such as oil and gas, telecommunications and services rely on. The majority of the workforce in Mozambique have not completed primary school. (Vines et al. 2015).

The statistics on poverty in Mozambique are contrary to what one might expect in light of the amount of aid and economic restructuring that has gone into the country. In spite of the above mentioned high GDP growth rates (6%) poverty is still prevalent and in some statistics increasing in Mozambique (Ministério De Economia e Finanças 2016). Cunguara and Hanlon (2012) argue the reason economic growth in Mozambique has not significantly impacted poverty levels – particularly for rural inhabitants[5] - is due to the neoliberal economic model the country was pressured to adopt through restructuring programs in the late 1980s. Proponents of the neoliberal development approach distrust the State as a vehicle of economic growth and as an alternative endorse markets as the key to tackling poverty. Aid provided to Mozambique had to follow the premise of this economic model. Hence development aid was, and still is, part of a neoliberal economic policy in which "economic growth and poverty reduction were to be left to the private sector" (Cungara and Hanlon (2012). The subsequent large amounts of aid Mozambique received were partly due to the vigor to which the country adopted these restructuring policies.

[5] See poverty statists to follow Section 2.3

This economic paradigm shift resulted in most government interventions being shut down. To replace them, privatization, the opening up of markets and foreign investments were initiated (Hanlon 2017). However, without the means[6] to access the necessary resources (such as seeds, fertilizer or irrigation equipment) to bring their products to these global markets and participate in large scale investment projects, large swaths of the population continue to remain on the periphery of economic development in the country. In effect it has largely been foreign owned and run businesses and finance structures (some from the colonial period) that have been able to pursue the development strategy laid out in the restructuring programs. The drawback is these projects (particularly mineral and energy projects) have not developed strong links to local economies, particularly the agricultural sector of which circa 80% of the population is linked to, and hence have had little impact on poverty reduction (Hanlon 2017). These industries have high levels of elite capture and leakage further exacerbating the problem of poverty and preventing neoliberal economic theory – the tickle down effect- from occurring effectively. So while economic growth has been witnessed at such impressive levels as the current GDP growth rate, this has not been realized equitably throughout the country, leaving Mozambique with some of the highest levels of poverty in the world - see below for some of these statistics.

2.3 Poverty in Mozambique

2.3.1 National poverty

Mozambique has a population of approximately 24 million, 60% of whom live on the coast. In the 2008/09 household survey the national level of poverty (measured as headcount ratio) was on par with the 2002/03 results at 55% of the population. However, the 2014/15 household survey shows that, although overall poverty has continued to drop in Mozambique, in the northern regions, including Niassa and Cabo Delgado Provinces, there has been an increase in the percentage of households

[6] Mainly financial or human resources such as business expertise

below the poverty line (Ministério De Economia e Finanças 2016). Cabo Delgado, where Ibo Island is situated, has seen a 5% increase in the level of poverty between 2008/09 and 2014/15.

An examination of non-economic poverty indicators taken from surveys such as the Demographic and Health Survey (2010) reveals interesting trends in the northern regions that are not reflected in the national 2014/15 poverty and wellbeing survey. Particularly relevant to the northern province of Cabo Delgado is child health and nutrition. Cabo Delgado has the highest level of child malnutrition and one of the highest incidences of stunted growth in children stunting (upwards of 40%) in Mozambique (Lopus, 2015).

2.3.2 Female poverty

The incidence of female poverty in Mozambique is pronounced. Women represent the poorest sections of the population. The poverty headcount ratio for women is 62.5% and for men it is 51.9% (AfDB 2010). Moreover, these indicators do not capture the subtleties of intra-household resource division in male-headed households which would only serve to increase this number. Female poverty indicators are even more noticeable in other development indicators (Table 2.1). More qualitative measures of poverty such as the incidence of domestic abuse have been documented by authors such as Chant but no known estimates exist (Chant 2006). Another key indicator of poverty is the incidence of female headed households. The southern region of Mozambique has over twice the number recorded in the north : 54% vs. 21% (INE 2004). The National Institute of Statistics (INE) report suggests this might be due to the stigma in the north of not having a husband which discourages women from formally registering themselves as a female-headed household, suggesting that actual levels might be higher. Female-headed household status in Mozambique is used widely as an indicator of vulnerability, illustrating the importance of marital status to reduce vulnerability (Vala, 2009).

Table 2.1 Development indicators for Mozambique by gender. Source UNDP (2008)

	Rank of 177/157		**Life expectancy at birth**		**Adult literacy rate**		**Gross school Enrolment**		**Estimated income (PPP)**	
GDI [7]	HDI	GDI	Male	Female	Male	Female	Male	Female	Male	Female
	172	150	42.0	43.6	54.8	25.0	58	48	1,278	1,115

2.4 Mozambique's fisheries

The national fishery sector is dominated by small-scale fisheries which are responsible for an estimated 91% of total catch landings (ASCLME, 2012). Unfortunately the small-scale fisheries sector has limited linkages to the national economy and therefore its economic contribution goes largely uncounted in the country's GDP. The story is slightly different for the industrial and semi-industrial sectors. However in the early 1960s Mozambique established its first national fleet under Portuguese administration, which supplied shrimp to national and international markets such as Japan, France, Spain and Norway (OECD and FAO 2015). This has provided a link to national economic growth in the provision of foreign exchange earnings (Normann 2006). Table 2.2 summarises the size, target species and main markets of the five key fisheries sectors in Mozambique.

[7] Gender Development Index (GDI); Human Development Index (HDI)

Table 2.2 An overview of Mozambique's fisheries sector. The table is constructed from the following data sources: ASCLME, 2012; Swennenhuis, 2011 and FAO, 2015.

Sector	**Size**	**Target species**	**Market**
Industrial (Vessel size > 20m)	1550 workers (FAO, 201%)	Knife shrimp and deep water shrimp (*Haliporoides triarthrus, Aristaeomorpha foliacea*); Sword Fish (*Xiphias gladius*); Albacore and Big eye tuna (*T.alalunga*) and (*T.obesus*); Yellowfintuna *(T.albacares*).	Majority of catch is exported to the EU, Japan and South Africa (ASCLME 2012)
Semi-industrial (Vessel size 10-20m)	Approximately 351,000 people employed in this sector(ASCLME 2012)	Shrimp (*P. indicus* and *M.monoceros*) and demersal fish (ASCLME 2012)	A mix between national and international markets (as above).
Small-scale (Vessel size <10m, Approximately 40% operate on foot).	Approximately 280,000 fishers(Swennenhuis 2011)	Keele shad (*Hilsa kelee*); Northern whiting (*Sillago sihama*); Anchovy (*Thryssa vitrirostris*);Tigertooth croaker(*Otolithes ruber*); Mullet (*Mugil cephalus*); Rabbit fish (*Siganus sutor*); Javelin grunt (*Pomadasys kaakan*); Emperor fish (*Lethrinus* species) (Swennenhuis 2011)	Services national markets with an annual value of over US$50 million (Swennenhuis 2011)
Recreational	Number of people: n/a Landings of approximately 796 tonnes (FAO 2015)	Commercial species e.g. marlin, sailfish, spearfish and tuna (FAO, 2014)	Tourism (FAO, 2015)
Aquaculture	95,000 workers (90% of which are small-scale) (FAO, 2015)	Mainly freshwater tilapia farming, prawns (giant tiger and Indian white), common and silver carp and a few marine shrimp farms. (FAO, 2014)	The majority of marine aquaculture is exported to regional and international markets. (FAO, 2015)

2.4.1 The small-scale fisheries sector and fisheries co-management

Between 1982 and 1990 fisheries development initiatives were rooted in the socialist principals of the Frelimo government at the time. These initiatives aimed to add value to small-scale fisheries by providing capture and processing technology and market networks. The *Combineiro Pesqueiro* programme (literally translated as 'combined fishing') was the most prominent programme. It aimed to promote small-scale fishing through improving transport to fishing grounds, among other activities[8].

Post-structural adjustment, the Frelimo government readjusted its relationship to the small-scale fisheries sector. Hands on government-led initiatives such as the *Combineiros Pesquieros* were abandoned and new fisheries legislation promoted more market and less government involvement in fisheries development through a system of co-management (Menezes, et. al., 2009b). The government created the legislation for the creation of community fisheries councils (CCP) in 1998 with the support of IDPPE[9] which was supported by a wider fisheries project called PPAN[10] (funded by IFAD[11], and OPEC[12]). The rationale behind the establishment of CCPs was both economic – that of limited resources of State bodies to implement rural fisheries management – and biological, a concern over the use of mosquito nets in fishing gear (IFAD 2010; Menezes, Smardon, and de Almeida 2009a). Their establishment and functioning are now governed by the new Fisheries Law of 2013.

CCPs are to act as a representative body in voicing concerns to the national government. They do this through the district level government and the Provincial Fisheries Administration (ADNAPE). Annual co-management meetings are organised by ADNAPE to facilitate this process.. Each CCP defines their own objectives and mandates, however some commonalties noted between them have

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[8] Other activities included: distribution of fishing goods, materials and gear; purchase transportation and storage of fish products; distribution of products and to act as a source of information for other fisheries sites in the country.

[9] IDPPE - National Institute for the development of small scale fisheries

[10] The Nampula Artisanal Fisheries Project / Projecto de Pesca Artesanal em Nampula

[11] International Fund for Agricultural Development

[12] The Organization of the Petroleum Exporting Countries

been the desire to regulate migrant fishers, conflict resolution between local fishers, reduce theft of fishing gear and improve co-operation between boat and gear owners and their crew (Normann, 2006). The first co-management committees set up had some leverage in fisheries policy as demonstrated when restrictions on net size, which they felt had been set too wide, were reduced and the zone for small-scale fishers was extended from one to three miles (Normann, 2006). Menezes et al (2009) make a pertinent conclusion in their assessment of fisheries policies in Mozambique. They observed that where local institutions are perceived to be relatively fair and legitimate co-management committees work relatively well, however, in contexts where there is a lack of trust between community members and co-management committees, greater State intervention is desired to help redress the balance of power (Menezes et al 2009).

Table 2.3 summarises data showing the key characteristics of Mozambique's small-scale fisheries. It is worth noting that these estimates are based on rather narrow definitions of small-scale fisheries, that is, commercial, male dominated finfish and coral reef fisheries.

Table 2.3. Key characteristics of Mozambique's small-scale fisheries sector

Characteristic	**Statistics**	**Source**
Number of fishing dependent people	334,000	1. CTV, for TRAFFIC Fisheries Governance Project, "Inhaca Field trip report",
Number of fishermen	280,000	
Fishing associated activities (such as boat makers or fish processors)	54,000	
Fishing gear	Accounting for 83% are: beach seining (18%), hand lines (23%) and surface gill nets (42%)	
Number of boats	39,400 (3% motorised)	
Annual estimated catch	136,000 tonnes	2. Centro Terra Viva, Annual Report 2011/12, (Marco et al. 2012)

Annual estimated value	170 million US$	Centro Terra Viva, Annual Report 2011/12 2012 (Marco et al. 2012)

2.4.2 Intertidal fisheries management in Mozambique and the WIO

Intertidal fisheries management in Mozambique falls under the jurisdiction of fisheries management efforts as intertidal resources are generically referred to as fish. Hence there is no formal management regime for intertidal fisheries. However, some intertidal zones within conservation areas, namely mangrove habitats, have been protected under strict no-take zones[13]. Other intertidal areas protected under no-take zones usually occur as a secondary effect to a species protection measure. For example intertidal areas that border coral reefs or surround rich water channels have been placed under no-take zones in the Quirimbas National Park. Early attempts in 2007 to manage specific resources found in the intertidal zone include a cowrie rotation plan on Quirimbas Island, which lies immediately south of Ibo Island. The rotating zone is closed for a 3-month period each year. The rotation areas provided good catches for a few days after opening (pers comm with Rachid Casimo, AMA[14] project officer).

Nordlund et al's, assessment of intertidal management in the WIO region shows that intertidal management also takes the form of species level approaches e.g. octopus, oysters and sea cucumber or habitat based protection measures, namely sea grass beds and mangroves: two very valuable intertidal habitats in the WIO (Nordlund et al. 2013). In addition Nordlund et al stress the importance of social and ecological integration in management interventions. An often-cited example of intertidal management in the WIO is that of cockle conservation efforts in Menai Bay, Zanzibar. They were placed under community management and no-take zones were used to protect cockles from fishing pressure. It had varying success with only one of the three sites showing signs of recovery. However this was partly due to improper

[13] no-take zones prohibit any form of extractive activity

[14] AMA stands for Associação do Meio Ambiente. It is a Mozambican NGO

design of the reserves (in terms of size and habitat) but also poaching in the lead up to religious festivities. The project[15] recommended turning the no-take zone into a temporal reserve thus allowing community members to fish in the area during socially important times such as Eidd (Crawford et al., 2010).

2.4.3 Octopus management

In Mozambique and many countries within the WIO, such as Madagascar, Tanzania and Kenya to name a few, octopuses are an important income generating resource for fisherwomen. However there are growing concerns over the sustainability of octopus fisheries. Rocliffe and Harris's summary of octopus fisheries shows that on the African continent there was a decline in total catches between 1990 and 2012 (approximately 40%[16]) (Rocliffe and Harris 2016). Their review also illustrated that out of all of the WIO countries considered, there appears to be the least available information on the octopus fishery in Mozambique. In 2014 the government of Mozambique produced a report on the potential of octopus fisheries to contribute towards rural development in the region (Instituto de Investigacao de Pescaria, 2014). It showed the octopus fishery from the District of Ibo (which includes Quirimba Island to the south) has the second highest landings in the region. However this data should be treated with caution due to the limited data sources and the omission of women's catch. Nonetheless in the midst of declining catches a number of researchers have explored a range of fisheries management measures that can be or are applied to intertidal octopus management across the WIO. These range from:

1) Local periodic closures (e.g. Madagascar; Rodrigues).

2. Licensing of fishers (e.g. Tanzania and Zanzibar).

3) Restrictions on size (e.g. Comores, Kenya, Seychelles and Zanzibar).

4) Closed seasons (e.g. Madagascar).

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[15] WIOMSA and University of Dar Es Salaam

[16] Largely due to a decrease in production from Morocco.

5) Restrictions of octopus fishing in the neap tide (e.g. Tanzania, Comores).

All of these management measures entail some kind of restriction on fishers. Currently the most advanced form of octopus management in the region (Madagascar), referred to as 'periodic closures', considers the growth rate and life span of the species alongside fishing patterns (e.g. how often and where fishers catch octopuses) (Oliver et al, 2015). At the time of the study none of these octopus-specific measures had been introduced in northern Mozambique. Currently, in Mozambique, however, the introduction of periodic closures is being promoted by WWF within QNP as well as further north in Palma District.

2.5 Cabo Delgado and the Quirimbas Archipelago

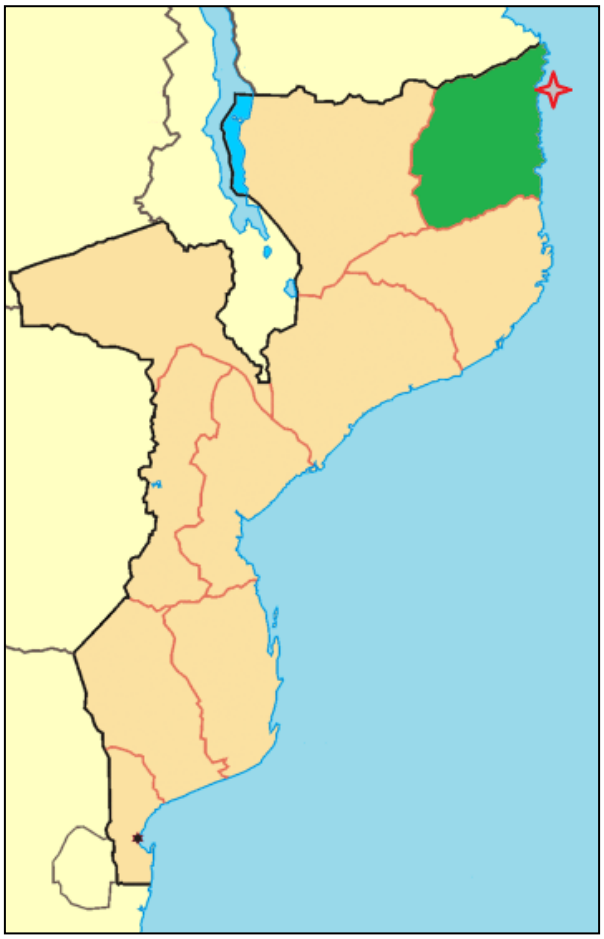
Cabo Delgado is the northernmost province of Mozambique, bordering Tanzania to the north on the Rovuma River. It is believed the entire Cabo Delgao region is an elevated coral reef (Igor 2010). The abundance of limestone in Cado Delago and the archipelago makes farming particularly challenging in this region. The province is characterised by (Medeiros 1997):

- a row of islands, known as the Quirimbas Archipelago, which stretch from the northern shore of the bay of Pemba in the south to the Romuva river in the north.
- The coast and coastal plains which extend up to 50 kilometres into the mainland which form vast stretches of sand beaches and sand dunes interspaced with muddy river estuaries.
- The middle plateau
- Some high plateau/uplands between Montepuez and river Rovuma.

2.5.1 Cultural history

The Quirimbas Islands have provided refuge from invading or warring groups from the earliest accounts of western records (Newitt 1995). The region has gone through two distinct periods of colonisation, firstly that of Arab traders in the 1400s and then by the Portuguese in 1843. Populations within the Quirimbas Archipelago have also fluctuated with two population explosions during the slave trade period (Finnegan 1992). The richest source of historical documentation for these regions is from Arab and Portuguese trade documents and the diaries of merchants and government administrators, which means that ethnographical knowledge documenting the cultural history before this time should be treated with caution. These documents focused mainly on descriptions of trade materials, transport and economies over and above descriptions of communities, livelihoods and society at the time.

Figure 2.2 Map showing the province of Cabo Delgado (green) and the Quirimbas Archipelago situated within it (red star). Adapted from André Koehne website: https://commons.wikimedia.org/w/index.php?curid=2215177).



Up until 1593 Cabo Delgado had closer links with Kilwa and Zanzibar in Tanzania up to Malindi in Kenya than with the southern part of Mozambique. Even under Portuguese rule Cabo Delgado was still heavily influenced by Arab culture through their persisting dominance of certain trade routes (Bonate 2010; Bonate 2006). Some of the northernmost regions of Cabo Delgado were still under Swahili rule during colonial times, such as the village of Quiwia which was previously known as Tungi[17]

[17]the historical name of the Swahili sultanate

(Chittick 1963). Hence the cultures of the archipelago have stronger links with these northern regions than provinces and towns further south in Mozambique. The most salient features that exist today can be heard in the regional language of the Kimwani which has approximately 60% similarity with Swahili, and the dominance of Islam (> 90% of coastal populations are Muslim) (Alves et al. 2011).

All Kimwani speaking communities are coastal: the name Kimwani means 'at the coast'. It is spoken along the coast of Cabo Delgado and the islands in the Quirimbas Archipelago. There are four major dialects of Kimwani, that of the central island groups (including the study site of Ibo), the central variety of the Quissanga areas, the northern variety from the Mocimboa da Praia area and the urban variety from the city of Pemba (NELIMO 1989). Islam's influence on trade relations still operates today, and is based on a system of client-patron relationships, which operated as far back as the early fourteenth century. It is reported that local traders would entertain international traders in a system that would secure exclusive sales (Bonate, 2010). Within the Quirimbas Archipelago Islam is a religion that is associated with prestige. Many ruling elites in Cabo Delgado trace their ancestry to this cultural history which is tied up in the trade documents of early dynasties such as the Shirazi (Rzewuski, 1991) Today, one may find, in daily interactions a combination of local cultural spirits with Allah, sometimes used interchangeably in local ceremonies or formal events. Village leaders (*regulos*) may address the audience in a mixture of Kimwani and Swahili, referencing the Quran in Swahili and incanting local prayers in Kimwani. Elements of African culture remain but were always secondary to the Islamic framework (Ogot and Kieran 1968). This hierarchy is still present on Ibo Island where traditional beliefs –exist – largely informally – with Islam. Despite the higher social status afforded to Islam, it was common to find people on Ibo Island reverting to traditional rituals during periods of personal conflict or stress.

During Portuguese rule, great Muslim trading families were forced into the role of the middleman, which is thought to be the origins of the distinctive Mozambican Swahili culture that is most evident in Cabo Delgado today (Newitt 1978). Africans with no mix of Arab or Portuguese blood have throughout this historical period

occupied the lower class, often assigned the role of menial trade-related tasks or tilling the fields. Even with the onset of independence, international traders have dominated the market. Part of Mozambican's political and economic policy was to re-address this historical imbalance by allowing local Mozambicans greater opportunities to enter into the market at the level of local, national or international trader. One such notable scheme by the government was a micro-credit scheme in the late 1990s granting 7,000 Mts to successful applicants to set up local businesses.

Matrilineal structures and female gender power

The matrilineal structures that exist in northern Mozambique largely follow tradition that is thought to extend back to the Bantu-speaking peoples of central Africa. One of the main advantages of matrilineal structures is that they allow a degree of power to women. For example, Gerrits (1997) shows how, in cases of infertility, matrilineal kinship structures among the Macua in Montepuez (northern Mozambique) prevent women from suffering the same mistreatments and repudiation suffered by women in the south where patriarchy prevails. One of the most evident matrilineal structures that exist in northern Mozambique is the lineage system, which organises descent in the household along female kinship lines (Arnfred, 2011). This matrilineal system grants access to children through the woman's lineage in direct contrast to patrilineal systems. Therefore, in the case of divorce, or the death of a parent, the mother's family will take on responsibility of the children. This arrangement is sometimes signalled when the woman and her children take on the surname of the mother's father. Matrilineal structures may take on forms other than household organisation. Another prominent example is the pia-mwene (Bonate, 2006). The pia-mwene is a female traditional leader, often the mother or elder sister of the chief. It is believed she represents a symbolic link to ancestors - the first village settlers. She is called on to perform rituals to ensure the wellbeing of the land and the community. As such the pia-mwene occupies an important role within political decision-making. When the Portuguese arrived in 1834 they allowed pia-mwenes to remain until the end of the colonial era in 1975. However the strong patrilineal cultures of Muslim and Portuguese colonisers meant formally male chiefs dominated public affairs. Other examples of continuing matrilineal structures in northern Mozambique are the (Tufo)

dancing groups. As well as maintaining traditional religious practices these groups provide financial, logistical, social or any other kind of support required to group members.

Research on women and gender in northern Mozambique by authors such as Arnfred and Bonate have documented the influence Swahili and Portuguese colonisations have had on the existence of matriliny in Mozambique (Arnfred, 2011; Bonate, 2006). Their research shows that matriliny has either disappeared or been significantly transformed to adapt to present day contexts largely due to religious and economic transformations in the region. Supporting this research some of the more recent studies on matrilineal systems and land rights in northern Mozambique have highlighted that matriliny is far from clear and female power has either been weakened or pushed into informal or private spaces (Villanueva, 2011.; Lidström 2014). On Ibo Island, economic modernisation (particularly during the colonial period) and Islam are the two main structural forces that have impacted matrilineal traditions. These forces have been particularly strongly felt on the Island due to its historical post as the capital of Cabo Delgado. Therefore, identifying existing matrilineal structures on Ibo is challenging and requires a specific methodological focus. As matrilineal systems were not studied explicitly over the course of the fieldwork no conclusive inferences regarding the extent and nature of matriliny on Ibo can be made. Nonetheless in discussions concerning their personal circumstances women referenced some matrilineal customs. Notably this was not done explicitly, but was rather the unspoken preference against which women judged their situation. The two customs were marriage arrangements and the provision of resources in the household (mainly food).

Informal discussions and observations revealed that few fisherwomen had a positive attitude towards their marriage arrangement, namely polygamy. This is similar to what Arnfred Signe experienced in her conversations with women in Cado Delgado province in the late 1990s, in fact her impression was stronger in saying ‘they detest it’ (Signe, 2011: 97). Polygamy on Ibo is associated with Islamic custom in which it is permissible to marry more than one woman. The main grievance women voiced was in the lack of control over their husbands’ decisions to marry or divorce. This

can be contrasted against traditional matrilineal structures in the region where women can exercise a degree of power if they are unhappy with their husbands' decisions. This is often done by threatening divorce as it is within their rights to do so (Signe, 2011). Additionally not only can women initiate divorce themselves but is it an easier process as women's families do not have the burden of having to pay back the bride price 'lobolo' and the women has the security of being able to keep the marital home. Women on Ibo spoke a lot on the issue of divorce leaving them homeless. The four female research assistants that I worked with all spoke of the desire to build their own home. In fact one of the first things my primary research assistant did with money from her salary was to purchase a plot of land even though she was married and her husband had a house. However in accordance with Islamic custom women's right to divorce lies with the husband. This means when it comes to polygamy, women feel particularly powerless in their marital arrangement. This also extends more generally to marital issues such as infidelity or an unsupportive husband. As I mention later in the thesis, unhappy women who were practising Muslims later confessed to me that they had visited curandeiras[18] in an attempt to prevent infidelity or their husbands taking second wives.

In terms of the provision of resources in the household, the emphasis on Ibo (similar to throughout the country) has moved from subsistence food production to cash generation. Money is now seen as the principal means to livelihood security. Men have been quicker to adapt to the cash based economy and have found with it new freedoms to access and control resources within the household. This has challenged one of the fundamental sources of female power in the household: food production (the other being reproductive ability). In matrilineal household structures, and to a lesser degree in patrilineal households, women occupy a central role in the household economy as the (subsistence) providers of food. They work on the farm, oversee the food stores and cook and distribute the meals. This central role in food production and distribution allowed women a degree of authority in the household. However with the increased importance of cash income as the most important

[18] Female traditional healers

resource in the household this role has been undermined and hence the power associated with it. In this context of lessening female power and increasing male freedoms women are finding it harder to access resources within the household leaving them vulnerable to food or other livelihood insecurities.

More generally Islamic customs have also influenced matrilineal structures by assigning women to the private sphere. Arnfred Signe describes how female initiation ceremonies practised in parts of northern Mozambique were 'Islamicised' by moving once public rituals behind closed doors (Signe, 2011). Limiting women's presence in the public sphere is related to controlling sexual energy by imposing 'external precautionary safeguards such as avoidance rules' in society (Murdock 1949 quoted in Signe, 2011 page 54). Women are seen to threaten this sexual order and hence are they subject to stringent laws such as veiling and purdah - segregation in public affairs (of which the influence on octopus fishing is illustrated in chapter 7). This influence that Islam has had on women's presence in the public sphere may have contributed to the lack of visibility of matrilineal structures on the Island.

2.5.2 Economy and infrastructure

Local fisheries have formed the backbone of local economies in the coastal communities of Cabo Delgado. Trade in marine resources allowed households to exchange or buy agricultural products from the mainland or start-up small farms on island and coastal mainland plots. Agriculture is practised in small family plots that plant cassava, maize, and vegetables such as beans and peanuts. Fruit trees, namely mango and coconut, are the main commercial species. In addition to these agricultural products, natural resources such as mangrove poles, sand, shells and elephant grass provide valuable sources of construction material and energy in coastal communities. The principal markets for seafood products from the Quirimbas Islands include inland markets such as Montepuez and Nampula, and the Provincial capital Pemba. Traders from southern Tanzania also come to buy local products such as coconuts and fish.

2.5.3 Local institutions and governance

Local chiefs (*regulos*) are the main customary authority pre-dating the colonial period. However they have been heavily influenced by colonisation (Virtanen 2005). Arab dominance relied heavily on forming kinship ties through polygamous marriages with chiefs' families in order to secure trade rights. It was through these ties that various forms of Islam interacted with local chiefdoms and sacred authorities. Traditional and Islamic values and symbols were contested and power was gained through control over local religious institutions (Bonate 2010). Hence, in the period leading up to Portuguese colonial rule, ethnic identities and territorial chiefdoms were constantly forming and reforming.

Following independence Mozambique's socialist government (Frelimo) attempted to establish a regime that delegitimised customary chiefs, as they believed traditional authority was a construct of the colonial era. Having traditional chiefs in place, they argued, conflicted with their plans for socialist modernisation (Henriksen 1978). However some local chiefs managed to maintain authority through relatives that held positions in the government (Meneses et al. 2006). In 2000 this regime ended and a decree was passed that recognised customary chiefs as legitimate local units of government. Reinstating *regulos* has been a contentious issue and is debated among scholars and government officials alike (Obarrio 2010). The concern voiced by sceptics is the wisdom of empowering individuals whose model of authority derives from the colonial era when local populations had severely limited human rights. They also question the ability of these *regulos* to operate in a vastly different political world. Local populations have lived through this changing political structure on their local forms of government and it is the reason, some argue, that local chiefdoms may not always be the panacea they are often purported to be (Demian 2015). It is important to understand the nature of the social-institutional context on Ibo and the Quirimbas Islands as fishing and other livelihood activities are embedded in this context. Recognising the combination of Islamic and traditional beliefs and the role of colonial and post-colonial governments' influence on the local power structures and institutions, is essential to better understanding of how and why people fish and live on Ibo.

2.6 Ibo Island

Ibo Island lies at the centre of Cabo Delgado's range of islands (Figure 2.3). Its surface is approximately 16.2km^2 and on the western side borders with the mainland. Ibo Island is part of Ibo district which includes five other islands depicted in Figure 2.3. Ibo Island is home to a number of administrative offices: the headquarters of the district governor; the police chief and an office of Quirimbas National Park. The offices are found in the old colonial residential district on Ibo Island called barrio Cimento.

Figure 2.3 Location of Ibo Island within the District of Ibo (google map image).

Historical population estimates for Ibo Island indicate that, both in terms of size and composition, its population of has changed throughout its history. The Portuguese arrived on Ibo Island shortly after invading the Cabo Delgado coastline circa 1522. They brought agricultural products to the island such as goats, cattle, millet, rice and beans and along with water tanks and wells some of which are still in operation today. Ibo Island became the capital of Cabo Delgado in 1770 and developed into a prosperous port with companies such as the Niassa Trading Company operating out of it. During this period the population of Ibo district also grew to the highest ever recorded at approximately 20,339. It remained a successful port until 1929 when a

new capital was formed in Pemba (at the time Pemba was called Porto Amelia). This shift naturally led to a decline in trade which affected the local economy significantly. Ibo was no longer a bustling port and the population dropped as many migrated to the new capital. Ibo Island suffered further, along with the country as Mozambicans fought for their freedom and even though it was won in 1975 the subsequent Frelimo-Renamo civil war destroyed much of the infrastructure that had been left behind by Portuguese fleeing the country. Direct combat never occurred on the Island but the population effects were felt as inland refugees arrived in tens of thousands on Ibo Island (Meneses et al. 2006). In the period after the civil war - 1997 and 2005 - population estimates of the district from government surveys grew from 7061 to 8773 (Ministério da Administração Estatal 2005). This coincided with the greater economic stability in the country and arrival of several NGOs and tourism lodges. Since the late 1990s on Ibo Island, there have been a number of other push and pull factors that have resulted in population growth. These include the employment and development opportunities associated with tourism development, an increase in NGO work on Ibo Island, human wildlife conflict on the mainland disrupting farming[19] leading people to move to the island, and a decline in fisheries resources elsewhere, particularly southern Mozambique and southern Tanzania. An independent survey in 2012 estimated that there are 1000 households and 4000 individuals on Ibo Island itself (Lopus, 2012). In 2010 electricity was re-established on the island for the first time since the colonial period. Ibo Island has the highest number of wells in the archipelago: 96 of which 46 have pumps.

There are a range of livelihood activities on the island including agriculture, fisheries and formal employment (see Appendix S2:I for a full list). The primary natural resource-based livelihood activity on the island is fishing, and limited agriculture is also practised. Similar to other islands in the archipelago, people farm cassava, beans, maize, peanuts and pumpkins on small plots of land on the island. Livestock rearing, particularly goats, is quite common on the island. Coconut trees are the most

[19] The main source of human wild conflict was in relation to elephant damage in the fields due to an increase in elephant populations in later years because of conservation efforts and wildlife laws. There are also reports of an increase in lions killing people within the Park (Sean Naazerali, pers. comm).

common and economically important fruit tree, while some people also have lemon trees, mangos and pawpaw. Small local businesses operate on the island, such as carpentry and handcrafts e.g. mat weaving, and tailoring. One of the most desirable activities is small to medium size trade in basic food products (salt, oil, and sugar) and household necessities such as kitchenware. Most of these trade products come from Pemba, Montepuez, Nampula (southern Mozambique) and Tanzania. Local business opportunities accessible to women are mat making and selling bread, cakes, and biscuits. Married women may help their husbands in their business (e.g. running a shop) or by drying and processing their husband's catch for sale.

2.6.1 The Ibo Island fishery

Ibo Island has a coral reef on its southern, eastern and northern sides. Mangrove stands occupy the western side of the Island. This is the largest mangrove stand in Cabo Delgado. It can only be traversed on the lowest of low tides by someone in the know. Fishing occurs all around the island but predominates in the northwestern side and eastern coastline. Fishermen mainly rely on dhows and canoes powered by wind to get to the fishing sites. Fisheries encompass eight main types of gear on Ibo: seine nets (cavogo), gill nets (nhavo), lines and hooks, spear guns, traps (marema), mosquito nets, mingalre nets and catch by hand. The dominant target resources are parrotfish (Scarids*: Scarus sordidu and S.ghobban*), emperors (Lethrinids, *Gnathodentex aurolineatus*), groupers (Serranids*: Cephalopholis argus, C.nigripinnis and Epinephelus fasciatus)* and snappers (Lutjanids, primarily *Lutjanus kasmira*). Also large shoals of fusilier (Caesionid*: Ptercocaesio pisang*) have been noted (Whittington and Myers, 1997). To a lesser extent the blue spotted ribontail ray (*Taeniura lymma*) and sea cucumber are also targeted. In the mangrove habitat crabs of the genera, *Sesarma* and *Uca* and species *Scylla serrata* are also targeted (Whittington and Myers 1997).

2.6.2 Women's intertidal fisheries on Ibo

The most popular intertidal resources targeted by women include octopus, edible shells, ornamental shells and fin-fish. Appendix S2:II presents a list of the key species targeted by fisherwomen on Ibo Island, what sort of habitat they like, their

use and who targets them. Edible shell fishing includes the collection of both gastropods and mollusks, and occurs in all intertidal fishing grounds (Figure 2.4; Figure 2.5 left).

Figure 2.4 Left: Fishing for pen shells in the distance. Right: Fisherwomen shucks a pen shell.

Fishing for octopus occurs predominantly in Cumwamba and Mwembe fishing grounds, to the east side of the island where there are significant zones of coral rock suitable for octopus. IIP (2014) state that the following octopus exist in the Quirimbas – Archipelago: *Octopus cyanea*, *Octopus vulgaris*, *Octopus aegina* and *Cistopus indicus* and *Octopus macropus*, but their empirical field study illustrates that the majority of all octopus fishs are composed of *Octopus cyanea* (Figure 2.5 Right).

Figure 2.5 Left: Fisherwoman targets a swimming crab. Right: Fisherwoman looking for octopus in the den.

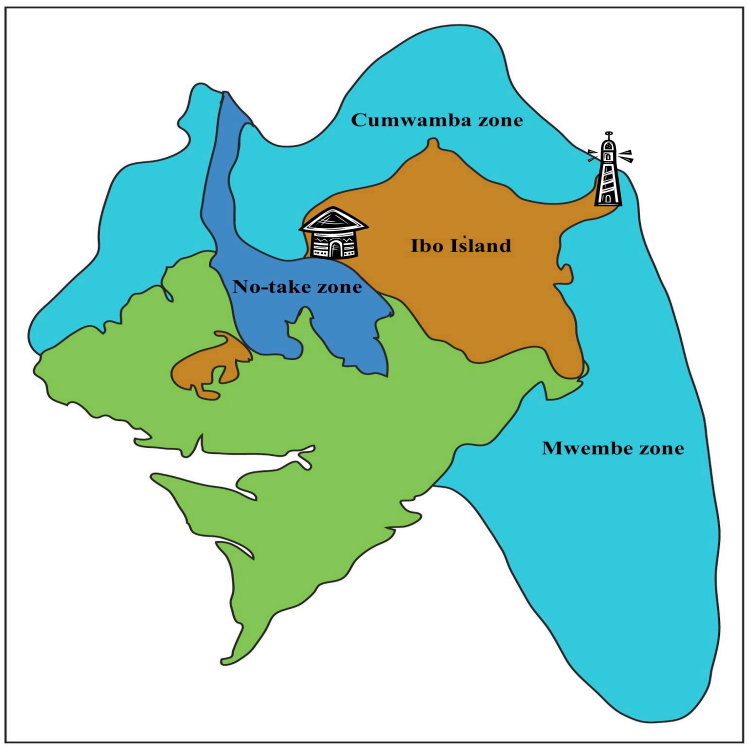
There are two principle net fishing techniques employed by women: gill net fishing which consists of dragging the net through the water. These could be mosquito nets (Figure 2.6 right), sometimes cloth, and other very small mesh gill nets, and

'*mingalare*' nets, a larger gill net (Figure 2.6, left). Mosquito nets are thought to catch a large proportion of juvenile reef fish (Bush et. al 2016), while gills nets target needle fish.

Figure 2.6 Left: Fisherwomen with a minglare net Right: A fisherwoman with a mosquito net.

On the island there is a natural divide between women's two fishing sites: the north-eastern reef (Zone 1, Cumwamba; Figure 2.7) and the south-eastern reef (Zone 2, Mwembe; Figure 2.7). The divide is a peninsula that runs out to the east of the island, and has an old Portuguese lighthouse. Due to the layout of the island, and the access paths that exist, women either walk out to Cumwamba zone via the north of the island, or to Mwembe zone to the south of the island. Key biological and social characteristics of each fishing zone are described in more detail in Appendix S2: IV.

Figure 2.7 Women's fishing sites on Ibo and no-take zone



2.6.3 Tidal cycle and the intertidal fishery

The tidal cycle is the period of changing sea levels, which follows the lunar period which lasts 29.5 days in which two tidal phases occur: spring and neap tide (Open University, 2000). The spring tide is the most important for women's fishing activities on Ibo Island and other coastal sites in the Quirimbas. During this period the greatest surface of intertidal area is exposed, and as women access this area by foot, they have access to the most extensive area. The low spring tide period occurs twice in every lunar cycle. This occurs both at the full moon and the new moon over approximately 3-4 days. Following the spring tide the sea level retracts over about a week culminating in the neap tide period and the half-moon lunar phase where the tidal range is the smallest (Open University, 2000). The tidal range along the east coast of Africa is between 2-4meters. Ibo Island occupies the higher end of this spectrum with the highest ever recording being 4.8meters (Sete, et al. 2002). This range and the local topography determine the extent of intertidal areas. Therefore, women's fishing and their other livelihood activities more generally are dictated by this tidal pattern.

2.7 Conservation and tourism on Ibo Island

Ibo Island is situated within the Quirimbas National Park (QNP). The park was formally created in 2002, and covers 7,500km^2: 80% of this area is terrestrial landscape on the mainland, and the remaining 20% is the coastal marine environment. A further 10km radius around the QNP forms the buffer zone. The QNP contains four of WWF's ecoregions[20]: South-east African Coastal Forest, East African Mangrove, East African Marine Ecoregion and Miombo Forest and Eastern Savannah. It is legislated under the Environment Act (no 20/97, MICOA). During the time of this study, the Ministry of Tourism was responsible for all of the national parks in Mozambique; within the ministry, the National Directorate for Protected Areas (DNAC) is the body that carries out this work. At the time of writing, it is still

[20]WWF Ecoregions are described as "large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions" (WWF website, accessed January 2014).

DNAC which is responsible for administering and approving all new Protected Areas, but the change in Ministries has resulted in the formation of a new Ministry, the Ministry of Land, Environment and Rural Development which is responsible for Protected Areas.

In 2006 a governing body for the QNP was created (the Park Development Committee, COMDEQ) which operates as a corporate body under public law[21]. It is this body that sets the management guidelines for Quirimbas National Park.

The list of the QNP's 6 objectives is presented below (Ministério do Turismo, 2004; page 30):

1. To protect conserve and where necessary restore the ecosystem processes and the species and genetic diversity of all terrestrial and marine resources (living and non-living) in the Park area and its area of influence
2. To promote the economic and social well-being of the park's ancestral inhabitants by the promotion of sustainable resource use strategies, by the development of ecologically sensitive livelihood options, and by prioritizing their interests in the economic opportunities deriving from the establishment of the Park
3. To ensure that all stakeholders – including but not limited to residents, tourist operators and investors, as well as Park management structures – share both the benefits of and the management responsibility for the Park
4. To protect, conserve and rehabilitate historical monuments, ruins and other cultural resources in the park area (including local culture and tradition)
5. To stimulate and facilitate the growth of eco-tourism in the Park area, the province, and the northern region of Mozambique;
6. To ensure the sustainability of the park itself by the adoption of appropriate fund raising mechanisms, cost effective operational systems, and the

[21] Its members constitute a DNAC representative (the chair of the committee), the Park Administrator (committee secretary), district representatives, representatives from the provincial departments for tourism, fishing, agriculture, forests and wildlife, a provincial Navy representative, 2 local community representatives, 2 village leaders, 2 private sector representatives (tourism operators) and 2 NGO representatives (Aga Khan Foundation and AMA).

development of partnerships with other stakeholders and relevant research institutions

Specific marine conservation goals of QNP as laid out in the management plan are i) to reduce pressures on the intertidal habitats; ii) coral regeneration; iii) conservation of sea grass beds; iv) conservation of turtles, whales and sharks and v) to harmonise the objectives of the fishery and tourism sector (Ministério do Turismo, 2004).

The selection of a study site within a conservation area is important as it allows for an understanding of women's fishing activities and livelihoods within a conservation context, which is relevant for other conservation areas in the Quirimbas Archipelago. There are a number of regulations within QNP that potentially influence women's fishing activities, and a review of QNP's management document highlights a number of regulations that govern the use of marine resource within the park area. Of importance to this study, and to women's access to and use of the intertidal zone, is QNP's zoning system which was introduced at the time of the annexing of the park. The different categories of zoning are illustrated below in Table 2.4. There are three types of use zones: i) total protection zones (TPZ); ii) specific use zones and iii) community development and use zones.

Table 2.4: Zoning categories of QNP (Ministério do Turismo, 2004).

Zone	Description	Permitted	Not permitted	Sites
Strict protection zones (sanctuaries or no-take zones)	Habitats or species of outstanding interest Relatively untouched zones Zones of importance for migrating species Zones where natural restoration is essential	Scientific research and certain tourist activities subject to agreement from relevant authorities	Resource extraction of any kind	Quilalea and Secar islands Mangrove stands and harbour zone of Ibo Rolas islands Zala bank Quirimba islands And more to be

				added
Community development zones	Promote sustainable prawn, fish and sea food fishing in the intertidal zone	All activities – may be subject to quotas system in the future	n/a	
Special use zones	Areas reserved for special use	Sport fishing	Any other activity, e.g. commercial fishing	Saint Lazare Bank

Two of these zones types – the total protection zone and the community development zone – are active in the marine zone around Ibo Island. The total protection zone (TPZ) covers the bay on Ibo Island and the no-fishing regulation is enforced by QNP rangers in collaboration with the local CCP. The other areas of the island are community development zones, which means the areas are co-managed by the local CCP and local government, in close collaboration with the QNP authorities. In these areas, according to the QNP management plan, "*the capture of live fish or other marine organisms for sale*" is prohibited (Ministério do Turismo, 2002 50). As a result, the current use of fishing grounds on Ibo Island is reflective of these restrictions and regulations.

In addition to the spatial and regulative restrictions that apply to women's fishing, and are of interest in this study into the dynamics of the social-ecological system in a women's intertidal fishery, QNP is also purposefully promoting tourism as a mechanism to boost the local economy and reduce dependence on marine resource use. The Ministry of Tourism's Strategic Plan (2004-2013) explicitly aligned tourism promotion and development with conservation areas, calling for a "symbiotic relationship" between the two. The creation of QNP was inextricably linked to the

new tourism interest of the area, and the establishment of high-end tourism lodges on Ibo Island, Quilalea and Sencar[22] (two islands south of Ibo Island), and Matemo Island were all conducted in parallel with the establishment of no-take zones adjacent to the lodge, referred to as 'sanctuaries'. This approach has been adopted elsewhere in the archipelago, such as Vamizi Island's sanctuary area managed through collaboration between the lodge management and the local CCP (Rocliffe et al. 2014).

On Ibo Island, not only are fishing restrictions closely linked to tourism interests, but the island economy is increasingly influenced by the growing number of tourism outfits and tourists visiting the island. While tourism used to be particularly prominent in southern coastal Mozambique, due to proximity to South Africa and major cities such as Johannesburg and Pretoria, high-end luxury tourism has now started to take hold in Cabo Delgado. The type of tourism promoted by the high-end lodges is a form of 'eco-tourism', which was the trend in the late 1990s and early 2000s, and values exclusivity and pristine natural environments. Increasingly on Ibo local people are employed in tourism lodges, or establish tourism-related businesses, such as local cafes and restaurants but this is still an elite and very small section of the community.

The conservation and tourism developments described above are similar to those happening elsewhere in the WIO region (Benjaminsen and Bryceson 2012). These processes usually rely on a degradation narrative, which states natural resources are in decline and/or crisis, and this is largely due to how local people are using these resources, and sometimes but not always situated within a Malthusian narrative. This narrative necessitates a solution, allowing for the introduction of management measures such as rules and regulations that effectively limit peoples' access to natural resources. The idea is often promoted by conservation and development organisations, private sector, and government, and solutions proposed often require the increased involvement of the private sector, such as tourism operators.

[22] Website for the luxury tourism lodge on Qulelea can be found here: http://www.azura-retreats.com/azura-quilalea/ (last accessed December 9th 2015).

Researchers have noted these processes of environmental conservation (i.e. the introduction of management measures) essentially turn 'wild' areas into 'productive' or 'sustainable' spaces. Benjaminsen and Bryceson (2012) refer to this phenomenon as 'blue grabbing', where marine resources are appropriated by outside interests. This phenomenon is particularly evident in less developed countries, and leads to a loss of access to the marine environment.

Blue grabbing is not unique to Ibo Island, and it has been researched outside of the fisheries and conservation sector by political ecologists and economists. Their work has shown these processes are rooted in early forms of capitalist expansion, what Marx referred to as primitive accumulation, and Harvey later developed into 'accumulation by dispossession' (Marx 2010; Harvey 2003). In Harvey's more recent conceptualisation, capital is acquired (accumulated) through divorcing people (by restricting their access) from assets (or capital). In addition, and specific to forms of blue grabbing experienced in the WIO, the labour of local people is not required as part of the accumulation processes (Li 2010). Instead, where job creation occurs, it functions more as a mechanism to facilitate of the process of dispossession. It is used to present tourism and conservation activities as forms of 'pro-poor' development or community conservation.

The tourism and conservation processes described above align with Mozambique's national economic policy to use private and foreign sector investment to increase economic growth and decrease poverty levels. The ability of such strategies to achieve these goals is questionable (as discussed in section 2.2) and thus has worrying implications for local livelihood development. In the case of QNP there have been no comprehensive studies on the impacts of conservation and tourism on rural development and poverty alleviation. However, the literature on the social impacts of conservation contains substantial evidence for the negative livelihood impacts of joint conservation-development initiatives, although it also highlights that these impacts have to be understood on a case by case basis (Bidaud et al. 2017; Duffy 2006b). Researchers often examine the livelihood implications of conservation through looking at the different components of human wellbeing that are likely to be affected, including health, basic material assets, security, freedom of

choice and action and social relations (Bidaud et al. 2017). In the marine section of the QNP it is likely fishing restrictions will have had some level of impact on those who use marine resources directly or indirectly. This is particularly due to the closing off of fishing grounds for no-take zones and protecting species such as marine turtles traditionally relied on as a source of food and income. Hence, while this study site will have unique contextual factors, the broader economic and political environmental conservation processes at play are mirrored in other regions of the WIO.

Methodology

Chapter 3

Fisherwomen on a fisher-follow heading out to Mwembe zone.

Chapter 3 – Methodology

3.1 Introduction

This chapter presents an overview of the methodology used to explore the research objectives presented in the proceeding chapter. As this research aims to understand the dynamics of a specific social-ecological system – a women's intertidal fishery in northern Mozambique – method selection to understand the different components of the system is a very important consideration. As Ommer et al. (2012; 316) state in reference to understanding complex coastal marine systems:

> *"this requires the systematic collection, comparison and (where feasible) integration of scientists' and stakeholders' knowledge from a broad range of natural and social science and humanities backgrounds, different social-ecological locations (spatial, temporal and organisational), local experiences and traditional practices, as well as formal knowledge"*.

The introduction chapter highlights that studies into fisher behaviour have included methods from the biological sciences, particularly behavioural ecology, and more recently have included the disciplines of anthropology and human geography to explore the wider social context in which behaviour operates. However, there are limitations to what a PhD thesis can cover. While an awareness of the role social science plays within the wider debates of fisheries and livelihoods is crucial in adopting the right methodological approach, the focus is on the social-ecological interactions at a local level, from the lived experience of fisherwomen, in order to generate empirical results that can contribute to understanding what is a complex small-scale fishery in northern Mozambique.

In light of this, the methodological challenge for social science enquiry in fisheries is not one of prediction but one of explanation. One that puts perceptions at the basis of our understanding and explores the differences between what people say and what they do. It is this understanding that has gone on to structure the methodological approach adopted here, and hence the nature of the results.

This thesis aims to further understand pertinent issues of fisherwomen's behaviour by applying novel approaches to established issues (Brockington and Duffy 2011). It adopts a mixed-method approach, in a purposeful chronological development of different methods, including a pilot study to design study methods and train research assistants. The methods used include an intertidal catch survey, a fisher questionnaire survey, Participatory Rural Appraisal (PRA) techniques including focus group discussions and a participatory wealth assessment, and ethnographic techniques including participant observation, interviewing and fisher-follows.

3.2 Chapter structure

This chapter describes the fieldwork approach, including working with different stakeholders in the area, and how I aimed to ensure validity of results and ethical considerations. The mixed-method framework is then introduced, followed by a summary description of each method. Supplementary information on the methods and data analysis can be found in each empirical chapter (chapters 4-7).

3.3 Approach to fieldwork

3.3.1 Reflexivity

I refer to reflexivity here as the process of reflecting on my presence in the community and how this influences the data gathered and presented. In addressing the central issue of reflexivity in the social sciences – particularly ethnographic work – I briefly discuss my relationship with research participants and organisations I encountered during my fieldwork (Delamont 2009).

Building trust is a vital process in collecting valid data through qualitative methods (Bernard, 2006). Building trust requires the researcher to be consistent in practice and open in nature. This can mean exposure to hostilities, suspicion, ostracism and, sometimes, outright rejection in the first few months of fieldwork. I experienced all of this, particularly in the pilot study and first few months of fieldwork. This was

partly due to Mozambique's recent history, as a country emerging from civil war, partly due to the nature of the particular ethnic group I was studying, and partly due to the communities' previous experiences with foreigners.

Approach to working within Quirimbas National Park (QNP)

The research site of Ibo Island is situated within Quirimbas National Park which is managed by the Ministry of Tourism with the technical support of WWF Mozambique. It was essential to gain permission from the park administration (Quirimbas National Park) prior to starting the research. All the administrative preparations for this permission was carried out in Pemba, the provincial capital. My collaboration with QNP did not extend beyond this administrative requirement, as it was important to maintain a neutral positioning in relation to the national park. On the island it was important that the community did not associate me with working with QNP or for WWF as this would have created a bias in respondents' answers to questions. For this reason I did not rely on any logistical support from the QNP in terms of office space, accommodation or transport. Managing my relationship with QNP was a key part in establishing trust with the local community.

Approach to working with Ibo Island community

As the old capital of the Provence of Cabo Delgado, a key trading centre, and an island of cultural and historical significance, Ibo Island has been the focus of a lot of development and conservation research. Hence, I decided any extensive survey would a) place unnecessary time burdens on fishing households which would harm community relations and b) be subject to the perils of research fatigue, that is when people are less likely to provide truthful answers, and unlikely to fully participate. I was keen to rely more on ethnographic and participatory methods instead, which required the creation of relationships of trust prior to starting the methods. In addition, to collect quantitative socioeconomic data I decided to keep the work as focused as possible by targeting fishers through techniques such as snowball sampling (Atkinson & Flint, 2004).

In terms of personal relations, I was aware that the experiences the community had with foreigners was less than favourable. Whilst I was living on the island there were numerous cases of foreigners harassing, abusing and even harming locals. The Island administrator had to call a meeting to warn foreigners of their behaviour on more than one occasion. The impact this had on a researcher such as me was in establishing trust. I went about this in three ways. Firstly, was the decision to live inside the community as opposed to the cement district where foreigners lived. Secondly, it was to introduce myself and associate myself with community leaders across the board from religious, to district, political and women. Lastly, I attended all invitations to local ceremonies and actively took part in them myself in terms of celebrating locally significant festivals (Figure 3.1). The more people I was able to talk to, the more helpful it was when it came to corroborating the findings from the survey.

Figure 3.1 House I stayed in and ceremony to bless the house

Approach to working with fisherwomen

The first 3-6 months of fieldwork was solely a process of habituation to allow people to get used to my presence and for me to learn the appropriate ways in which to interact with people. To build trust I did a number of things including: dressing appropriately at all times, never revealing my shoulders or knees in public, learning Kimwani greetings immediately, instead of speaking Portuguese, following women

out into the intertidal zone and becoming familiar with the patterns of fishing to show willingness on my part to experience things from their perspective.

In addition, I read out some of the notes I made on each fisher-follow, much to people's amusement: this was not sensitive data as it consisted of octopus extraction times. I would do this as they were beating and sorting their catch. It took away the mystery of my constant writing in their presence. I accepted an invitation to participate in a local savings group. I spent evenings socialising with members of the local community sitting on people's verandas, being open about who I am and where I came from, attending local film nights and participating in the local economy of reciprocity – giving and receiving gifts.

Approach to working with research assistants

Developing a good relationship with (local) research assistants is essential to data validity and accuracy in two respects:

1) Data accuracy: working in locations where formal structures regulating work codes and ethics are unknown, to local assistants in particular, trust forms the basis to establish understanding and to regulate expectations. Accurate data collection requires consistency and a level of precision that was unfamiliar to my research assistants whose original expertise was in intertidal fishing.
2) Data validity: as an independent researcher one cannot be at all places at all times and so trust is relied upon that researchers will carry out their work according to predetermined criteria.

The pilot study was an opportunity to spend 3 months with my principal research assistant to develop a good working relationship and to give her a chance to a) feel comfortable in my presence and b) understand the nature and requirements of the work. She then helped in training the three additional research assistants for the catch data collection. Establishing and maintaining a good relationship with my research assistants created a bridge between the local community (particularly other fisherwomen and I, as the research assistants were the ones to quell any suspicions

about me and/or the research and convince sceptics that it was worth participating in the research. A lot of judgements on my character were made, through people observing the type of relationships I had with my research assistants, in order to answer the ubiquitous question: what kind of 'muzungo' (wealthy foreigner) is she? (Figure 3.2).

3.3.2 Ensuring validity

Within the context with which I was working the issue of validity took the form of striving to assure, as Drury et al. (2011: 19) put it, '*respondents understood the question in the same light as the person asking it*', and secondly, that they understood '*the truth of their answers*'.

Interpretation of questions: "respondents understanding the question"

How to gauge respondents' level of understanding to research questions is a challenge. On Ibo Island the only way I could do this was through repeated questioning of the same issues and reshaping the research questions from those with the inevitable Western-science logic to ones that actually characterise local relationships with the environment. There is also an added layer of complexity to this process, as the researcher must try to avoid research fatigue on the part of the respondents. This is where techniques of cross-validation are imperative

Figure 3.2 Walking to Mwembe intertidal zone with my primary research assistant (Bia) and doing some observations at a fish landing site in Cumwamba zone with Bia.

Interpretation of responses: "the truth of respondents answers"

An understanding of local customs in terms of storytelling, social norms and behaviour helps to interpret the results. Particularly when discussing opinions regarding more sensitive topics such as laws and outsiders' influence on the local community. Literal interpretations of people's response are not always appropriate even if they may appear to be so. For example, on a fisher-follow a local fisherwoman was lamenting the lack of octopus and blaming fishermen from Nacala (coastal province to the south of QNP) over-fishing the area the previous day. When I asked her what she thought a good solution to this may be she said to create a no-take zone. I further asked what she would do if she couldn't fish and she said just sit at home and wait for the octopus to come back. Finding this slightly puzzling I asked the lady the same question a couple more times throughout the day when the issue was raised again. Finally, seeing my slightly perplexed look, my research assistant explained to me, she would not really do that, as she was being facetious.

3.4 Ethical Considerations

Within the context of Ibo Island, I felt the most pertinent consideration was for individual privacy in which I had to respect to be aware of my limits as an outside researcher. This informed:

1) What kind of questions I asked. For the catch survey I restricted the socioeconomic data collection to information that was publicly available. For this reason, I did not ask the age of the fisher, but instead I used age categories (adult and child).

2) When and where I asked questions. Opportunities to ask more sensitive questions were not structured around any specific time or place. Instead I judged *ad hoc* when would be the most appropriate time to ask questions. These questions were largely related to illegal activities and sensitive questions surrounding the division of resources within the household.

3) How I picked my local research assistants who were suddenly in the sensitive position of amassing a lot of information on individuals. This issue applied specifically to the fisher questionnaire, which collected sensitive information on household demographics and more personal socioeconomic information. The women who carried out the catch survey also occasionally fished, placing them in the same wider social network as fisherwomen on the Island. For this reason, I thought that they would not be appropriate to carry out the questionnaire as issues of jealousy between women could mean some respondents would refrain from answering truthfully. Therefore, I chose an individual who was not a fisher to carry out the questionnaire survey.

Another important ethical consideration was an awareness of the extent I was intruding on people's lives. For example, fisher-follows with women involved in net fishing were particularly challenging for two reasons 1) some of their techniques and locations were illegal under QNP regulations 2) the participatory nature of net fishing (which is done as a group) raised questions regarding my share in the catch. Although I did not want a share, it did cause heated discussions among the women as to the best course of action. For this reason, the additional time and resources needed

to accurately capture the nature of this activity meant I felt it better not to attempt to include it as an analytical part of the thesis.

Finally, compensation to participants was in the form of food gifts. During the fisher-follows I took out additional food and water for the participants which would be seen as an advantage to having me around as this was something which they considered too cumbersome to carry out with them. For the questionnaires a kilo of rice was given for the hour it took to administer it. Focus groups followed the same format as formal village meetings which also included soft drinks; participants were also given a kilo of rice. Finally, in structuring the level of pay for my research assistants I examined village-wide salaries and fitted it accordingly. Hence research assistants were paid the equivalent of local QNP staff on the island, and had the additional benefit of the recognition of all local holidays and ceremonial occasions.

3.5 Field Methods

3.5.1 Mixed Methods Framework

Research into a social-ecological system draws from more than one, and often several disciplines, hence it was necessary to select several different methods to understand the social-ecological dynamics of fisherwomen's behaviour. Both qualitative and quantitative techniques were selected. The quantitative data collection involved two core methods which required the most amount of time and resources – a catch survey and a fisher questionnaire survey. The qualitative data collection drew from two families of methods: ethnographic and participatory. In summary, the methods used included:

- Catch survey
- Fisher questionnaire survey
- Ethnographic methods
    - Observations
    - Interviews
    - Fisher-follows (including observations and interviews)
- Participatory techniques: focus group discussions

- Participatory resource mapping
- Participatory wealth assessment

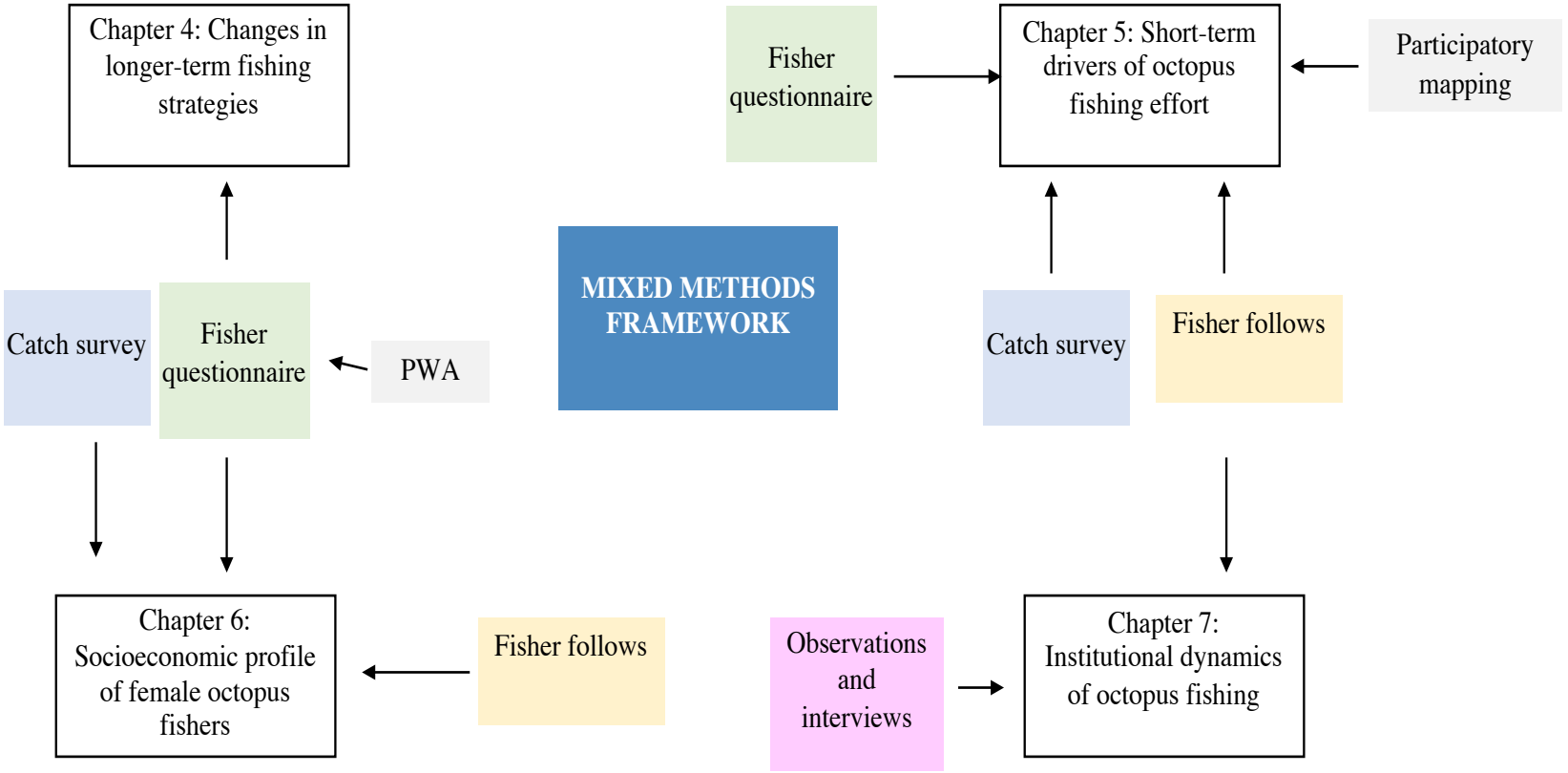
The inclusion of both quantitative and qualitative methods allowed for a balance of descriptive and exploratory data. For example, the catch data was applied as a quantitative approach to addressing the questions of catch rates and resource use patterns in time and space. Trends from these data, and the fisher questionnaire, were then explored in more detail, through the qualitative methods, to understand reasons for fishing patterns or anomalies. In addition, some methods were complementary: for example, the fisher questionnaire allowed for the collection of socioeconomic characteristics of fishers to be included in the analysis of the catch data, which wouldn't have been possible from the catch survey alone.

Figure 3.3 below summarises how the main methodological approaches feed into each of the results chapters. In summary:

- The analysis of longer-term changes in women's fishing behaviour (chapter 4) was based on the fisher questionnaire which examined past and current fishing activities. The questionnaire combined descriptive quantitative data, like fishing grounds used, and included open-ended exploratory questions.
- The analysis of daily octopus fishing effort (chapter 5) relied on the data collected in the catch survey. However, this catch survey also relied on the socioeconomic characteristics of the fisherwomen, extracted from the fisher questionnaire. These quantitative data were then complemented by participatory resource mapping and fisher-follows to identify perceptions of resource abundance and location.
- The analysis of octopus fisherwomen's socioeconomic profile (chapter 6) relied on the quantitative data from the fisher questionnaire to analyse fisher characteristics, and then data from the catch survey to compare these characteristics with fishing effort. These quantitative data were then complemented by information from the fisher-follows which included direct observations and informal interviewing.

- The analysis of the institutional dynamics of octopus fishing (chapter 7) relied predominantly on ethnographic techniques, including the fisher-follows (observations and interviews), key informant interviews and direct observations in the community.

Figure 3.3 Illustration of how key research methods were applied in each of the four areas of research (PWA - participatory wealth assessment).



3.5.2 Pilot study for method selection and design

The pilot study took place between April and June 2009. There were three main objectives of the pilot study. These are listed below:

1. Familiarity with the study site: introduce myself to some fisherwomen; identify key inter-tidal marine resources women use; identify women's key fishing practices; familiarise myself with the main biological and social characteristics of women's fishing areas; meet with village chiefs and island administrator to explain the research. Language learning – Portuguese and Kimwani.
2. Pilot methods: pilot methods including fisher-follows; identification of variables to include in the catch survey; participatory wealth assessment; participatory mapping; key informant interviews to understand the composition of households
3. Research permissions and team: Obtain research permit for the Quirimbas National Park; hire primary local research assistant; secure appropriate accommodation on the Island.

The pilot study set the tone for the methodological approach taken. Upon initial contact with the island community the issue of research fatigue arose due to extensive past research surveys associated with Quirimbas National Park. This gave me time to reflect on the best approach to use. At this stage a community wide household survey was deemed inappropriate. In addition, fishermen had been interviewed extensively both by the park and independent researchers. However, as fisherwomen had not participated directly in any research projects or development programmes research fatigue was not such an issue among this group.

The pilot study was extremely valuable in identifying which methods would be most fruitful in the given context. Fisher-follows were very successful in establishing a strong relationship with fisherwomen, and so the decision was made to use observational and more informal techniques over the more classical household survey during the main field period. Changes in marine resource abundance emerged

as a key issue during informal talks with fisherwomen and this informed the questionnaire sections looking at change.

The chronology of the methods was also established at this stage. Due to the trust issues mentioned previously I decided that fisher-follows should be among the first set of methods undertaken and the fisher questionnaire survey among the very last. This meant that the fisherwomen to be involved in the fisher questionnaire would already be familiar with the research at the time of the survey. This also meant that as the fisher-follows started, there were still 3 months into the main fieldwork period prior to starting the catch survey, which allowed time to communicate the survey to district chiefs and fishers to familiarise themselves with me and my research assistants, so everybody knew what the research assistants were doing and local legitimacy had been granted.

3.5.3 Catch survey

The catch survey aimed to collect data on fishing patterns over 12 months. For this it was necessary to identify where to collect data from returning fishers, define a sampling strategy, and design a data collection template.

Identification of data collection points

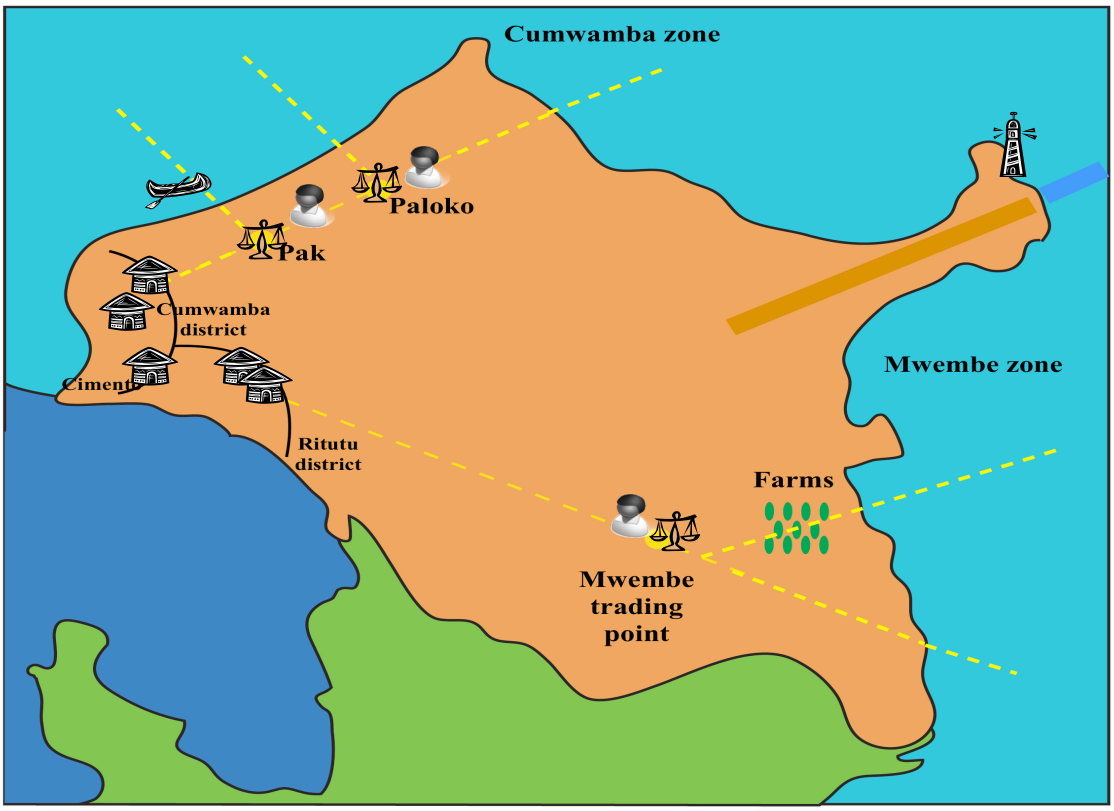
Participation in fishing trips (fisher-follows) and informal interviewing were used during the pilot study to understand the routes fisherwomen took to return to the village after fishing. This indicated three data collection points each located next to a trading spot where women stop to sell their catch (Figure 3.4). These spots were situated along a well-known path between the village and the inter-tidal area. Cumwamba intertidal area had two research assistants to cover its two exit points. Paloko[23] is the main path octopus fishers' use; it takes them past the western side of the beach, which is mainly sandy with some areas of seagrass to where the intertidal topography changes to predominantly coral rock – octopus habitat. Pak[24] is an

[23] Named after the main road into the village.

[24] Boat harbour and fish trading centre.

alternative but less popular exit point for the western side of Cumwamba which is predominantly sandy with seagrass habitat. This is the main habitat for shells, and this is where local boat traffic arrives and departs. The Mwembe intertidal area had one point where women fishing Mwembe sold their catch. This formed the main route off the beach into the village.

Figure 3.4 Map showing data collection sites on Ibo Island. Figure heads represent research assistant; scales show trading posts; boat is local docking areas; yellow dotted line shows paths to intertidal areas. Boundary between two areas thick brown and blue line.



Research assistants were stationed at three data collection points every other day throughout the month, for a period of 12 months (Jan 2010 – Jan 2011). On sampling days the research assistants arrived at the data collection site when the tide was low, prior to fishers going out to fish and remained until all fishers returned with their catch. Depending on the tide, research assistants were at the data collection points for 4 to 6 hours. The 12-month period was selected in order to account for the

seasonality of fishing.

At the end of the day each catch sheet was reviewed by myself to check the data collected had been placed in the right sections. In addition, the primary research assistant and I would visit each data collection site once a week. These visit days were chosen at random in order to ensure research assistants did not adjust effort according to my presence. Two of the research collection points, Pak and Paloko, were sufficiently close together to combine check-up visits, meaning that one person could check up on Cumwamba collection points (moving between the two points) and the other covered Mwembe collection point. These check-up visits provided an opportunity to observe the data being collected, and conduct additional observations and allowed for informal interviews with fishers and traders. At each collection point, a research assistant collected standard CPUE information (illustrated in Appendix S3:I Catch data sheet and shown in Figure 3.5).

Figure 3.5 Research assistants filling out a CPUE data sheet.

3.5.4 Fisher questionnaire

A questionnaire survey was selected in order to generate quantitative data on changes in fishing strategies over time. The questionnaire also aimed to generate information on the socioeconomic characteristics of these fisherwomen, in order to link these with the octopus catch data. Questionnaire surveys offer the benefit of collecting information on a number of individuals for representativeness. However their main limitation is the ability to elicit reliable information from the respondents (Adams and Megaw, 1997; Bernard 2006). Hence their application in this thesis was to generate quantifiable but general individual level information.

Questionnaire design and sampling

Individuals were selected through snowball sampling. This sampling was started with one frequent female intertidal fisher, familiar to the research team, who then suggested the next fisher to include in the survey (Atkinson, & Flint, 2004). The total target number of questionnaires was 120, and during the period of October 2010 and January 2011, approximately 5–10 interviews per week were carried out (depending on the tide).

The questionnaire aimed to collect data on the socioeconomic characteristics of respondents, their household composition, principal livelihood activities of the respondent and the household head, their wealth category and the nature and extent of past and current inter-tidal resource use. It also explored changes in resource use, in terms of catch and consumption (Appendix S3: II Fisher questionnaire survey).

As Bernard (2006) states, the age, gender and social standing of research assistants influences what sort of information and the quality of the data one can collect. Hence, to administer the questionnaire, it was necessary to weigh up the skills required, such as literacy, language skills (Portuguese and Kimwani) and the amount of time required with these characteristics. Based on these criteria, a local resident was chosen to carry out the survey. Although he was a man, he had good social standing among fisherwomen. He was respected primarily because of his unusually soft temperament, which was regarded as non-threatening. He was an unmarried older man with no children, something that was extremely unusual on the Island, and

in many ways he did not conform to the social norms surrounding male relations with women. For example, he would greet women first and not wait to be greeted by them before initiating a conversation. He was also well known among many: I often witnessed women calling out to him from their houses, inviting him in for chats and in some instances, and most importantly, on occasions talking openly in his presence about marital issues.

The questionnaire was administered face-to-face in the local language, Kimwani. The first 10 questionnaires were carried out in my presence, until I felt he was sufficiently trained to carry on himself. The respondents selected the most appropriate time for interviewing and were given a kilo of rice for their time spent (approximately 60 minutes). Completed questionnaires were reviewed on a daily basis with the research assistant in order to become familiar with the responses, to clarify any uncertainties and to verify the data prior to entry. This exercise in itself proved an enriching experience and a relevant departure point to discuss emerging issues.

3.5.5 Participatory Rural Appraisal (PRA) techniques

In addition to the two key quantitative data collection methods presented above, two other groups of methods were used in this research. These included techniques most associated with Participatory Rural Appraisal (PRA), and ethnographic methods. The most commonly employed PRA technique was focus group discussions, introduced below. Within these focus group discussion sessions, participatory techniques including participatory resource mapping and participatory wealth assessment were completed.

Focus group discussions

Focus groups were conducted with fisherwomen during the initial stages of the fieldwork. Focus group discussions are a good entry-level fieldwork method, allowing for the discussion of particular themes among individuals. In total six focus group discussions were completed during the research period. The focus group discussions were stratified by districts on the island (of which there are three) and two sessions were completed in each district. The criteria for selection of participants

were women, who lived in that district, knew each other, were vocal, and had been identified by my research assistant as fisherwomen. The average number of participants was six women, with groups ranging from a minimum of five to a maximum of ten.

The first set of focus group discussions (n=3) were based around women's perceptions of resource abundance and location. Participatory resource mapping is a well-known PRA technique that assists people to map their perceptions of resource abundance (Pretty 1995). In these sessions women informed the drawing of the base map with recognisable geographical features including tracks, the island's airport, the lighthouse, and intertidal zones themselves. Once these features were marked, women were asked to indicate where the most abundant resources were located. These discussions included a range of resources, including octopus, cowries and fin-fish. Women predominantly used catch to discuss resource abundance. In the second set of focus group discussions the focus was on understanding women's perceptions of wealth, and the generation of locally-appropriate wealth categories (elaborated on in the section below).

In all the focus groups the primary research assistant and I jointly carried out the role of moderator. My role was to ensure discussions stayed on track based on pre-defined themes, invite and encourage input from all participants, and discourage 'groupthink', a common issue identified with focus groups (Chambers 1994b; Krueger and Casey 2000). The primary research assistant's role was to translate from Portuguese into Kimwani. Respondents were compensated for their time spent with a kilo of rice and refreshments during the meeting.

Participatory wealth assessment

A participatory wealth assessment (PWA) with fisherwomen was conducted to identify locally appropriate indicators of wealth to include in the fisher questionnaire (Chambers 1994b). This was completed in order to categorise fishers' households into different wealth categories, in recognition of the links between wealth and natural resource use. The critique of participatory wealth assessment lies in the fact that this is a subjective measure which will be influenced by the people whom you

choose to participate in the assessment; even the researchers' presence may cause people to respond in a certain way (Campbell 2002). Therefore the results from the focus group discussions were triangulated with key informants who were best suited to providing additional explanations behind local indicators of wealth. This shed light on norms and customs surrounding ideas of wealth within the community. Conceptualisations of wealth did not touch on broader wellbeing, but focused very much on the idea of wealth in Kimwani society.

Wealth indicators

The indicators that emerged from the participatory wealth assessment are discussed below. Ideas surrounding differences in wealth in the community provided a useful starting point for discussions in the focus groups. The indicators generated were not mutually exclusive; assessments of wealth were a consideration of all these factors. Some were more strongly associated with each other whilst others showed a generational bias. The indicators of wealth drawn up can be split into the following categories: i) food availability; ii) household head occupation and iii) women's own livelihood activities and diversity; iv) house ownership, type and condition; v) marital status and number of the people in the house; vi) size of social events that the household can hold (ceremonies); vii) health; viii) women's material assets; and ix) receipt of remittances (Appendix S3:III).

The first category considered was food availability. Poverty was principally referred to by one's food availability in the household, with women using daily purchases of food in the market as the indicator for poor households, and availability of a stock of rice throughout the year as an indicator for wealthy households. While actual diet was also discussed, including dependence on rice, beans, fish, and how many times a day the household cooks, the availability of rice in the household was the principle indicator cited.

The second category considered was livelihood activity and diversity. This both included the occupation of the household head (for married women), and women's own livelihood activities. For both men and women, women related people's livelihood activities closely to their wealth status and category. Women easily listed

a hierarchy of the most desirable activities through to the least desirable activities. The value-based judgments that informed the positioning of different activities were a mixture of modern and traditional factors. Employment was highly desirable for both men and women, although there was a clear gradient within this category. Formal employment was most desirable, for example working for the state or in a tourism lodge, and then informal wage labour, personal business (e.g. trade) and then informal employment (working for expats living on Ibo). Traditional resource based livelihoods were the least desirable category, and included intertidal fishing and collecting and selling firewood. There was also a hierarchy among the types of fishing activities women participated in.

Additional to this was the time spent doing various activities, which largely followed religious based concepts of wealth. Men classed in the rich to normal categories work every day, but the reverse could be said for women. If you are a married woman and are able to stay home and look after the house it is considered desirable, and increases one's social standing within the community as it falls in line with Islamic teachings that men are responsible for providing all household members' needs. Those women who had to leave the house to work were therefore categorised in the lower category.

The third category considered was house ownership, type and condition. It was clear during the pilot study that to use the material the house is made of as an indicator of wealth, before establishing ownership, is misleading. Among those that do not own the house they live in, many rent instead. Those that didn't pay rent lived in a house of a relative or trusted individual that was living on the mainland, which prevented 'squatters' from using the property. This was most often observed for individuals living in cement houses in the Cement district right next to the island centre with all the administrative buildings and tourist lodges. House type and condition considerations are shown in the table Summary of results from the Participatory Wealth Assessment (Appendix S3:III) with houses built using modern materials such as zinc roofs and cement walls representative of wealth on Ibo Island.

The fourth category of indicator considered by women was marital status and number of individuals living in the house. For women, marriage is an indicator of wealth. Married women are perceived to be better off than unmarried women. In terms of the number of people living in the house, women insisted that it was ideal for married couples to live in their own house with their children and any member of the extended family that needs assistance. However, if the house consisted of more than one married couple (able-bodied) then this was considered a sign of poverty.

Another important wealth indicator for women was their ability to put on or participate in traditional ceremonies. These were socially desirable activities that people viewed as an indicator of wealth. This was normally described as the number of people you were able to invite to the ceremony and how much of a show one could put on in terms of entertainment and food. Finally, other indicators that came up in discussions included the health of the household head and the woman herself, material possessions that each woman owned, and receipt (or lack) of remittances from family members (Appendix S3:III).

Defining wealth categories in the fisher questionnaire

Based on these discussions, it was possible to establish an improved understanding of how men and women see wealth, and generate a list of potential indicators for inclusion in the fisher questionnaire. From these indicators, a total of six (livelihood activities and diversity of the fisherwoman and household head; house ownership, type and condition; marital status and household composition and material assets) were selected for inclusion, based upon their measurability and their social appropriateness. Rather than categorising each fisher's household into a wealth category during the questionnaire, these indicators were included as questions (or observations for house type and condition), and a scoring system based along the lines of the categories for each indicator measure was used to then place a household in a given category.

3.5.6 Ethnographic methods

Ethnographic methods were chosen for two reasons: firstly, due to the research fatigue described previously, which makes extensive household surveys challenging;

and secondly, from an analytical standpoint, ethnographic methods are particularly useful for understanding the complexities of social and power relations, and the 'why' behind the 'what'. Once descriptive and quantitative methods (the 'what'), such as the catch survey and questionnaire survey, are complete, ethnographic methods have the ability to provide the meaning and guidance (the 'why') to these more structured methods. Two methods were used: observations, and interviewing. Observations were written up in field notebooks and referred to directly when writing up. Semi-structured interviews were entered into Word or Excel depending on the nature of the data.

Observations

As Bernard states *"Participant observation or ethnographic fieldwork is the foundation of cultural anthropology"* (Bernard, 2006:342). Participant observation was used throughout the entire fieldwork period. It was however most crucial during the early stages of the fieldwork on Ibo Island, and during the course of the quantitative data collection.

Participant observation can take many forms, but essentially it requires involving oneself in daily life. As an outside researcher, this started with following, as closely as possible, local ways of life. The accommodation was basic: there was no electricity or running water, which meant automatically I had to adjust my schedule to make full use of the daylight hours. I soon found myself falling into the Island's daily schedule for waking up, eating, sleeping, carrying out chores and socialising times. I spent a lot of time with women in the Districts ('bairros') of Ibo Island, away from the administrative and tourist centre, observing people's way of life. This meant I quickly understood the most appropriate times to approach individuals and what to expect in terms of work hours from the research assistants. I made use of local networks, not those of the expatriate community, which gave me a better understanding of the challenges islanders experience associated with travel and food. Tapping into local networks also gave insight into the dynamics of tolerance in the community. What behaviours were particularly frowned upon and what sort of expectations come from living in a community? From this, I began to understand where differences lie in the values between the western culture I came with and that

which existed on Ibo. In doing so, it helped me to understand where to place emphasis on participant's responses. All this provided me with the more intangible aspects of research knowledge.

In addition to observations in the community, I also applied participant observation to all fishing activities, referred to here as 'fisher-follows'. This soon became an invaluable tool in triangulating the information from the catch survey, the fisher questionnaire and the participatory exercises. It was essential to visit these areas to experience the same conditions that the women experienced, verify the other sources of information, and observe women's behaviour in this very different social space. Specifically, fisher-follows:

- Provided qualitative information on women's fishing practices.
- Validated information from the catch survey, particularly fishing times.
- Provided the foundation for the institutional access map, which conformed to the access nodes women negotiate in their fishing activities (Chapter 7).

Appendix S3:IV Semi-structured interview guide for fisher-follows shows the data collected during each follow. Follows were with fishers identified to have good local knowledge and with whom a trusting relationship had been established. The fisher-follows were split into wet and dry season, and fishing site: Cumwamba and Mwembe. However, due to cancellations by fishers, slightly more were conducted in Mwembe intertidal area.

Fisher-follows were not thought to affect fisher behavior as a) the intertidal resources targeted are semi- sedentary and are not affected by the presence of large numbers of people and b) women are often accompanied by children or 'learners' themselves and so are used to having people around. However, at all times the author kept a respectable distance of approximately 2–3 meters so as not to interfere with the activity.

Interviewing

In addition to observations, interviews were also used during the fieldwork. These interviews took two main forms: the informal and opportunistic form, and the more

structured processes that occurred both during the fisher-follows and with key informants in the broader community (Figure 3.6).

Figure 3.6 Picture taken with key informant on political and religious affairs on Ibo and on a fisher-follow in Mwembe.

Informal unstructured interviews were largely spontaneous and provided insight into the issues that mattered to women and how the research themes featured in women's lives. As individuals became more trusting of me women began to conduct personal conversations in my presence. These usually took the form of male and female relationships in a variety of forms in which the central contentious issue was power and how it was exercised to achieve some desired result. As time went on, I realized I would have to discount a lot of what was said to me in the formative months of my fieldwork, as what was revealed in these later discussions illustrated that what women disclosed in these early conversations was couched in socially desirable norms. For example, the use of witchcraft by aggrieved wives was far more prevalent in the community than I was led to believe in interviews and discussions during the first 3–6 months.

Interviews during fisher-follows were semi-structured (Appendix S3:IV). These interviews had two key aims: firstly, to provide more in-depth information on fishing strategies which will complement the catch survey and calculations of CPUE; secondly to provide qualitative data on resource distribution and access to the benefits of octopus fishing.

In addition to the initial unstructured interviews and semi-structured interviews on fisher-follows, towards the end of the study period I started to conduct semi-

structured interviews with key individuals in the community (key informants) in order to explore emergent themes from the research. These individuals were identified on an issue-by-issue basis through my local network (e.g. Senhor X who knows a lot about that type of fishing gear) and key informants ranged from villages' chiefs and imams, to members of the community that had been around to witness a lot of the change surrounding issues of household dynamics, cultural changes and resource control and abundance. Key informant interviews were also useful in gaining a male perspective on some of the issues brought up by women.

Large amounts of writing created a barrier between the respondent and me; it interrupted the flow of conversation and was inimical to customary practices of 'chatting'. Instead extensive notes were written after informal unstructured interviews (Figure 3.7) and key informant interviews. There was some note writing during the fisher-follows due to the length of the exercise (4-5 hrs.).

Figure 3.7 Less formal interview approach on Cumwamba intertidal zone.

Changes in fisherwomen's longer-term fishing strategies

Chapter 4

A selection of intertidal resources targeted by fisherwomen on Ibo Island. From left to right; needle fish and half beaks, pen shells, humpbacked conch and tiger cowrie

Chapter summary

Small-scale fisheries are experiencing rapid changes in relatively short periods of time, and fishing behaviour is reactive to both fishers' intentional decisions regarding resource abundance and environmental factors, and broader political, economic and social factors. This chapter examines how fisherwomen on Ibo Island perceive changes to their intertidal fishing strategies over the course of their living memory, and to which factors they attribute any change. A questionnaire survey was used to interview 120 fisherwomen, and the results illustrate that they perceive changes in where they fish, the resources they target for income and consumption, and their catches. However, they do not perceive a change in the frequency of fishing or gears they use at the time of the study compared to previously.

Women's fishing sites have largely been enclosed to sites around the Island. Participants reported that target resources have been depleted, particularly bivalve and gastropod resources, although the rate of depletion has not been even. Fisher's catches are now less diverse and smaller. These changes have resulted in a reduction in the level of productivity of women's fisheries during the dry season, and a shift to the wet season as a more profitable time. As a result of poor catches women reported they have to eat lower quality or out of season resources. The implications of these changes could be that effort shifts to the octopus and net fisheries to supplement declines in productivity.

Fishers' reasons for change illustrate that multiple drivers have shaped their changes in fishing strategies. Some of these are interlinked, such as tourism and conservation, whilst others have interacted with each other to influence behaviour, such as an increase in fisher numbers and changes in the market for marine resources on the Island. Other drivers have influenced fisher behaviour indirectly: the creation of the National Park affected the seafood market and indirectly fisher's target resources. Finally, considered over this longer-time period, conservation and tourism initiatives outweighed resource abundance as the main driver of fishers' choice of fishing grounds.

4.1 Introduction

This chapter examines the changes in women's fishing behaviour over the long-term in relation to a changing external social, political and economic setting. The aim of this chapter is to understand how these external changes, particularly those occurring over fishers' living memory, have influenced fisher's use of gear types, the resources they target, where they fish, how often they fish and the size of catch per trip.

This chapter uses livelihood theory that hypothesises livelihoods activities are intrinsically linked to wider national and international social, political and economic factors. These factors can drive and structure local livelihoods (Karlsson and Bryceson, 2016). Livelihood scholars such as de Haan and Zoomers (2005) recognise the importance of external drivers on local livelihoods, which they refer to as structural factors. They argue for increased attention to be paid to how structural factors influence local process and practices, albeit indirectly. Research into external drivers highlights the influence of factors such as political regimes, shifts in export markets, changes in economic development strategies, and prevailing fisheries policy (Walley 2004). These external factors force fishers to adapt their behaviour at the local level. As a result, fisherwomen's choices may be more limited than fisheries managers would recognize. Therefore it is important to acknowledge not only the local limitations to behaviour but also the wider external forces that may impinge upon fisherwomen practices. As articulated by Karlsson and Bryceson (2016; 138):

> "*…scholars have pointed out that models ascribe complex environmental problems to local resource users and their nature practices in ways that disregard political and economic forces that impinge upon local people's access to resources and markets*".

It is particularly important to understand the role of these external factors for women's fisheries that are being over-exploited, which is increasingly thought to be occurring in intertidal invertebrate fisheries (Basurto, et al., 2013). Research indicates that fisherwomen are particularly at risk to changes in resource use and

access (Riddell and Rosendo, 2015). In the case of fisherwomen on Ibo Island, it is likely that these external drivers have directly and indirectly affected their fishing strategies. Studies from the WIO region such as Frocklin et al. (2014) report a 60% reduction in bivalve abundance over a period of five years, linked to fishing pressure, while Nordlund et al. (2010) show that increased fishing of invertebrates in sea grasses in Zanzibar has resulted in a reduction of resources abundance and diversity, resulting in a reduced income from this activity. In male-dominated fisheries, reduced abundance has been shown to affect fisher behaviour, as fishers move to new areas or use new technologies in an effort to maintain their catches.

This chapter aims to illustrate how women's fishing strategies have changed over their lifetime and the interplay of drivers that have influenced these changes. In order to do so, the chapter starts presenting changes in fishing strategies and the reasons for change as reported by fishers (section 4.4). It then discusses the implication of these changes to the fisheries and fisher behaviour and finally how these drivers have interacted to influence current fishing strategies, providing insight into how fisherwomen adapt to such changes (section 4.5).

4.2 Methodological approach and methods used

The assessment of drivers of change in a women's intertidal fishery required the application of mixed methods. A literature review of the study site (chapter 2: study site), laid the groundwork for this. Additional research that focused on understanding social, political and economic changes over the last two decades in northern Mozambique was also conducted. Secondly, in the field, a questionnaire survey was used to collect quantifiable information (perceptions of change). In addition, ethnographic methods such as direct observations on fisher-follows and living in the community provided additional context. These methods were triangulated to improve the validity of the results.

4.2.1 Local perceptions

The use of fisher's own perceptions of change is a commonly accepted methodological approach in areas with a paucity of data and historical statistics on

fisheries (Jacquet et al. 2010). Local resource users' perceptions of the condition of the natural resource base are commonly used as an indicator of the state of local harvests, particularly for data poor areas such as northern Mozambique (Rosendo et al. 2011). Incorporating fishers' perceptions into the analysis of change has the additional advantage of allowing an understanding of the local context and meaning applied to change. It is important to understand how change is experienced and interpreted by fisherwomen in order to produce a narrative that has been locally generated. Local perceptions of change also help to reveal what drivers fishers are responding to, and can lead us to question the relative importance of some of the more common explanations of change, such as overfishing, in small-scale fisheries.

4.2.2 Semi-structured questionnaire

A questionnaire was used to quantify change in terms of frequency of responses. The purpose of the questionnaire was twofold: firstly, to collect quantifiable indicators, and secondly to provide a qualitative output which would allow an assessment of the drivers of change. The survey sampled intertidal fisherwomen and was generated through using snowball sampling, starting with influential and frequent female intertidal fishers known to the research team. For more information on the sampling strategy please see chapter 3, section 3.5.4.1.

Each question was split into two parts. The first part required fishers to provide a description of the change itself, and the second part, which was a single open-ended question, solicited fisher's opinions on the reasons for any changes noted. Non-parametric chi-squared tests were used to assess the statistical significance of reported changes.

4.2.3 Indicators of change in fishing strategies

In order to measure changes within a fishery it is critical to understand how the fishery functions, including where women go to fish, how women fish, what resources women catch, and the effort involved in doing so (Wallace et al. 2015). This understanding was generated through prolonged research on Ibo Island (Chapter 3: methods), allowing for the selection of specific characteristics of women's intertidal fishing for this analysis of change. The indicators of fishing practice

selected include fishing gears used, fishing grounds, frequency of fishing, and target resources for both food and income (Table 4.1). Information on fishing gear was obtained by proxy through questions on target resources. Information on catch size (kilograms per trip) emerged through discussions when fishers spoke of their frequency of fishing trips.

To collect data on the consumption and income from intertidal resources fishers were asked to list the top three intertidal resources they fished in both categories (consumption and income), as shown in questions 2.4 - 2.9 in Appendix 3.2. Data on fishing ground location was collected by asking fisherwomen to list which fishing grounds they currently and previously used, using a standard checklist generated through informal discussions with intertidal fishers (question 2.10, Appendix 3.2). Changes in women's fishing frequency (question 2.11) was explored through an open-ended question (question 2.11). Finally information on women's target resources (question 2.4 – 2.5) was used as a proxy for exploring changes in gear. The key questions are listed in Table 4.1 below. Perceptions of reasons for any changes noted were explored through an open-ended question.

Table 4.1 Questions asked, fishing strategy measured and indictors used

Question	Category	Indicator
List your three principal sources of income from marine resources (Qu. 2.4 – 2.6)	Target resources (for sale) and, by proxy gear type.	The top three resources reported by fishers. The percentage of individual fishers who reported a change in the resources they target for income.
How does your frequency today compare to previously [when you first started] (Qu. 2.11)	Frequency and catch	The percentage of fishers who reported an increase, decrease or 'same'. Average catch per trip for each resource mentioned.
Where do you fish? (Qu.	Fishing location	Number of sites visited by

2.10)		fishers. Mean number of sites visited per woman. Number of sites off Ibo Island
List the three most common marine resources you eat daily (Qu. 2.7 – 2.9)	Target resources (for consumption)	The top three resources reported by fishers.

4.3 Analysis

4.3.1 Local perceptions

The first part of the analysis of the qualitative data took a linguistic approach to content analysis (Franzosi 2008). In this process one pays particular attention to forms of interpretation. Categories were chosen to reflect certain words or expressions contained in fishers' responses. An example from the responses to questions regarding target resources is given in Table 4.2.

Table 4.2 Example of the categorisation of local phrases

Categories	Linguistic phrases (Portuguese and Kimwani)
More fishers	"o número de pessoas que foi maior",
Nacalese fishermen	"pescadores de Nacala"
I don't know	"Si-quigiwa"
I have not noticed a difference	"igual", "sempre … bons resultados"
Beyond reach/access	"Difícil atingir" , "pouco próximo" "olhar para um monte" " andar muito/corta"
Marine protected area's no-take zone	"zona fechada", "Park"

Re-appearance and disappearance of resources	"fugir", "desaparecimento"
A decline in resources abundance	"não tem.." "uma pequena colheita" "falta de abundancia"
A lack of clients	"clientes" "mercado" "tudo tem valor"

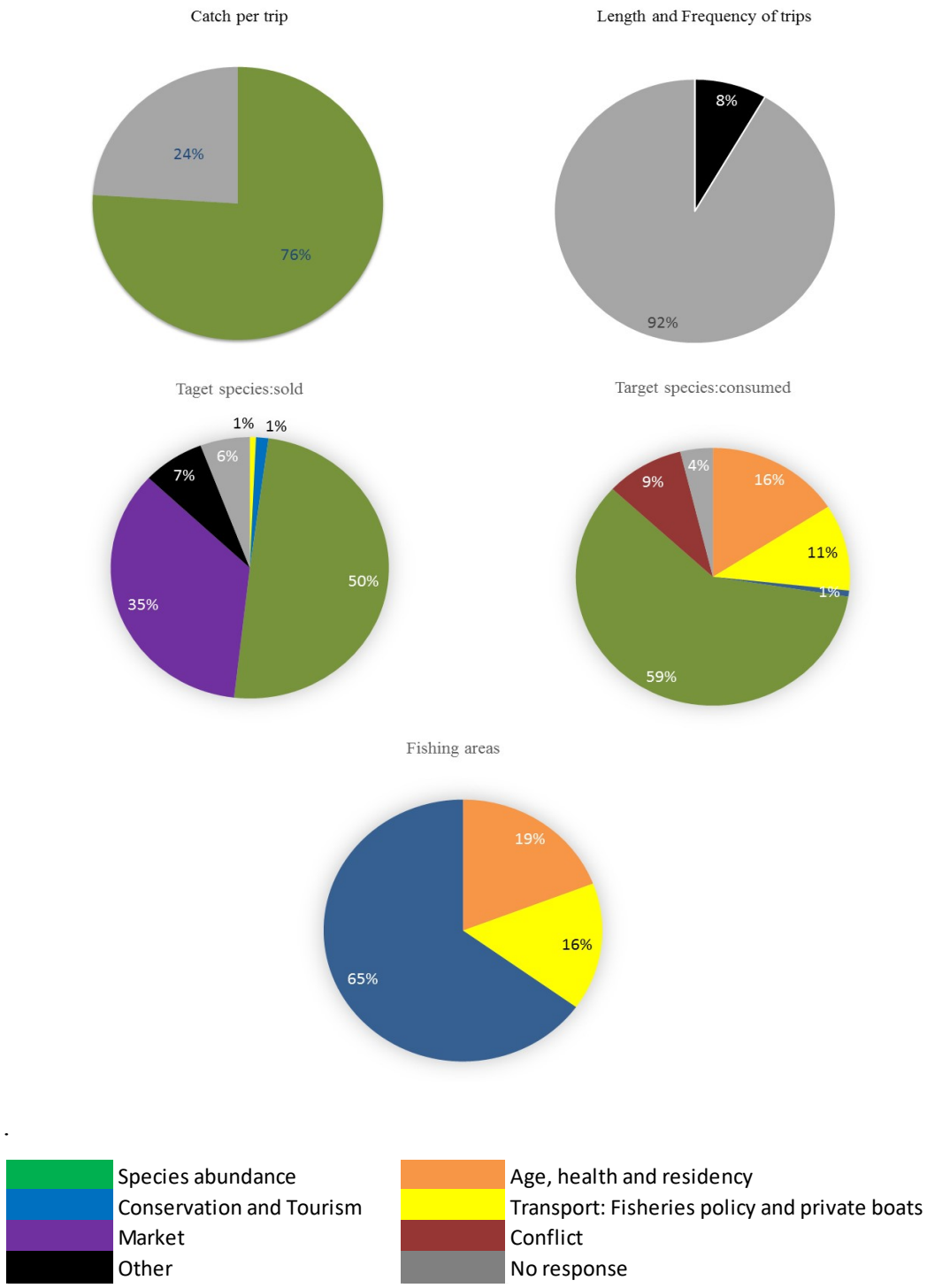
From this categorization of fisher's responses, themes were created that relate to categories of drivers of change commonly referred to in the literature. This resulted in the following categories: 1) age, health and residency (personal circumstances); 2) fisheries policy and access to transport; 3) conservation and tourism; 4) resources abundance; 5) conflict; 6) market; 7) other; 8) no response (when participants did not answer the question.

4.4 Results

4.4.1 Changes in women's fishing practices

Figure 4.1 summarises the drivers of change in women's fishing strategies according to frequency of trips and catch per trip, fishing grounds, and target resources consumed and sold. Where fisherwomen reported a change, their perceived reasons for this change, and the drivers of change are discussed.

Figure 4.1 Fishing strategies measured and drivers identified. Figures show percentage of respondents that mentioned each driver.



4.4.2 Gear type

At the time of the study fisherwomen on Ibo reported using four different types of gear to target intertidal marine resources. These included hand gleaning (96.7% of respondents), iron rods (85.8 %), mosquito nets (44.1%) and gill nets[25] (35.8%). Among the survey group the overall percentage of fishers that recalled using these four principle techniques to collect intertidal resources remained relatively unchanged (Table 4.3). Fisherwomen did not report adopting any new gear types or fishing techniques.

Even though the types of gear fisherwomen use have not changed as a group, on an individual basis they do appear to move between gears (Table 4.3). This change in gear type was particularly evident among individuals who reported using nets. The vast majority of fisherwomen (69.7%) that used *gill* nets at the time of the study were not the same that previously used them. Similarly, 35.8% of fisherwomen who targeted smaller fish using mosquito nets at the time of the study were not the same that previously used this technique. In comparison, hand gleaning and rod fishing did not show much change on an individual basis (0.9% and 16.5%).

Therefore, there appears to have been little change in the proportion of fishers engaging in different fishing techniques, and on an individual basis, hand gleaning and rod fishing remain relatively constant. Rod fishing and hand gleaning do not require collaboration with other fishers, which may explain the relative lack of change over time. However, individuals do appear to go in and out of net fishing over time. Fishers explained that net fishing, both gill and mosquito net fishing, requires either owning a net, or knowing a woman who owns a net who was willing to share it. As female net fishers work in groups of between four and eight people, this means that disagreements or conflicts with other fisherwomen played

[25] Nets with a larger mesh size than mosquito nets used to capture fin fish such as needlefish in sandy sea grass beds.

an important role in defining a woman's access to this fishing technique.

As one woman explained:

"*I used to net fish during the rainy season, but the women said I was not good enough so they asked me to leave the group. Now I mainly eat humpbacked conch and tiger cowrie during the rains*." [Questionnaire respondent number 56].

Table 4.3 Gear used previous recollections and 2010. Table shows the percentage and number of respondents (n=120) that answered the question

Fishing gear	Previous recollections		2010		Change	
	%	n	%	n	% change	% of individuals who previously used and now no longer use the gear
Hand gleaning	97.5	117	96.7	116	-0.8	0.9
Rod fishing	84.2	101	85.8	103	+1.7	16.5
Mosquito net fishing	42.5	51	44.1	53	+1.6	35.8
Gill net fishing	30.8	37	35.8	43	+5.0	69.7

4.4.3 Frequency

Fishers were asked how does your frequency of trips today compare to previously? Similar to gear type, fisherwomen did not perceive or report any significant change, with the majority reporting that they make the same number of fishing trips as previously (88.3%). Only 10.0% reported going less than previously, and 1.7% more (Appendix 4.4).

When asked if the time they spent fishing on any given trip had changed, fishers explained that there had been no change, as the time spent on the intertidal zone is

determined mostly by the tide. Fisherwomen's explanations pointed to habitual behaviour, and they made remarks such as "*it has always been like this*" and "*this is how we always do*" were the most common explanations (8.0%), listed under 'other' category in Figure 4.1.

This result is supported by observations during the fisher follows, which showed that fisherwomen spent between two and four hours on the intertidal zone, depending on the activity. Fishers targeting gastropods and bivalves by hand would generally take less time compared with fishers targeting octopus or finfish. However, there is some variation in the amount of time women spend fishing gastropods of bivalves depending on whether the harvest is intended for consumption or sale. If there is a trader on the Island looking for cowries, fishers will spend the maximum amount of time on fishing, approximately four hours.

4.4.4 Fishing areas

Fishers identified sixteen sites that they used previously but by 2010 this had reduced to five sites. Of the sixteen sites identified previously, thirteen[26] are located off the Island (Figure 4.2). The vast majority (80.8%) used to fish an average of three of these 'off-island' sites.

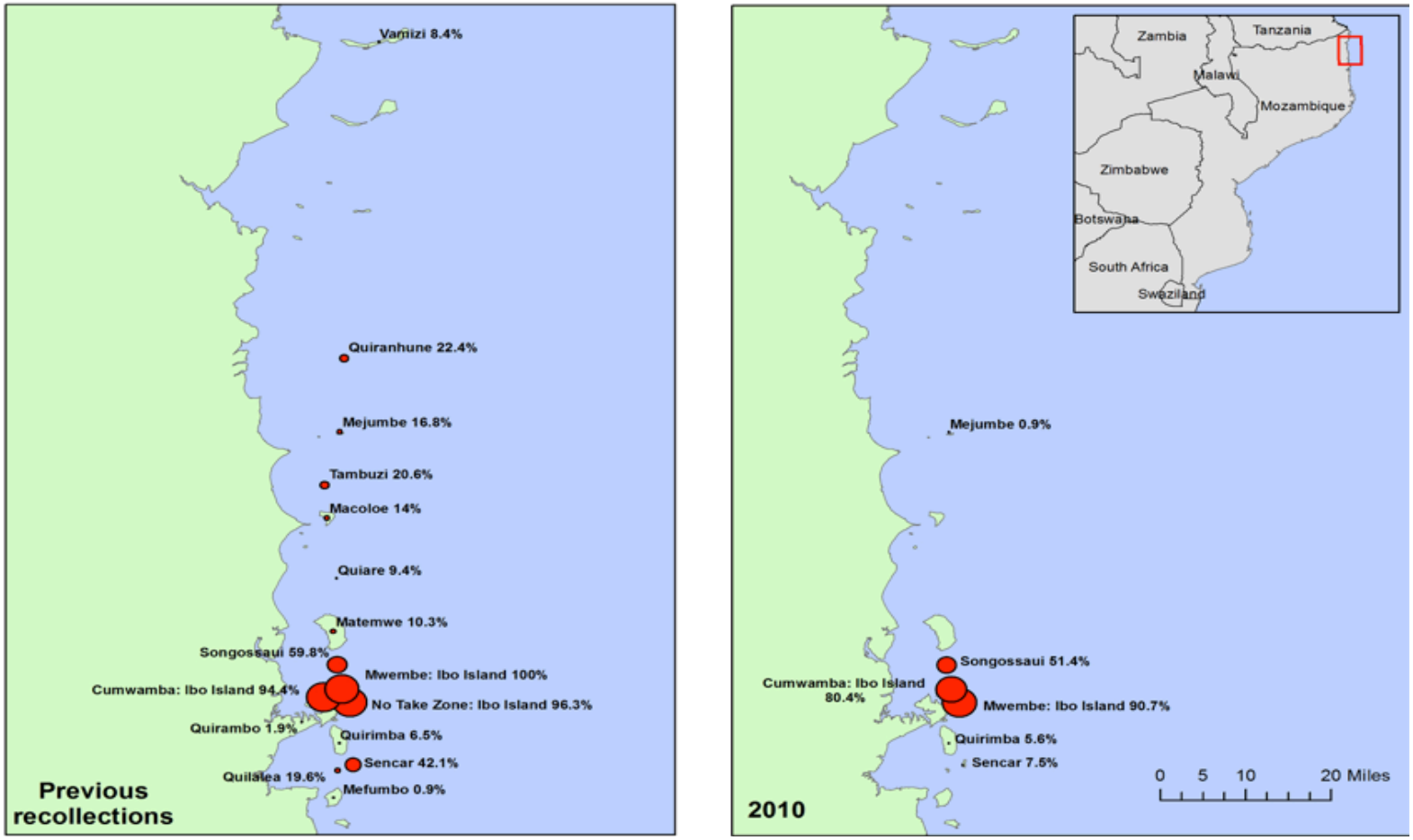
By 2010 the percentage of fishers leaving the Island to fish decreased to just over half (55.0%) and the number of 'off-island' sites had reduced to five. The five sites outside of Ibo used at the time of the study were Songossaui, Sencar, Mejumbe, Matemwe and Quirimba. Songossaui is within a 30 min boat journey north of Ibo, and when this relatively proximate site is taken out of the analysis, the percentage of fisherwomen leaving the island to fish drops from 81.7% previously to 16.7% at the time of the study.

On Ibo Island itself, fisherwomen reported using the same areas they always have, with one exception: the no-take zone in front of the main harbour where fishing is

[26] These were: Songossaui, Sencar, Quilelea, Mejumbe, Tembuzi, Quiranhune, Macoloe, Mefunvo, Vamize, Quiaure, Matemwe, Quirimba, Quirambo.

prohibited as part of the Quirimbas National Park regulations. Almost all of the fishers (94.2%) said they previously fished in the no-take zone before the Park was established, and no longer fish there. This finding is supported by data from Whittington et al. (1997). The authors describe the distribution of fishing effort across the intertidal areas on Ibo showing the highest effort (number of individuals) occurred in the sandy area and sea grass beds of what is now the no-take zone, as well as along the reef crest of Cumwamba zone.

Figure 4.2 Women's previous recollections of fishing areas and present day (2010)



Reasons for changes in fishing location

Fishers' reasons for a shift in fishing location were sought each time a woman noted a change. The most frequently mentioned reasons for changes to fishing site were: the introduction of no-take zones within the Quirimbas National Park (65.0% of responses), changing accessibility of sites due to age, poor health and residency (19.2% of responses), the reduction of transport options due to fisheries policy and the reduction of privately owned transport boats ('fisheries policy and transport': 15.8% of responses) (Figure 4.1).

The most prominent reason, the introduction of No Take Zones (NTZs) which are closely associated with tourism establishments was discussed animatedly by fishers. For example, one woman said:

> "*I learnt to fish in Sencar, my father had a farm there. Now it is only for tourists we no longer go there*." [Questionnaire respondent number 32].

These fishing grounds represented not only areas of higher catch, but formed part of a household's broader livelihood strategy. Fisherwomen would travel to these sites with their husbands, and stay there for extended periods of time in the dry season, fishing, drying catch, and returning with a stock-pile of dried fish, octopus and other marine resources. One fisher recollects:

> "*I remember going with my husband and a group of friends to Quirianhune to harvest. We would stay there for weeks fishing and drying our catch. When we returned it was like a party, and we had a lot of money*!" [Questionnaire respondent number 33].

Transport was another perceived driver of change to where women fish. Transport to surrounding islands provided access to areas with lower fishing pressure, and therefore to larger and more diverse catches. Some of the islands mentioned were Quiranhune, Tambuzi, and Vamizi. As one woman explained:

> "*I no longer go to Quiranhune* [an island to the north of Ibo] *because of the difficulty getting there. No boats go there anymore. People would rather use their boats to take people to the mainland. It is sad because there is lots to catch on Quiranhune*" [Questionnaire respondent number 16].

The difficulty in accessing boats to travel to other sites illustrates how dependent fisherwomen are on their husband's boats or links to fishermen who own boats, and the economy at that time. As fishers explained:

> "*It is more profitable for them* [traders and business men] *to carry food and people than fishers so they have stopped carrying us*" [Questionnaire respondent number 22].

Changes in access to transport were not only due to changes in local boat use but also indirectly linked to trade. Tanzanian traders were more prevalent on Ibo in the period after the civil war (1975, Figure 4.1). They provided transport options to local fishers on condition that they received a commission of the harvest upon return or have exclusive right to buy their catch. However, when the Quirimbas National Park was created trade was banned, dramatically reducing the number of traders and fishers from Tanzania and further south in Mozambique and thus transport options for fishers.

Finally, in relation to fishers' personal circumstances (cited by 19.2% of respondents), the most frequent reason given for a change in fishing location was due to older age (10.8%). Old age prevented access to more distant sites they used to use previously. For others, ill health or change in residency meant they had changed the intertidal zones they used. As one fisher explained:

> "*When I moved into my husband's house I stopped going to Mwembe* [intertidal zone on Ibo] *because it was too far*." [Questionnaire respondent number 96].

For these fisherwomen making the journey to the same spot they fished previously was not worth the additional effort.

4.4.5 Target resources consumed

Changes in resources fisherwomen target for consumption

Fishers were asked to list the key resources they targeted for consumption and for sale, and if these had changed. At the time of the study the three most commonly cited resources targeted for consumption were two edible shell resources - the

humpbacked conch (65.8% of fishers), cockles (62.5%) and small fish caught in mosquito nets, known locally as '*sala*' (68.3.9%), which are either eaten fresh, or salt dried. In addition to these, pen shells (48.3% of respondents), tiger cowries (45.8%) and octopus (44.2%) are also used for consumption (Figure 4.3).

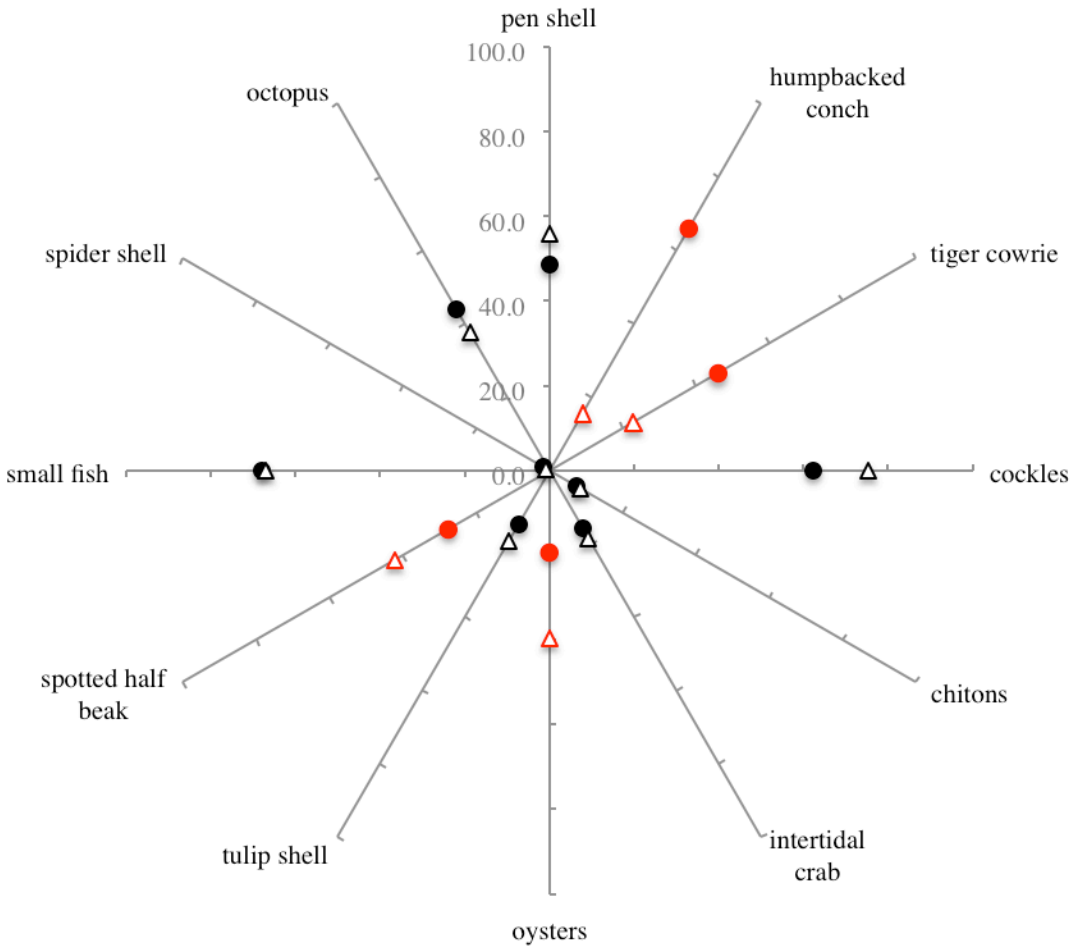
The results illustrate that there has been some change in resources targeted for consumption. The significant changes [27] include two resources that are now increasingly targeted for consumption, including humpbacked conch (previously only used for consumption by 15.8% of respondents), and tiger cowrie (previously 22.5%), and two resources now used less for consumption (oysters, reduced by(20.8%[28], and spotted half beak, reduced by 15.0%[29]). Other resources, such as pen shells, cockles, small fish and octopus remained common target resources for consumption.

[27] Using a paired t-test

[28] p value 0.002

[29] p value 0.025

Figure 4.3 Change in resources targeted for consumption. Women recollections are represented by hollow triangles, 2010 estimates are represented by full circles. Statistically significant differences are in red.



Change in catch rates of resources targeted for consumption

Table 4.4 summarises the changes in reported catch rates of intertidal resources targeted for consumption. Pen shells were listed as one of the most common target resources at the time of the survey however fishers' estimates of catch decreased considerably, from an average of 6 kilograms per trip to present day estimates of 1-2 kilograms. As so few recollected humpbacked conch (15.8%) no estimates of catch were obtained. However, three kilograms a trip (wet weight) can be estimated from the 2010 catch survey, which is approximately one small pan size by fishers' estimates. Humpbacked conch is rarely collected alone, typically with cowries, or in combination with tiger cowries and cockles as a subsistence strategy. This made

reliable estimates untenable. However, some respondents commented on the increased dominance of humpbacked conch in their diet. One respondent explained:

> "[before] *people could choose which resources to harvest depending on one's taste now every day I am eating humpbacked conch*" [Questionnaire respondent number 87].

42% of fishers reported present day catch rates of small fish to be between 5-10 kilograms a trip. The catch survey estimates also fell within this range, with an average of 6 kilograms per trip[30] (see Table 4.4 in Appendix 4.2 for a comparison between fisher's estimates and estimates generated from the catch survey). It is important to note estimates from the catch survey are a random sample of finfish catch and trips as the secretive nature of the activity made it difficult to capture a representative sample[31].

Perceived catch rates of oysters and spotted half beaks also show a decline, from 3 kilograms of oyster to 1-2 kilograms (shelled), which is approximately half of a small 3-litre pan, and 14 kilograms of spotted half beaks to 4-5 kilograms per person per trip[32]. Despite declining catch rates of tiger cowries (from 6 kilograms per trip to 3 kilograms per trip) 25% more fishers reported targeting them[33].

Table 4.4 Mean catch rates of target resources as reported by fishers. Fishers' estimates included were available

Resource	Fishers' recollections (kg per trip)	Fishers' 2010 estimates (kg per trip)

[30] Estimates generated from 120 different individuals recorded over 12 months

[31] Fishing with small net sizes is illegal under Mozambican Fisheries Law instituted in 2000 and therefore women did not want their activities recorded.

[32] This estimate is based on 248 net fishing trips by 315 individuals who went in groups of 3 (on average) over 12 months. This averages at 3 trips per individual.

[33] p value 0.0007

pen shells	6	1- 2
humpbacked conch	n/a	3
small fish	10	6
oysters	3	0.5-1
spotted half beaks	14	4 - 5
tiger cowries	6	3
octopus	15	3 - 4
cowries	15	8
ornamental shells e.g. helmet shell	2-3 'pans'	1 small pan
sea cucumber	4-5	'one or two'

Reasons for changes in intertidal resource consumption

Interviewees that noted a change were asked why they had changed the resources they target in the intertidal zone. Respondents provided a diverse set of responses, but the majority mentioned the reduction in the abundance of resources (59.2%). Other reasons are shown in Figure 4.1, and include age, ill health and residency (15.8%), fisheries policy and transport to fishing sites (10.8%), and social conflict, such access to nets (9.2%).

Most fishers linked the reduction in the abundance of particular resources, such as oysters, spotted-half beak and pen shells, directly to the increase in the number of harvesters. As one fisher answered:

> "*Before* [1998] *there was an abundance of resources because the number of people were fewer in relation to today* [2010]" [Questionnaire respondent number 65].

Another harvester commented:

> "*Fishing is more challenging [in 2010] because there are more people doing it*". [Questionnaire respondent number 81].

Fishers' reasons for resource decline varied depending on the resources in question. For example, for oysters, one fisher explained that near shore fishing areas have become locally depleted, and the remaining oyster beds are located in the sub-tidal oysters, inaccessible on foot and only used by men who dive for them. Two fishers explained:

> "*During the dry season women eat cockles and pen shells because it is an easy activity to practice. Nowadays it is difficult to reach the zones where one harvests oysters*"; and [Questionnaire respondent number 39].

> "*Today oysters have become men's domain due to the distance they are now found in* – [the high sea]." [Questionnaire respondent number 77].

Change in personal circumstance was the second most cited reason for a change in resources targeted for consumption. This refers to changes in an individual's health and age, which restricted the resources they could target, limiting individuals to near shore areas. Some fishers also mentioned a change on residency on the Island meant fishing in Cumwamba was no longer possible and thus a number of resources were no longer accessible to them. For example:

> "*When I divorced my last husband and moved to Ritutu* [a residential district on Ibo Island] *I stopped going to Cumwamba* [the name given to an intertidal area] *and I could no longer harvest cockles"* [Questionnaire respondent number 69].

Fishers who were old enough (10.8%) referred to the government's fishery policy that provided transport to fisher folk, as part of an initiative to tackle rural poverty. During this time fisherwomen could make trips to intertidal areas surrounding Ibo. Since this policy stopped fisherwomen rely on local men to provide lifts to fishing areas. In addition, as reported fish catches have reduced since the 1990s, so too has the number of boats operating on the Island. Key informants interviewed in 2010 reported twelve sailboats operating as fishing boats on Ibo (see Riddell 2010). With these combined changes, one woman put it:

> "*It is now difficult to get to other areas such as Songossaui* [an intertidal area] *due to a lack of transport, for this reason I now have to eat humpbacked conch every day*!" [Questionnaire respondent number 23].

Only one woman mentioned the no-take zone as the direct reason for a change in their consumption. The closed zone, where fishing is prohibited, is an area of sandy sea grass bed that is a popular habitat for desirable edible shell resources such as cockles and pen shells She explained:

> "*..the problem is the consumption of tiger cowrie, cockles and pen shell has been restricted because the place where they are considered plenty has been shut* [the no-take zone]." [Questionnaire respondent number 91].

4.4.6 Target resources sold

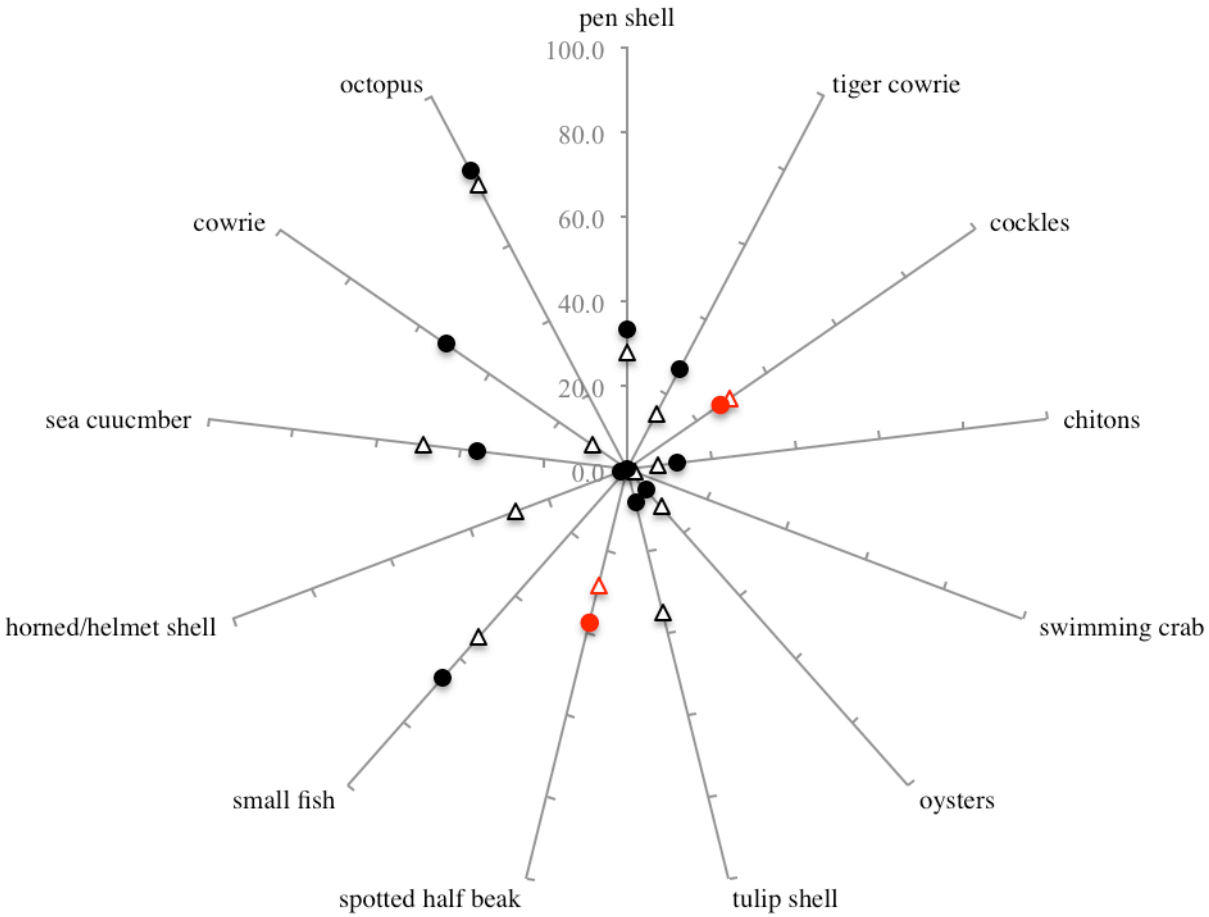
Changes in resources targeted for sale

Fishers' recall suggests that the main resources targeted for sale have changed. At the time of the study, the most frequently cited resources for income were octopus (80.0 % of respondents), followed by small fish (*sala)* (65.8%), and cowries (52.5 %). Other intertidal resources frequently used for income included spotted half-beak (37.5 %), sea cucumbers (35.8 %) and pen shells (33.3 %).

The most significant change was the increase in fishers reporting fishing cowries, which increased by 40.0 %[34]. Tiger cowries were also reported to be targeted for income by more fishers compared to previously, whereas tulip shells were used for income by fewer fishers (Figure 4.5). Sea cucumber reporting also reduced (by 12.5%) but was not found to be significant. Likewise, octopus, small fish, spotted half beak, and pen shells did not change significantly. Fishers reported no longer collecting the ornamental helmet shell.

[34] p value 7.91E-11

Figure 4.4 Change in species targeted for sale. Women recollections are represented by hollow triangles, 2010 estimates are represented by full circles. Statistically significant differences are in red.



Changes in catch of resources targeted for sale

Fishers reported that the catches of the top three resources targeted for income - octopus, cowries and small-fish[35] - have declined (Table 4.4). The decline was most evident for octopus, for which fishers remember catching up to 15 kilograms per trip and now catch between 3-4 kilograms per trip. Fishers' estimates show that cowrie catch has approximately halved from 15 kilograms to 8 kilograms. Fishers using mosquito nets to capture small fish (*sala* and *lucuzi*) recollected catching up to 10 kilograms per person per trip, and estimated present day catches to be approximately 6 kilograms per trip.

Fishers also mentioned changes in collection rates of two other ornamental shells: tulip shells and tiger cowries. Similar to cowries, more fishers reported collecting tiger cowries now as compared to previously (14.2%[36] increase) whereas fewer fishers reported collecting tulip shells (25.0%[37] decrease). While it is difficult for fishers to specify quantities for catches of these ornamental shells, as they are collected while gleaning for other resources, fishers suggested that they used to collect two to three pans of ornamental shells if there was a trader willing to buy them, whereas one small pan was the present day estimate. Although fishers still do catch sea cucumbers, it is mainly on an opportunistic basis as they come across them. 2010 catches rates were negligible as fishers reported collecting only 'one or two' whereas previously fishers reported collecting between 4-5 kilograms per trip, which was largely dedicated to the capture of sea cucumber.

Reasons for changes in intertidal resource sale

The principle reason fishers gave for changes in their target intertidal resources for sale was the same as target resources for consumption, decreased abundance (50.0% of responses). However, in addition to this the influence of local market conditions was mentioned by 35.0% of respondents. Fishers explained that the decline in abundance of target resources was due to the increase in fishing pressure, which was

[35] Fin-fish refers to both small fish and needle fish

[36] p value 0.04609

[37] With a significant p value of 6.79E-07

attributed to the presence of more harvesters, rather than increases in fishing frequency. During these discussions fishers made the distinction between external migrant fishers from Tanzania, who targeted commercial resources, and internal Mozambican fishers, itinerant or living on Ibo, who also targeted subsistence resources. A woman recalling the influence of Tanzanian fishermen said:

> "*There were more cockles and pen-shells before. Tanzanians came and took them all*." [Questionnaire respondent number 89]

Those fishers who referred to market changes mentioned the lack of traders for ornamental shells, particularly helmet and tulip shells, with '*falta de clients*' (a lack of clients) being a common remark. However, fishers made the link between resources abundance for the tulip and helmet shells, and market conditions, commenting:

> "*Today, small quantities of tulip shells result in a small market and lower income*." [Questionnaire respondent number 90]
>
> and
>
> "*Before the Tanzanian traders would come to Ibo to buy these* [ornamental shells e.g. tulip and helmet shell] *to sell them in Tanzania because there were many! Now these resources are hard to find and the traders no longer come*". [Questionnaire respondent number 111]

Similar to resources targeted for consumption, the Quirimbas National Park was cited in only two cases as having an influence on intertidal resources targeted for sale. One woman stated:

> "*The closed zone is where the resources that generated an income during the dry season are found*." [Questionnaire respondent number 118]

Whilst the another reported:

> "[the no-take zone] *it is where the most abundance is found*. [Questionnaire respondent number 17]

4.5 Discussion

This chapter aimed to understand how fisherwomen's strategies had changed over their living memory, and to explore the degree to which these changes (or lack thereof) were linked to external social, economic and political transformations. Broadly speaking, the main changes in fishing strategies have been to fisherwomen's fishing location, their catch per trip and the resources they target. Conservation and tourism restrictions have restricted their use of space, while changes in the market and resource abundance have reduced catch rates and altered target resources. These results are discussed here in relation to the broader literature on the influence of structural factors on fishing behaviour and peoples' livelihoods more generally.

4.5.1 Interpreting changes in fisherwomen's intertidal fishery

Care should be taken in the interpretation of peoples' perceptions of change. While this method has been applied elsewhere (see Jacquet et al. 2010), the description of change (reported change), the description of reasons for change (why a person thought it happened), and the broader links to structural factors need to be carefully analysed. In this study, fishers responded directly to questions regarding reasons for change, meaning they were likely to provide proximate (direct) reasons, and not make links to more indirect factors. An example of this was the influence of a changing market on target resources, which fishers did not relate to the establishment of the National Park, but nonetheless was a result of park rules and regulations prohibiting the commercial sale of marine resources.

4.5.2 The growing importance of octopus and finfish fisheries

Interestingly, the rate of depletion of different resources was not equal across the intertidal fishery. Of the fifteen resources targeted by fishers the ornamental helmet shell (*Cassis cornuta*) were reported as locally extirpated. In addition, fishers reported a more significant decrease in the abundance of resources targeted by hand, such as edible and ornamental shells (e.g. cockles, oysters and helmet shell) than octopus (rod fishing) and finfish fisheries (net fishing), which fishers reported continued to yield viable catches for them. These results indicate that overall fishers' intertidal fisheries have experienced a reduction in the diversity of target species.

This reduction in diversity is particularly acute for resources targeted for consumption. A similar trend has been reported in case studies in West Indian Ocean fisheries (Bryceson and Massinga 2002; Nordlund et al. 2013; Obura 2002). Nordlund et al. (2010) showed that animal abundance and diversity reduced as a result of fishing pressure. In a study from southern Mozambique on Inhaca Island Nordlund et al. (2013) showed a reduction in the diversity and abundance of many of the same bivalves that appear to be depleted on Ibo, including oysters (*Pinctade margaritifera*), cockles (*Trachycardium rubicundum, Trachycardium rugosum)*, cowries (*Cypraea annulus*) and tulip shells *(Pleuroploca trapeziu)*. In Mecufi, south of Pemba, Bryceson and Massange (2002) also noted signs of depletion of some of the more popular gastropods and bivalves such as the ones mentioned above. Similarly, these same authors also show that larger finfish, octopus or lobster showed no significant signs of depletion. A study conducted on Ibo Island in 1996 by Whittington and colleagues provides further evidence for this apparent depletion of bivalves on Ibo Island. The study, which looked at catch composition of intertidal harvesters, showed fishers' catches to be dominated by ornamental shells and sea cucumbers (69% of harvesters catch composition[38]). Fewer than 10 % of collectors were identified that targeted finfish, octopus, crabs, urchins and chitons (Whittington et al. 1997).

There is variation in the rate of depletion among bivalves and gastropods as well, with some bivalves, such as oyster, appearing to be being more vulnerable to exploitation pressure due to their lack of mobility and visibility. Other resources such as humpbacked conch (*Strombus gibberulus*) use mechanisms such as burying or are distributed in sub-tidal environments as well. They are also characterized as rapidly growing, low biomass and are smaller with a relatively higher fecundity when placed under stress (de Boer and Prins 2002; Jimenez et al. 2011). Studies have shown these resources dominate community structure and diversity (which can influence catch composition) in locales that have experienced significant fishing

[38] They include the tulip shells, including *Fasciolaria trapezium*, *Stombus mutabilis*, *Marginella* sp, *Turbo coronatus*, *Polinices tumidus* and *Chicoreus ramosus*.

pressure (de Boer and Prins 2002). In comparison to oysters and cockles, octopus are rapidly growing, have a far larger biomass and can be harder to harvest (Raberinary and Benbow 2012). The higher rate of depletion of bivalves and gastropods suggest that octopus and finfish may be more important to fishers' present day marine resource use than previously, and indeed may continue to grow in importance as other fisheries continue to decline (Anderson and Burnham 2002; Porter et al. 2008; Anderson et al. 2011). Such a trend has already been experienced in Tanzania (Porter et al. 2008).

4.5.3 Spatial restrictions

In addition to catch rates and target resources, the other major reported change to fishers' fishing practices was the fishing grounds that they use. There was a marked reduction in the number of fishing grounds used, as fishers' use of sites off Ibo Island reduced due to access restrictions and transport. This has led to more concentrated fisher efforts on the two intertidal sites around Ibo Island, and one site just to the north of the island (Songossaui). This result is contrary to what is often reported in fisheries that have experienced a reduction in resources. Fishers have been reported to travel further in an effort to maintain catches. An example is of male-dominated fisheries in Maputo bay in Mozambique (Bunce et al. 2010), and fishers in Zalala Beach in further south in the Zambezi province. At both locales fishers were reported to travel further off shore as a result of decreasing inshore catches (Blythe, 2014). In these instances, fishers have access to means of transport to allow them to travel further. In comparison fisherwomen in Mozambique lack access to canoes, boats or any other means of transport, which prevents them from adapting their fishing strategy. In this case, on an island site, fisher's effort has been displaced from a broader suite of areas to the only accessible sites on the island, essentially serving to intensify fishing pressure at these sites.

4.5.4 Seasonal productivity of fisherwomen's intertidal fisheries

Another key finding was the shift in the seasonal productivity of the intertidal fisheries. In addition to explaining changes in target resources and catch of these resources, fishers also spoke of the seasonal use of intertidal resources. Fishers

explained that previously the principle resources consumed during the dry season were edible shells such as pen shells, cockles, oysters and octopus shown in Appendix 4.1. However, as the results show, there has been as significant increase in the consumption of humpbacked conch (from 15.8% to 65.8%) and tiger cowrie (from 22.5% to 45.8%).

Informal discussions with intertidal users highlighted that customarily humpbacked conch is considered a child's activity, and people prefer to sell tiger cowrie rather than consume it. A harvester (38 years old, living in Cumwamba district) articulated the local significance of this change in consumption:

> "*Today humpbacked conch is eaten daily. It used to be collected by children, what was a form of recreation has now become caril*! [sauce for food]". [Questionnaire respondent number 99].

Respondents explained that the principle change they experienced during the rainy period was an increase in the consumption of less desirable resources, specifically humpbacked conch and tiger cowrie. Both of these resources are considered less desirable due to their taste, but were listed as more frequently targeted in the wet season. Fishers also mentioned eating bivalves during the rainy season when they are unripe. For example, although reported use of cockles as a target resources dropped overall, 10.8%[39] more fishers reported eating them in the wet season when they are locally considered unripe.

As one respondent described:

> "*Today the difference is humpbacked conch which has come to be eaten every day. Before I only harvested cockles, oysters and pen shells during the dry season because their location was easy and they were abundant in nearly all the zones. In the wet season it varied, if the weather didn't allow for net fishing I would harvest Mikiti (swimming crab) because there were a lot of them around*". [Questionnaire respondent number 83].

[39] p value <0.001

Similar to intertidal resources targeted for consumption, fishers described a pronounced seasonal change in intertidal resources targeted for sale. Previously the dry season would be the time to make money from intertidal resources, compared to the wet season. Fishers would target octopus, edible bivalves (pen shells, oysters, and cockles), ornamental shells (tulip shells, tiger cowries and cowries) and sea cucumber to sell. Due to the declines in catches described above and for reasons described below, fewer fishers collected these resources during the dry season, and those who did, went less frequently and caught less.

Instead, fishers suggested that there is little difference in income to be made between the two seasons, with some fishers stating that they made more money in the wet season compared to the dry season as the dry season is less productive. Wet season income is largely generated from mosquito net and *mingilare* fishing, and as one net fisherwoman suggested:

> "*Net fishing gives the most value today because it is easy to sell and dry and attracts buyers quickly*." [Questionnaire respondent number 1].

Therefore, not only has the dry season productivity reduced, but the sale of resources in the dry season, particularly ornamental shells, is not seen as predictable as the relative stability of wet season resources. As another woman explained:

> "*Today, due to the difficulty in finding them* [cockles, tulips shells and sea cucumber], *I think more success is achieved during the rainy season when income increases with the use of a net to fish*." [Questionnaire respondent number 3].

The decline in productivity of women's fisheries during the dry season is a worrying trend as this was a period that fishers would traditionally stockpile marine resources. Due to the relatively greater abundance of finfish compared to edible and ornamental shell resources it appears the wet season is becoming more profitable.

4.5.5 Limits to women's fishing strategies

The results show that there has not been a significant change to the number of trips fisherwomen go on nor the type of gears they use. Fishers attributed the lack of change in the number of trips they go on to natural limitations of the intertidal system, particularly the tidal patterns of spring and neap and between high and low tide, which is explored more in Chapter 5. However, the inability to switch gear is due to stringent gender norms that do not permit fishers to fish outside of the intertidal zone, and even discourage them from targeting more valuable intertidal fisheries such as the mangrove crab fishery. These findings carry implications for fisher's ability to adapt to their changing SE system or interventions such as octopus reserves (explored below).

Changes in gear type and fishing frequency are common behavioural responses to declining catches in small-scale fisheries (Alber et al, 2015; Cinner, 2015). In a study in central Mozambique (Inhangome, Sofala province) fishermen reported that they have shifted from fishing with beach seine nets to fishing with gill nets in response to various drivers, of which declining catch rates was the most common (Blythe, et al 2014). Further afield, similar trends have been reported, and Albert et al. (2015) revealed that between 1995 and 2011 artisanal fishermen in the Solomon Islands increased their use of drop line fishing and trolling and reduced their net fishing, as a response to declining catch rates. Similarly, respondents in Blythe et al's 2014 study which surveyed a coastal community in Msamgamkuyu near Maputo reported fishing takes up more of their time as they have to travel farther to fish (Blythe, et al. 2014). At a site closer to Ibo, Bryceson and Massinga's study (2002) in coastal villages further south in Cabo Delgado province also reported fishers had increased the amount of time spent from an hour (to fill a basket of shells) to several hours to fill the same basket. The reason for these different findings is not clear but it may in part be attributed to the different fishing strategies among fishers in the studies compared to fisherwomen interviewed on Ibo. Nonetheless, these limitations on fisherwomen's behaviour make fisherwomen highly sensitive to changes, more so than their male counterparts.

4.5.6 Drivers of change

This chapter aimed to understand not only how different aspects of women's fishing behaviour and fisheries have changed over time, but what factors fishers attribute this to. The study also shows external drivers affect aspects of fishing behaviour differently. It also demonstrates how drivers interact with each other to influence fishing strategies. These complex interactions and feedback loops means that fishers may sometimes perceive direct drivers as indirect drivers and vice versa.

Mozambique has experienced exceptional political, economic and social transformations within a single generation and the range of drivers identified reflects this. With little difference noted in gear type and frequency, the drivers considered affected predominantly fishers' catch, target resources and fishing grounds. Fishers did not perceive there to be one overall driver, but for each fishing strategy considered, noted multiple drivers.

Where fisheries research has focused the on drivers of fishing location analyses often occurs at the local level (Wallace et al. 2016). This study illustrates the influence of the often overlooked external (or structural) drivers of fishing choice location. The case study presented here is a pertinent example of unintentional decisions made by fishers which have been driven by external changes (Harari 2005). At this scale of analysis changes in fishing area where most commonly attributed to tourism and conservation initiatives, fishery policy and local transport availability. They were less tied to resource abundance, which is one of the main drivers associated with spatial fishing strategies in SSFs (Gillis et al. 1993; Gillis 2003; Branch et al. 2006). Tourism and conservation drivers are often interlinked in the Quirimbas National Park and broader archipelago, with no-take zones (referred to as sanctuaries by tourist companies) established adjacent to tourism lodges. This nexus is reflective of the policy adopted by Mozambique's Ministry of Tourism, described as a 'symbiotic relationship' (Ministério do Turismo 2004: 2). This relationship has been formed through newly instituted property laws (private ownership) and Ministry of Tourism policy, which allows tourism companies to create no-take zones surrounding their establishments. Bunce et al. (2010) note this phenomenon, which they refer to as 'coastal squeeze', in an extensive review of stressors on coastal livelihoods in

Mozambique and in the wider WIO region. In the Quirimbas Archipelago seven islands previously used by local fisherwomen now have a tourist lodge and accompanying no-take zones[40]. As well as these permanent tourist lodges there is a growing trend for Dhow and Catamaran safaris and recreational fishing trips which take tourists further throughout the Quirimbas archipelago[41], illustrating that tourism sites are likely to continue to increase.

For fisherwomen on Ibo the drivers of target resources and catch rates are strongly interlinked. While it was not cited as a significant driver of fishing location, it was cited as the main driver of changes in the resources targeted by fisherwomen and their catch rates. This is because fishers attributed the main change in their target resources of both income and consumption to the declining catches. The decline in resource abundance was linked by fishers to an increase in the number of harvesters, which fishers insisted was predominantly due to in-migration to Ibo Island. The two main reasons for the increase in harvesters on the Island are; the spike in dependence on the primary economy (natural resources) immediately after the breakdown of the national economy following the Portuguese exodus, and the immigration from mainland refugees during the civil war. More recently increases in the Island's population are due to the increase in the tourism economy and presence of NGOs on Ibo that has also attracted people from surrounding Islands and even the capital Pemba. Hence island populations changes were the indirect driver of behavioural changes.

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[40] Quilalea Island (approx. 10 km south of Ibo island and is 0.6 km by 0.3 km, approximately 86 acres) is home to Azura Private Island lodge, Mejumbe (approximately 50 km north of Ibo and is 1 km long by 350 meters wide) is home to Anantara Medjumbe Island Resort, Vamizi Island is home to Vamizi Island Lodge (approx. 40 km north of Ibo island and an area of 48km^2 with a 38km^2 marine reserve), Rolas Island (with a no-take zone approx. 1 km by 0.3 km), Ibo Island (3.6 by 4.5 km with approx. 20km^2 no-take zone), Matemo island home to Matemo Island Resort (approx. 10km north of Ibo island and 7.3 by 3.3km) and one private and yet undeveloped island called Mogondula, previously home to temporary fishing camps, is actively guarded to ward of fishers (approx. 04.0.7km).

[41] New sites sfor Dhow and Catamaran safaris include St Lazarus Bank (approximately 42 nautical miles off the Quirimbas Archipelago and a no-take zone), Farol (a popular nearby fishing location for Ibo islanders), Metundo Island (just south of Vamizi in the northern part of the archipelago), Ponta Diabo (part of the central island group) and Quirihanue Island (home to temporary fishing communities).

This increase in harvesters occurred in parallel with shifts in the market for marine resources, which this study shows has influenced the resources fisherwomen target for cash income. As markets for marine resources on Ibo opened up once the Portuguese left Mozambique and colonial restrictions were no longer in place, fishers began to target resources not previously used by them - for example sea cucumbers, ornamental shells and cowries[42]. However, markets for a number of intertidal resources, ornamental shells in particular 'disappeared' as some fishers explained it, when international traders stopped coming to Ibo. This happened around the time the National Park was established, which prohibited the trade in marine resources (QNP General Management Plan 2004-2008). Local middlemen residing on the Island sustain a low-level market for cowries and sea cucumbers. However, the switch from international to local traders has meant that markets for women's intertidal resources have shifted towards octopus and finfish. This example illustrates how two distinct external drivers have interacted. However, whereas fishers correctly see changes in the market influencing their target resources, the underlying cause for this was conservation policy, which they did not appear to recognise as a direct driver.

Two further indirect drivers of changes to target species were also noted. The first is the government fisheries policy, which affected fishers' target resources for consumption. The impact of government fisheries policy on small-scale fisheries has been shown to be substantive, and their effects have been reviewed extensively by Menezes (2009). This study supports Menezes findings by illustrating that for fisherwomen on Ibo Island, previous government policy supported transport to fishing grounds and facilitated purchase of fish through the government run fish market. Inability to assess these sites, and the decline in local transport options, has also influenced target resources and catch rates. The second change is related to

[42] This market expansion happened at a time when Mozambique's economy crumbled during the fight for independence and for a significant period afterwards, as Mozambique struggled to establish a working state. Many people lost their jobs (which on Ibo Island mainly consisted of service jobs in Portuguese households and, to a lesser degree, skilled work such as, tailoring, carpentry and boat making) and were left to make a living off the natural resource base.

fishers' personal circumstances, including their age, residency and health, which have changed over the time period. Hence fisherwomen on Ibo have responded to the dynamic nature of external divers as they switch between target resources depending on their abundance (estimated through catch rates), accessibility and marketability.

These results highlight the intricacies and dynamics of drivers affecting fishers' behaviour. The results of this study suggest that a more nuanced understanding of the ways in which drivers influence fisher behaviour. Failure to understand the diversity of behaviours and drivers that operate in a fishery might inadvertently lead to management measures that impinge upon fishers and their ability to secure resources for their livelihoods.

Short-term drivers of fishing effort in a women's octopus fishery

Chapter 5

An octopus fisherwomen heads out on a fishing trip to Mwembe.

Chapter summary

This chapter explores why fishers fish on certain days and in certain fishing grounds in order to provide much needed empirical evidence to feed into octopus reserve design in the WIO. As octopus fisheries in the WIO region are expanding at a steady rate, there is a growing need to manage an increasingly exploited resource in order to ensure its sustainability. To date, the key approach to octopus management has been the establishment of reserves that restrict fishing effort in time and space. This presents a unique opportunity to specifically incorporate women's fishing behaviour into the design of such initiatives. More generally, some understanding of what drives how often and where women go to fish will allow managers greater certainty when assessing the impact of catch rates on the resource and in any assessment of potential costs to fishers. Information on fishing effort and octopus abundance was generated from a catch survey and socioeconomic data of octopus fishers from a questionnaire survey. Alongside these two principal methods, participatory approaches were used, to understand any changes observed to fishers' effort on a daily and monthly basis and between the two fishing zones on the island. A general linear mixed effects model assessed the temporal drivers of effort while fishers spatial allocation of effort was assessed using the ideal free distribution model. The results show that while environmental drivers such as tide, season and wind most strongly predicted fishers' time investment, fishers' spatial allocation of effort appeared to be driven by a number of social factors: travel time, familiarity with the zone, suitability of the area, and proximity to the farm. This suggests that when making decisions as to when to hold closures for octopus, managers may be well advised to consider the environmental limitations of the intertidal zone, whereas decisions regarding where to place the reserve would benefit from a consideration of social factors.

5.1 Introduction

Short-term fishing effort has an immediate and direct effect on resource abundance and hence is an important component of small-scale fisheries' systems (Salas and Gaertner 2004). However, the drivers of small-scale fishers' time investment and spatial behaviour are rarely included in interventions (Gerry et al. 2011). Researchers focusing on the human component of SSFs argue that if this information were to be included, it would increase the likelihood of fisher support and compliance (Fulton et. al 2011). To date predictions of fisher effort have been predominantly based on the assumptions established by rational choice theory, a principle which states that people will typically act to maximise profit to themselves (Hardin, 1968). Applying such a model to fisher behaviour has had unintended effects on SSFs and their management. Some of the most damaging outcomes have been effort displacement and unfair burdens placed on fishers (Powers and Abeare 2009; Mascia et al. 2010; Ramirez et al. 2015). The former occurs where fishers simply move their effort to another area of the fishery in response to fishery closures. Unfair burdens result when fishers suffer disproportional costs of management due to a lack of compatibility of their fishing behaviour with management measures. Hence SSF researchers must shift the focus from how much can be taken to how, when and where it can be taken (Salas and Gaertner 2004, Aguilera et al 2015). Researchers have begun to ask this question in the context of male SSFs, however it has yet to be considered in relation to fisherwomen (Abernethy et al. 2007; Wallace et al. 2016).

Octopus fisheries are a good case study in which to apply this question, as they are one of the few fisheries of commercial importance that fisherwomen participate in. This is because women are able to access octopus in intertidal areas such as along coral reef edges and rocky reef flats where octopus are found in dens. Madagascar and Tanzania lead the way for octopus management in the WIO region (Harris, 2011). They have adopted the ubiquitous approach of fishery closures but instead of the earlier approaches timed purely from a biological perspective, they aim to vary closures in time and space, paying particular attention to local context. This approach

has been termed periodic fishery closures and it takes into account the dynamic nature of species' abundance alongside the natural ebbs and flows of fishing pressure (Cohen et al. 2013; Cohen and Foale 2013). As such, closures are timed as closely as possible to coincide with recruitment and spawning peaks and changes in locally optimal fishing periods to improve the likelihood of success (i.e. sustained or increased populations), (see Raberinary and Benbow, 2012 for a Tanzanian example and Oliver et al 2015 for a Madagascan example). The example from Madagascar indicates that periodic restrictions on effort have been successful in a) increasing catch and b) increasing village income. Such results have prompted the expansion of periodic closures into small-scale fisheries management in Mozambique making this a timely case study to provide much needed data on octopus fisherwomen's effort dynamics. The Our Sea Our Life programme[43] will be the first to implement this strategy, taking into account octopus fisheries in five coastal communities in Northern Mozambique. WWF Germany is also funding the Bengo project aims to introduce on octopus management in Quirimbas National Park including Ibo and the surrounding islands of Quirimba, Matemo as part of its climate adaptation project. However, whereas the biological component of timings is fairly well established (Guard and Mgaya 2002; Prieto-Porriños 2016) there is a need to balance this knowledge with an understanding of fishers' effort distribution.

5.1.1 Drivers of fisher effort in SSF

Comparatively little is known about the drivers of fishers' effort in SSFs compared to commercial fishing fleets. However, evidence from SSF case studies has shown that drivers span both the social and ecological realm. Whilst ecological drivers of fishing effort (e.g. resource abundance and distribution) are relatively well researched, the social drivers of fishing effort are less well understood. Examples of social drivers include market prices, transport costs associated with accessing particular fishing grounds or costs associated with different gear types, social norms

[43] Website: https://www.zsl.org/conservation/regions/africa/our-sea-our-life

such as sacred areas and socioeconomic characteristics of fishers such as age and level of education (Béné and Tewfik 2001; Cabanellas-Reboredo et al. 2014; Macusi et al. 2015; Muallil et al. 2013; Libre et al. 2015).

Often social and ecological drivers of fisher effort are explored in isolation. However, a recent study by Chollett *et al*. (2014) explored the relative influence of two very different sets of factors – environmental and economic – on fishing effort in Utila, Honduras. The authors demonstrated the influence of fuel price increases over and above climatic factors as a stronger determinant of localised fishing effort and on the subsequent depletion of local stocks. In this case study the relative importance of the social element of the system over rode that of the ecological (Chollett et al. 2014).

In addition, when selecting drivers to measure, a common assumption is drivers of daily effort are governed by factors that operate over the short term. These can be daily weather patterns or fluctuations in the market price of target resources (Bene 1996), whereas drivers operating over the longer term influence fishers' longer term strategies such as entry and exit into a fishery (Cross 2015). However, combining socioeconomic characteristics of fishers (which are generally considered to operate over the long terms as rarely do fishers circumstance change day to day) with environmental characteristics of the fishery presents a rare opportunity to explore the influence of long and short-term drivers together in a SSF.

Understanding the drivers of effort in time only presents one half of the picture (Ling and Milner-Gulland 2008). Research has shown that fisher effort also varies spatially (Abernethy *et al*. 2007), which influences decisions on where to situate closures (Morsan 2007; Powers and Abeare 2009; Gerry et al. 2011). To better understand fishers' use of space, researchers have applied spatial theories of effort distribution. One such theory is Ideal Free Distribution (IFD). It predicts how resource users will distribute themselves over a given area. Critically though, the hypothesis is that they will do so in such a way that the number of individuals that aggregate at any given locale within this given area will be proportional to the resources found there (Fretwell and Lucas 1970). These predictions are based on the assumptions that fishers have ideal information (regarding distribution and abundance of resources)

and freedom to move to each locale without any constraints. While studies have shown that these assumptions rarely hold true, and there are a variety of reasons for deviations from IFD, this is has proven to be a useful null model for examining the factors that determine the distribution of fishers over a given area (Gillis 2003; Abernethy et al. 2007; Wallace et al. 2016).

Spatial assessments of SSF effort most often occur at the aggregate scale for multi-species fisheries (Wallace et al. 2016). Such studies show that gear type is a strong predictor of spatial differences among fishers (e.g. line fishers prefer deeper waters whereas trap fishers prefer sandy sea grass beds). When studies are further disaggregated by gear type they show that when effort is considered over the whole fishery it may be predictable but, within a gear type different groups of fishers (migrants, women etc.) may deviate from the predictions of spatial theories (Wallace et al. 2015). Researchers therefore suggest that disaggregating at a scale that is significant from fishers' perspectives could bring us closer to understanding effort allocation from a perspective appropriate to local realities (Teh et. al. 2012; Beuving 2015). For this reason, the two time scales (daily and monthly) by which fishers' spatial effort was analysed were considered locally appropriate, as drivers of fisherwomen's daily effort may be distinct from monthly drivers that capture seasonality.

This chapter uses information from catch surveys and a fisher questionnaire substantiated with participatory techniques (resource mapping and fisher-follows) to ask: What influences the likelihood of a fisher going out to fish on any given day and on certain fishing grounds? It explores this question through asking three sub questions:

1. How do environmental and socioeconomic factors influence short-term fishing effort in the octopus fishery?
2. Do octopus fisherwomen distribute themselves 'optimally' according to the prediction of ideal free distribution theory?
3. If not, what factors drive octopus fisherwomen's spatial effort

5.2 Methods

Variables for analysis were identified through an assessment of the literature on drivers of fishing effort in SSFs, and through discussions with octopus fishers on Ibo during the pilot study. Three environmental variables: i) season; ii) wind; and iii) tide and seven social: i) gender of household head; ii) wealth (of the individual woman); iii) education; iv) livelihood characteristics; v) age; vi) residency; and vii) household size were initially selected.

5.2.1 Catch and effort data and environmental drivers

Please refer to Section 3.5.3: Catch survey in Chapter 3 for details of the sampling strategy. Data on women octopus fishers' catch and effort was collected temporally and spatially, using a catch survey. Octopus catch landings were sampled from all women that used the two island intertidal sites: Cumwamba and Mwembe. For each fishing trip, the research assistants recorded the location women used, the number of kilograms caught, and noted whether she sold it. Environmental variables were also collected during the catch survey. The data collection sheet used is shown in Appendix S3: catch data sheet.

5.2.2. Socioeconomic drivers

Please refer to Section 3.5.4: Fisher questionnaire in Chapter 3 for details of the sampling strategy. Octopus fishers' socioeconomic characteristics were collected through a semi- structured questionnaire to allow a more in-depth and sensitive questioning that was not ethically or logistically appropriate for the research assistants to carry out during the catch survey. It was then possible to match sixty-seven of these women octopus fishers with their names in the catch survey dataset, allowing environmental and social variables to be matched with these octopus fishers' effort on any given day. The sections of the questionnaire used were Section 1: basic socioeconomic information, Section 4: income generating activities and Section 5: material wealth score (see Appendix S3: Fisher questionnaire survey).

Wealth categories generated from the participatory wealth assessment (see Section 3.5.5.2 in Chapter 3) were generated from information provided throughout the questionnaire. Information generated from the questionnaire was: age, household head status, education, wealth, residency, livelihood activities and household size of the participants.

5.2.3. Octopus fisherwomen's perceptions of resource abundance

Please refer to Section 3.5.5.1: focus group discussions in Chapter 3 for details of the selection of those that participated in the focus groups. Fishers' perceptions of resource distribution and abundance were explored through participatory resource mapping conducted in three focus groups. Response sample size varies due to the poor quality of responses which made some difficult to categorise.

5.2.4. Fisher-follows

Please refer to Section 3.5.6.1: Observations in Chapter 3 for full details. Fisher-follows were conducted to provide in-depth information on fishing trips which could be triangulated with catch survey data, focus group data and semi-structured interview data.

5.3. Statistical analyses

5.3.1 Temporal analysis

The statistical analysis aimed to assess the influence of the environmental and social variables on whether a fisher embarked on a trip on any given day. As the dependent variable is bimodal, i.e. a binary response: yes or no, and the error distribution is binomial a generalised linear mixed-effects model (function glmer) was used. In this case, the unit of replication is fishing trip. As fishers conduct multiple trips during the course of the year, one cannot assume the independence of errors between each unit. Generalised linear mixed effects models are able to group the units by explanatory variable, in this case trips were 'grouped' by fisher. This grouping effect eliminated non-random variance between the trips caused by the influence of the same fisher going on multiple trips. To allow for this, at the point of data collection, I gave each fisher an ID. 'Fisher ID' was then entered into the model as a random

effect. This controlled for the effect that fisher had on the unit of replication: 'trip'. Information-theoretic approaches such as Akaike's Information Criterion (AIC; Akaike, 1974) are able to rank each model generated in the GLMM (as there are many variations of how one may input the variables) according to how close each one is to the null model[44]. AIC approaches also provide a statistic on the level of difference between each model which allows one to choose a good cut off point when deciding which models to keep for further anlaysis (Anderson and Burnham, 2002; Bolker et al. 2009). In this study models with AIC values less than three were retained for model averaging and comparison (Anderson and Burnham, 2002). This was done in order to understand the relative weighting of each variable in the model. The MASS package in R, the MuMIn package was used for this purpose.

In order to prevent over parameterisation it was necessary to reduce the number of variables entered into the GLMM. To select the most appropriate variables to include in the GLMM a selection of key fishing characteristics were tested using parametric and non-parametric statistical tests (independent t-test and ANOVA) against the socioeconomic variables to see if there were any significant relationships. This was done by calculating: the mean number of fishing trips; mean number of trips over the wet season; mean number of trips to Mwembe intertidal[45] zone; mean number of spring tide trips; mean number of trips with no wind. A full list of the results is detailed in Appendix S5: Fishing characteristics of octopus fisherwomen. The socioeconomic variable household head tested significantly against both mean number of trips and mean number of spring tide trips and so was retained (0.038 and 0.025 respectively). Table 5.1 shows the final set of variables entered into the GLMM.

[44] The null model is the model stating the interaction term but contains no variables.

[45]as there are only two zones and each mirror each other it was not necessary to do this for Cumwamba zone as well.

Table 5.1: Environmental and socioeconomic variables tested in relation to women's fishing characteristics

Explanatory variables	**Variable type**
Environmental: Tide	Categorical (spring and neap)
Environmental: Wind	Binary (present: absent)
Environmental: Season	Categorical (wet and dry)
Socioeconomic: Status of household head	Categorical (head and not head)

5.3.2 Spatial analysis

Two indirect measures were used to measure resource abundance. The first measure was women's perceptions of resource abundance, assessed through participatory mapping exercises and the second measure was average Catch Per Unit Effort (CPUE) generated from the catch survey[46]. The ideal free distribution theory (IFD) was used as the null model with which to assess fishers spatial distribution of effort. Effort (number of trips) and resource abundance (fisher catch) were compared to that expected under the ideal free distribution. The two assumptions of IFD, firstly that individuals are free to move between fishing areas, and secondly that equal knowledge of resource abundance between individuals exists, were explored through participatory resource mapping exercises. IFD's analytical strength lies in its ability to quantitatively identify instances when effort is not predictable. Deviations were explored visually by plotting fishers' catch and effort statistics alongside the 1:1 line that represents the proportional relationship between catch and effort as predicted by the IFD. Deviations from the IFD were qualitatively explored using fishers' reasons for site selection obtained during follows. Women's responses were reviewed and placed into categories based on themes that emerged from their responses. Data are presented as the percentage of fishers that mentioned each reason.

[46] The limitations of using catch per unit effort as a proxy for resource abundance are discussed in the methods chapter.

5.4 Results

5.4.1 Temporal drivers of fishing effort

Results from the GLMM showed all four variables: season, wind, tide and household head were significant predictors of daily fishing effort (Table 5.2). The random variable, fisher ID, accounted for was 1.6, which suggests that the effect of individual (fisher ID) was minimal. Two environmental variables, season and tide, were the most significant predictors of daily fishing effort (Table 5.2). Effort in the wet season drops (by a factor of 0.44), and effort during the spring tide goes up (by a factor of 0.85). However, wind also affected daily fishing effort, with the number of octopus fishing trips dropping (by a factor of 0.42) on windy days. The social variable household head also affected daily fishing effort, with women from male-household heads less likely to go on an octopus fishing trip on any given day (by a factor of 0.79). Appendix S5:II graphically illustrates the outputs of these results.

Figure 5.1 A favourable day for octopus fishing. Photo taken in the dry season over a spring tide with no wind.

Table 5.2: Results of generalized linear mixed model of environmental and socioeconomic variables tested against fishing effort (measured as whether a trip was carried out on a given day).

	Estimate	Standard Error	z value	Pr(>|z|)	
Reference: dry season, no wind, neap tide and women who are the head of their household	-2.44854	0.27049	-9.052	< 2.00E-16	***
Wet season	-0.44053	0.0771	-5.714	1.11E-08	***
Wind: present	-0.4268	0.1353	-3.154	0.00161	**
Spring tide	0.84695	0.07884	10.743	<2.00E-16	***
Male household head	-0.78742	0.33219	-2.37	0.01777	*

5.4.2 Spatial distribution of effort

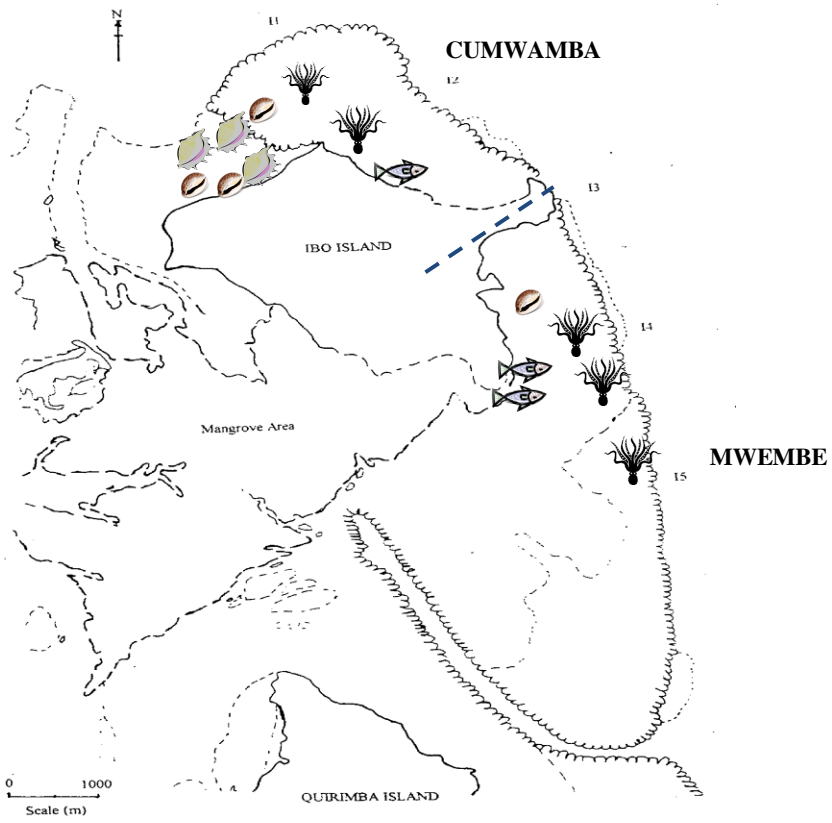
The participatory resource mapping focus groups illustrated that women perceive there to be a higher abundance of octopus in Mwembe intertidal zone, compared to Cumwamba (Figure 5.2). This is supported by the catch survey data represented in Table 5.3. CPUE of octopus is significantly higher in Mwembe (on average 0.82 kg/trip more) compared to Cumwamba (t-test, $p>0.001$). The additional resources in the columns were collected at the same time as rod fishing for octopus.

Table 5.3: Catch per unit effort (kg/trip) from rod fishing for octopus in the two principle intertidal zones, Ibo Island

	Octopus	Cowries	Edible shells	Pen shells	Total
Cumwamba	3.05 (+/- 0.002)	0.39 (+/- 0.020)	0.14 (+/- 0.002)	0.02 (+/- 0.003)	3.60 (+/- 0.007)
Mwembe	3.87 (+/-	0.62 (+/-	0.01 (+/-	0.01 (+/-	4.51 (+/-

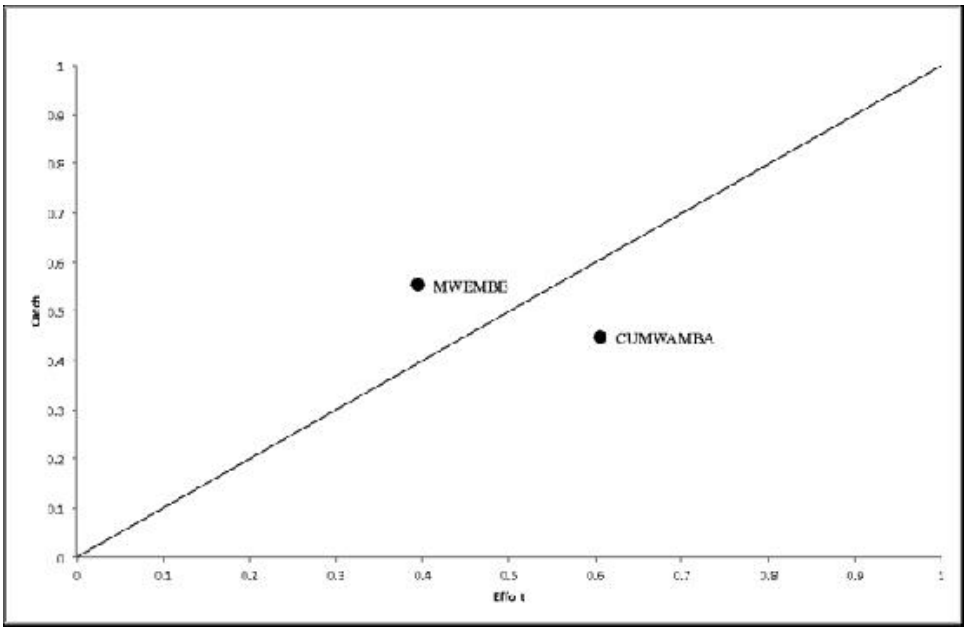
	0.003)	0.026)	0.003)	0.003)	0.009)

Figure 5.2 Map of intertidal zones surrounding Ibo Island and women octopus fishers' perceptions of resource abundance for five groupings of intertidal resources. One icon indicates low abundance two indicates medium abundance and three icons indicate high abundance (Source of base map: Whittington and Myers 1997) (represents cowries and indicates edible shells, denotes octopuses and fin-fish caught with nets).



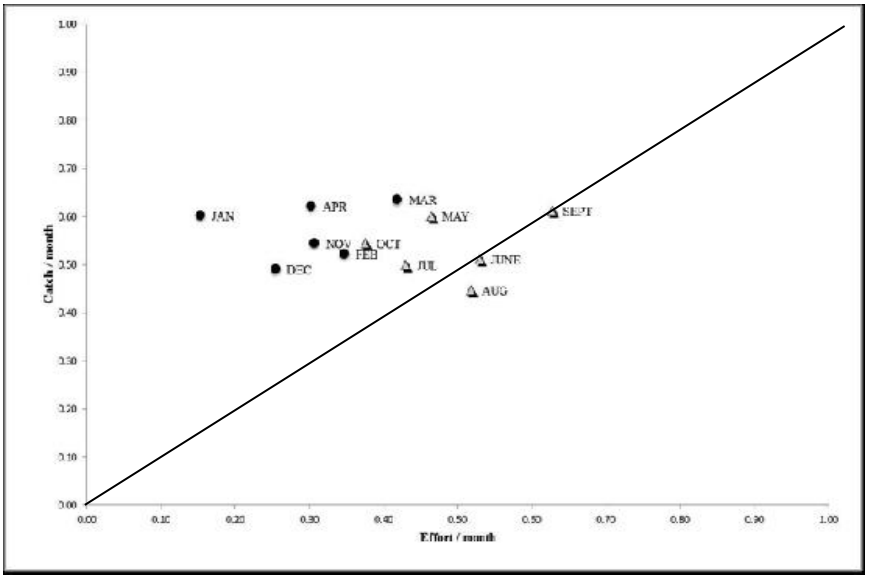
When catch and effort from Mwembe zone are compared to the ideal free distribution, Mwembe sits above the IFD line, and Cumwamba below. This means that on Ibo Island octopus fisherwomen's effort (number of trips) is not proportional to resource abundance (i.e. catch rates) at each site (Figure 5.3 illustrates this graphically).

Figure 5.3 The proportion of catch and effort observed over Ibo Island



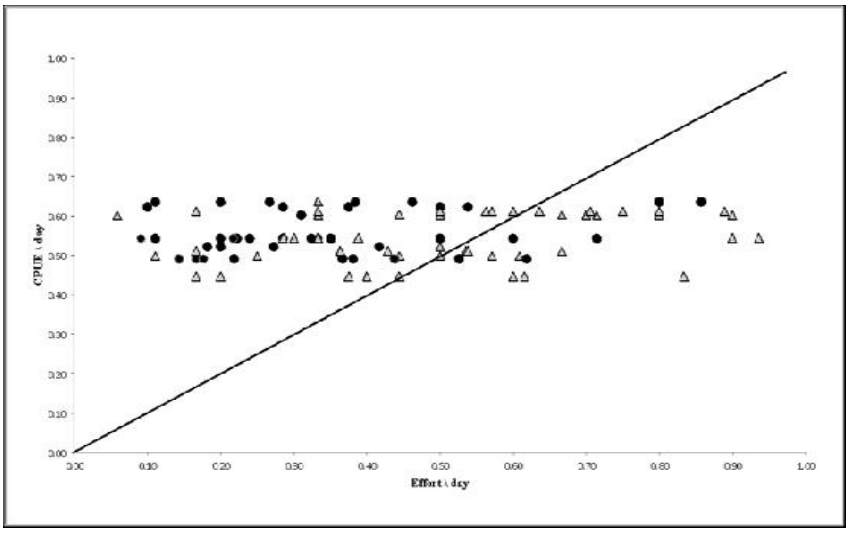
Fishers daily and monthly spatial effort distribution is presented in Figures 5.4 and 5.5. Figure 5.4. shows that deviations from the IFD are most pronounced over the wet season months. During this period catch rates are higher in Mwembe but effort is lower. For example, in January, Mwembe intertidal area experienced fewer than 20% of the entire octopus fishing trips on the island and approximately 60% of all catch (Figure 5.4). The opposite being true for Cumwamba zone as the two zones mirror each other. However, throughout June, August and September (dry season months) fishers do appear to conform to IFD.

Figure 5.4 The proportion of catch and effort observed in Mwembe: monthly.



When results are graphed on a daily basis, the same seasonal pattern emerges, although a higher degree of variation is evident (Figure 5.5). Similar to the monthly statistics the majority of days in Mwembe sit above the IFD line, showing that Mwembe was comparatively advantageous in terms of catch but less frequently visited 74% of the year (131 days).

Figure 5.5 The proportion of catch and effort observed in Mwembe: daily. Black dots represent wet season months. Hollow triangles represent dry season months.



5.4.3 Factors influencing fishers' spatial behaviour

Fishers' responses as to why they chose a particular fishing site were categorised, and are shown in Table 5.4. Travel time was the most frequently mentioned reason determining zone choice (88%). Women travelling to Mwembe intertidal zone reported a higher travel time than women travelling to Cumwamba intertidal zone, and fisher-follows confirmed that there was over 50 minute difference between travel times from the village to the intertidal zone (Appendix S5: supplementary travel information). After travel time, the second most frequent response from women was "*acostumei!*" – "I am used to it", or "*siempre usava"* - "I have always used", showing they have become accustomed to using that particular site (44%). Closely linked to this response, women reported what was categorised as 'suitability' of the site, which included social suitability: knowing people who used the site, their perception of the physical conditions of the intertidal zone, and the timing of the tides (32% of responses). Finally, some women mentioned that the fishing site was close to their fields so they could work on or check the fields on the way or on return from fishing (21%), while only 7% reported that their decision was related to their perceived abundance of octopus at the site.

Table 5.4: Women's reasons for choice of fishing site (n=50 respondents during fisher-follows).

Factor	**Description**	**Number of responses**	**Percentage of all responses**
Travel time	The other fishing zone is too far from home. Example response: "*I won't get back in time*"… (to feed the baby, and make the food).	44	88
Accustomed	Women report they have always used the zone.	22	44

	Example response: “My mother used to catch octopus in this site, and this is where I learnt to fish.”		
Suitability	Women reported knowing people that use the site and going fishing with them. Example response: “I always fish with Donna Swenge, and that is the zone she uses”. Women described different physical conditions at the two fishing sites. Example response: “Cumwamba is not as hard on my feet compared to Mwembe where there are a lot of rocks”, and “My sandals get destroyed at Mwembe!”. Women reported differences in low tide times affecting whether they could reach the intertidal zone early in the morning or late afternoon. Example response: “When the tide is very early in the morning I can only reach Cumwamba”.	16	32
Proximity to fields	Sites close to the farm were preferable. Example response: “Returning from fishing I pass my field and if I have some energy I do some work”.	11	22

Resource abundance	Women reported there being more octopus at Mwembe. Example response: "I am going to Mwembe because there are more octopus!".	4	8

The factors in Table 5.4 varied in importance for women living in different districts on the island. When women stated travel time (n=44) as a reason, this was related to the travel time to Mwembe fishing zone. Data from the catch survey showed that of those fishers living in Cumwamba district, only 17.6% of trips were to Mwembe, whereas of those fishers living in Rituto district, 99.2% of trips were to Mwembe and for fishers living in Cimento district, which is situated in between Cumwamba and Mwembe district, 46.6% of trips were to Mwembe. The travel distances for women, and average travel time, are shown in Table 5.5. The travel distances are calculated from the closest and most distant point in the district to the octopus fishing zone, and travel time are averages calculated from the fisher-follows. This shows that for some women living in Rituto district, the intertidal zone of Cumwamba is closer (2.8 km) than Mwembe, but they do not choose this zone, while for women from Cumwamba living closer to Mwembe, it is still an additional 0.9 km to Mwembe, but some of these women still choose Mwembe (17.6% of trips). For women in Cimento, where Cumwamba is obviously the closer option, 46.6% of trips were still to Mwembe. The average travel times calculated on the follows reinforce this, showing that even for women living in Rituto travelling to Mwembe the average travel time is 52 minutes higher than for women living in Cumwamba that use Cumwamba intertidal area.

Table 5.5 Travel distances and times for the two intertidal zones

TRAVEL DISTANCE	**Cumwamba zone: close**	**Cumwamba zone: distant**	**Mwembe zone: close**	**Mwembe zone: distant**
Cumwamba district	1.7KM	3.4KM	4.3KM	5.7KM
Rituto district	2.8KM	4.5KM	3.3KM	4.4KM
Cimento district	2.9KM	4.6KM	4.4KM	5.5KM
AVERAGE TRAVEL TIME	**Cumwamba (n=20)**		**Mwembe (n=30)**	
Octopus fishing time	172 minutes		190 minutes	
Travel time	150 minutes		202 minutes	
Total trip time	**331 minutes**		**394 minutes**	

While the difference in travel distance might not appear significant considering the additional kilo of octopus that could be caught at Mwembe, women consistently referred to their obligations within the household. Women explained that they had no time ("*falta de tempo"*), and that "*I have work in the house too*" ("*tenho trabalho na casa*") and " *I have to make the food*" ("*tenho que fazer o caril*"). Many octopus fishers were mothers with babies or young children, and they would leave young children or babies at a kin's house whilst they fished. If they were breast feeding (over 10% of the women accompanied on octopus fisher-follows) they explained that it was crucial to be back by a certain time, and they would choose a family member with a house nearest to the intertidal zone. Of those women who mentioned the suitability of the zone in terms of timing of the tide, it was clear that travel time affected their ability to reach the site. One woman explained during a follow:

> "*if the tide is very early then I don't have time to go to Mwembe, by the time I get there all the women have already arrived and are collecting octopus*". [Fisher- follow number 50].

Similarly, in addition to household obligations, many women, particularly those in Rituto, also had farms. The largest farming area is located on the way to Mwembe intertidal zone and therefore the preference is to fish close to the farm. As one woman explained:

> "*my farm is on the way back from Mwembe, this means I can check on it even on days I am not farming to make sure thieves haven't stolen anything*". [Fisher-follow number 3].

Hence, wanting to make the most of the time out in the intertidal zone fishing, travel time is deemed the easiest and quickest way to cut down on the time they spent out of the house and away from household obligations. For those women who responded that they were accustomed to a given fishing site, some of these women went on to explain this in that it was a tradition passed on from whoever taught them to fish, and by knowing the site better, they had more confidence that they would catch something (n=22). Others simply insisted that they were used to the zone, and wanted to continuing using an area they knew. For example:

> "*since I was a child I have been coming here, I used to come with my mother and sister when I was younger, now I come with my two daughters*" [Fisher-follow number 5].
>
> "*it is good to come to a place you know, otherwise you will waste your time looking when everybody around you is catching all the octopus*" [Fisher-follow number 9].
>
> "*my mother and grandmother taught me to come here, I don't know any other place*". [Fisher-follow number 46].

The way that women responded and explained this illustrated a combination of their learnt ecological knowledge that stood them in good stead to catch octopus in a zone they knew well, and a general familiarity and comfort in fishing in a zone they knew

well. The suitability of a fishing site was described in both biological and social terms. As one woman stated quite simply "*this beach [Mwembe] is bigger*" whilst other respondents described the disadvantages of large areas of rock to walk over.

> "*there are too many rocks in Mwembe, every time I go there I lose a shoe, shoes cost 150mts in the shops! so I stopped going there, I prefer Cumwamba as the rocks are not as many*" [Fisher-follow number 12] and
>
> " *the rocks in Mwembe are too much, it is easy to cut your foot on them, you need strong shoes to fish there, my shoes don't give*." [Fisher-follow number 11].

While Mwembe is a large area, it is more physically challenging, while Cumwamba's softer substrate is offset by the smaller overall fishing area and more competition with other fishers. Socially, women preferred the fishing zone where their friends and family members harvested, and this changed with time as personal circumstances changed. For example, one woman, when she divorced, changed fishing zone:

> "*when I was married to my ex-husband I would go to Mwembe beach because his family used to go there, now I am divorced and my new husband's family go to Cumwamba beach so I go with them"*. [Fisher-follow number 38].

Interestingly, very few women mentioned species abundance as a reason for choosing a particular site in which to fish (n=5). It was mostly mentioned as a secondary reason for deciding to go to a particular site

5.5 Discussion

The literature in small-scale fisheries management identifies the misalignment of fishing patterns and management tools (Cohen and Foal, 2013). This study shows a combination of environmental and socioeconomic factors influence when and where women choose to fish octopus. In summary, fishers' time investment in the fishery is dominated (but not limited to) environmental factors, whereas fishers' spatial decisions are dominated by social factors. The only socioeconomic factor to

influence fishers time investment was household head status, this in itself in unusual as this is a longer term variable than usually considered at this scale (daily effort).

5.5.1 Drivers of effort

The finding that women's daily fishing effort is most strongly determined by environmental factors supports previous research that illustrates the significant role environmental factors play in influencing short-term fishing effort (Wallace et al. 2015). The environmental factors considered here – tide, season and wind – affect women's fishing behaviour in different ways; fishing effort is significantly less during neap tides, during the rainy season and on windy days. On Ibo Island, these environmental factors make octopus fishing more challenging, resulting in lower catch rates. Tidal patterns are known to mediate access to the intertidal area and its resources (De Boer and Prins, 2002). For the octopus fishery, spring tides are a more favourable time to fish due to the exposure of large areas of underlying reef and rock substrate, allowing women to access areas with lower fishing pressure and where octopus abundance is likely to be higher. The wind's ability to distort the water surface creates a strain on fishers' eyes, making locating the octopus challenging. Not only do these factors affect catch, but they also discourage women from going on a trip due to the physical strain of coping with the elements on an extremely exposed intertidal flat.

The peak in fishing effort between July and November (the dry season) is linked to the strength and direction of the seasonal monsoon winds, which are characteristic to coastal East Africa. A particularly calm period occurs over the dry season (quite often September and October) referred to as '*matalai*' in Kimwani. During *matalai* the water surface is not affected by choppiness caused by winds, which makes spotting octopus easier. In addition to the seasonality of winds, fishers' other livelihood activities are also seasonal, particularly agriculture. During July to October there is very little farm work, but by November and December fishers with farms are clearing fields before the first rains, that arrive in late October to early November (Riddell and Rosendo 2015), which likely affects the number of octopus fishing trips during this period (Ferse et al., 2012). These findings illustrate that on any given day, knowing the tide, wind and season, one could give a reasonably good

prediction of the level of octopus fishing effort on the island. Octopus fisherwomen assess their potential harvest based on these factors, and decide whether or not it is worth fishing that day. The result of these factors is a pronounced temporal pattern of octopus fishing.

Interestingly only one of the seven socioeconomic factors had a significant relation to fisher effort – the gender of the household head. Women who were heads of their own household were almost twice as likely to go fishing on any given day, and as a result had a higher mean number of trips per fisher during the year. While the reasons for this apparent high frequency of octopus fishing, in comparison to fisherwomen with a male household head, were not explored here but this could be related to women's income-earning responsibilities in households with one less income earner. Female-headed household status is often used as a proxy for vulnerability in rural contexts in Mozambique, meaning female headed households may need to fish more (Medeiros 1997; Instituto Nacional de Estatística 2012). While other socioeconomic factors did not appear to significantly drive effort in this study, they have been shown to influence effort in other SSFs. For example, Muallil et al (2007) found age and education to drive effort in SSFs the West Philippine Sea.

One important seasonal characteristic of octopus fishing that was not considered in this study was the influence of octopus's seasonal life cycle on the availability of octopus on the reef. While *Octopus cyanea* breed throughout the year, elsewhere they are thought to have breeding peaks, and a resulting peak in recruitment into the fishery. In Madagascar, octopus are thought to recruit during April to July (Raberinary and Benbow 2012), while Guard (2009) has shown a brooding peak in June (and resulting recruitment in December). Early results from a recent study on the biology of *Octopus cyanea* in northern Mozambique indicate that there is a peak in recruitment of octopus in July, which could correspond with a peak in female octopus maturity in February-March, although this is still be confirmed. Therefore, while environmental factors are affecting women's ability to catch octopus, the availability of octopus during the year as a factor of their life cycle, is an unknown factor that has not been explored in this research.

5.5.2 Spatial distribution of effort

Analysis of fishers' spatial effort allocation illustrates that octopus fisher women do not conform to the predictions of ideal free distribution (IFD) theory. That is to say fishers' do not distribute themselves between fishing sites in proportion to available resources. When examined on a monthly and daily basis deviations showed seasonal variation. Over the wet season octopus abundance[47] appeared higher in Mwembe zone compared to Cumwamba, but effort at Mwembe was lower. Whereas women did not mention seasonality specifically in their responses to site selection participatory fisher-follows showed that travel time is exacerbated during the wet season. This may be why deviations showed up most strongly during this period.

This trend extended into the daily allocation of effort and was slightly more pronounced on some days, likely due to the number of factors that affect octopus catch on any given day. The difference in catch between the two zones averages out to approximately one kilogram of octopus which is a third of the average catch most women expect to get from one octopus fishing trip (3 kgs). This could buy a fisher, a kilo of rice or over a kilo of chima (the local maize meal commonly consumed instead of rice).

The theory of Ideal Free Distribution has been used in other SSFs to understand if fishers allocate their effort proportionally to the abundance of the target resource (Abernethy et al. 2007; Wallace et al. 2016). While fishers have been shown to maximise potential profits i.e. behave 'ideally' according to IFD theory in large-scale commercial fisheries (Gillis, 2003; Branch et al., 2006), it is fairly well established that artisanal fisheries are more complex due to the range of gear types, target species and fishers themselves. For example Abernethy *et al*. (2007) showed, for an artisanal Anguillan reef fishery, that there were departures from the IFD due to fisher age, experience, and target species, as well as type of gear used.

[47] Measure through catch rates

Other analyses of effort in small scale fisheries, disaggregated by gear type, have shown that it can be a reliable proxy in which to understand how the spatial distribution of effort is distributed within a fishery at the broad scale (Wallace 2016). However, past studies of IFD have used a range of proxies for resource abundance, from actual reef and fish surveys (Abernethy *et al*. 2007), to using total catch as a proxy for abundance. The latter is problematic in that total catch from an area is composed of both the actual catch per fisher, and the effort (number of fishers) – essentially compounding indicators – and therefore more likely to suggest IFD (Walters 2003; McCluskey and Lewison 2008). In this study, combined recorded monthly Catch Per Unit Effort (CPUE) with women's perception of CPUE[48], was able to highlight the departures from IFD that would not have been evident by purely assessing total catch.

Assessing the deviations from IFD, it was clear that the assumptions that 1) there is ideal knowledge of resource abundance and 2) there is freedom to move between sites, were true for 1) but not for 2). For the former, participatory resource mapping illustrated that women's perception of resource abundance was supported by the quantitative results from the catch survey, and that higher catches of octopus and other resources were evident in Mwembe. For the latter assumption, fishers' responses generated during the follows indicated that they are not free to move between sites – which is an important breach of the IFD assumption – but were constrained by a number of social factors.

Deviations were dominated by travel time which is an important consideration for women, who are constrained by their household and reproductive obligations, but also included fishers' familiarity with the zone: suitability, proximity to fields and lastly resource abundance. A range of factors have been shown to drive spatial effort allocation in male-dominated small scale fisheries, including the economic cost of travel, such as boat fuel and labour costs, and risk aversion, such as fear of gear theft and destruction or uncertain catches (Abernethy, 2007; Daw et al. 2011). In the case

[48] In this instance CPUE is equivalent to catch per tip as trip is the unit of effort measured.

of this women's intertidal octopus fishery, travel time is not purely an economic cost, but more of a social constraint due to women's household and child-rearing obligations. Fishers therefore appear to space themselves less than optimally between fishing site as a result of social factors. The factors driving women's spatial allocation of effort are specific to an intertidal octopus fishery, but most importantly, they are specific to women's livelihood realities.

Socioeconomic profiles of octopus fisherwomen and the relationship to the fishery

Chapter 6

A group of octopus fishers near Mwembe fishing zone

Chapter summary

Although disaggregated assessments of artisanal fisheries are now commonplace, broad categories are often used to group fishers, the most common being gear, gender or target species. This approach assumes a degree of homogeneity among members of these groups, ignoring the inherent complexities that exist between fishers' social classifications and level of fishing effort. In order to address this concern, quantitative questionnaires and catch survey data were combined with ethnographic methods to explore the degree of heterogeneity among female octopus fishers and how their socioeconomic profiles are linked to fishing effort.

Cluster analysis revealed that, although there is a certain degree of homogeneity among octopus fisherwomen, three discernable profile groups could be distinguished: the young, poor, educated; the older female-headed household fisher farmers; and the mature male-headed household of medium house size. These profiles are principally constituted by a combination of age, household head status, principal income generating activities, and relative wealth. However it was the interplay of socioeconomic characteristics within these profile groups that revealed important social complexities inherent in the category of 'octopus fisherwomen'. The two groups linked to higher fishing effort are characterized by indicators often associated with vulnerability, such as being a female-headed household, having a poorer relative wealth status, and a lack of other income sources. Although those groups with characteristics of vulnerability do not account for the majority of octopus fishers, their effort, measured as number of trips over the year, accounts for a high proportion of octopus catch. These findings illustrate that social differences and intra-group dynamics exist within groups of fishers, characterized by their gear type, gender and target species. The research cautions against an over-reliance on categorising fishers by these criteria without proper consideration of inherent social differences that co-constitute such groupings.

6.1 Introduction

Small-scale fisheries are known for their range of users and fishing strategies. However attempts by managers to capture this by applying functional groupings such as target species or gear type have been criticised by social scientists for not adequately refecting the social complexity inherent in this diversity. (Jentoft, et al. 1998; Bene 2009; Fabinyi, et al. 2010). As Jentoft et al. (1998) note, such groupings "risk marginalising large segments of the population" if their use in management does not reflect the "fate of local communities" (Jentoft, et al. 1998). Hence it remains an important challenge for managers to understand how fishers' socioeconomic characteristics vary, and how their fishing effort varies and the relationship between the two. Not only is this essential to ensure that management interventions do not affect fishers negatively, but also in order to engage the most frequent users, and therefore those most who stand to loose or gain the most by any changes in resource access.

Research disaggregating fishers along the lines of socioeconomic factors such as age, gender, wealth and education has shown these factors can influence the degree, or the way in which, these resources are exploited (Cinner 2007; Walker and Robinson 2009; Fabinyi, et al. 2010). For example, research indicates that poorer individuals or households are more dependent on the resource due to lack of access to other food or income sources, while, conversely, wealthier individuals control and receive greater benefits from access to commercially valuable natural resources (Bene 2009; Hill et al. 2012; Muallil et al. 2013). However, a limitation of these approaches is the tendency to reduce the relationship between socioeconomic factors and resource use to single, linear outcomes based on single socioeconomic categories. As a result, disaggregated assessments of complex artisanal fisheries often only penetrate the surface, identifying broad resource user groups, and have to then make generalisations about fishing effort across this group.

The majority of small-scale fisheries' research on women falls within gender analyses which are binary descriptions of men and women detailing. For example, the sexual division of labour (Weeratunge, et al 2010), men and women's different

knowledge types (Siar 2003; M Kronen and Vunisea 2009) or descriptions of the contribution women make to fisheries (Kleiber, et al 2014). While these studies have provided valuable insight and recognition to the overlooked importance of women in fisheries they fall short in describing the sorts of women that are involved in fishing. Feminist thinking in development studies has stressed the importance of not homogenising women (Gudynas 2013; Mishra 2013). Researchers who use the concept of intersectionality recognize that the way in which an individual relates to specific interventions or phenomena (e.g. health care reforms or climate change) is not the result of a categorical singularity such as race or gender (Hancock 2007; Hankivsky 2011; Djoudi et al. 2016). Applied to the concept of women in SSFs, one could say that women's relationship to the fishery is not only tied to their gender, although this is certainly a defining feature, but also to a host of other dynamics that interact to influence the relationship they have to the fishery. In addition an intersectional lens places emphasis on understanding the multiplicity and dynamic nature of social identities in any given context. This perspective is particularly useful in exploring heterogeneity among octopus fisherwomen.

This chapter explores the socioeconomic characteristics of female octopus fishers on Ibo Island and the degree to which these characteristics are linked to fishing effort. The principle questions that this chapter aims to answer are: 1) What are the socioeconomic profiles of female octopus fishers, and how do these vary within this grouping? 2) How are these profiles linked to fishing effort (number of trips) and catch? and 3) What are the context-specific meanings of these socioeconomic characteristics in relation to women's fishing effort and do these explain any variance observed?

6.2 Methods

6.2.1 Socio-economic characteristics of octopus fisherwomen

The seven socioeconomic characteristics used to explore heterogeneity among 103 octopus fisherwomen were generated from the resource user questionnaire. Full details of the method through which the questionnaire was devised and conducted are outlined in Chapter 3: section 3.5.4.

6.2.2 Octopus fisherwomen's effort

The data on the number of trips each woman went on over the course of the year was generated from the catch survey. Full details of the method through which the survey was devised and conducted are outlined in Chapter 3: section 3.5.3.

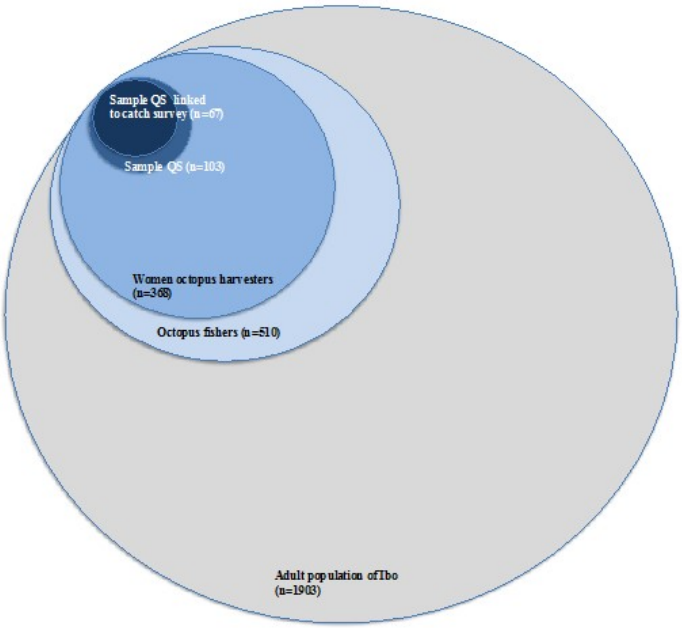
6.2.3 Interpreting the local significance of octopus fisherwomen's socioeconomic characteristics

Field notes from 50 octopus fisher-follows and additional notes generated from the questionnaire and informal discussions with women provided a rich source of qualitative information on the individuals in the sample. Details of the fisher-follows, and informal discussions, are outlined in Chapter 3: section 3.5.6.

6.2.4 Sample population

The population of octopus fishers sampled through the catch survey and the questionnaire is shown in relation to Island population figures that were derived from secondary data sources (Figure 6.1). The 'linked' sample (which contained individuals from the questionnaire sample that were linked to their catch data from the survey: dark circle in Figure 6.1) was cross-checked against the catch survey to assess how representative it was. The average number of trips is higher for the sample of 'linked' individuals than those from the catch survey, meaning that octopus fishers with above average number of trips are over-represented. Interpretation of this data in the discussion recognises this bias by refraining from statistical deductions such as 'estimates of total catch' when extrapolating the findings to the broader group of octopus fishers or other coastal communities.

Figure 6.1 Sample populations of octopus fishers profiled



6.3. Statistical analysis

Figure 6.2 below depicts the analytical process taken in this chapter. It begins with a statistical exploratory approach to identify patterns in the data and ends with a qualitative description of the trends found.

The R statistical package FactoMineR was used to perform a hierarchical cluster analysis to test the relationship between socioeconomic characteristics and the cluster groups. Hierarchical clustering is an exploratory data approach, which is subjective in nature and best applied where there is a good understanding of the context in which the variables were selected and measured. The advantage of the FactoMineR package is that it can take into account the structure of the data (structure on the variables, hierarchy on the variables, and structure on the individuals) and perform graphical outputs useful for data interpretation.

A hierarchical cluster analysis was deemed preferable over the k-means clustering approach due to the small sample size, the categorical nature of the variables and because hierarchical clustering approaches do not require one to specify in advance

the number of clusters to be generated (Baayen 2011). The analysis grouped individuals based upon the socioeconomic categories in Table 6.1. The output of which is called a hierarchical tree (aka dendrogramm). The algorithm used to merge individuals into clusters is Ward's criterion. Ward's criterion measures the degree of correlation between the individuals and the degree of difference to produce an overall measure called the total inertia. The total inertia output is displayed alongside the dendrogramm, which gives one an idea of where it is mathematically optimal to cut it to produce the clusters. However, the cutting of the tree is ultimately subjective in that it has to be balanced against knowledge of the data and what makes sense in the real world (Walelign 2016). Choosing the number of clusters is a core issue. The hierarchical tree and the degree of inertia provide the blueprint for selection. The soundness of the determined number of clusters was verified by analysing the interpretability of the results. This was done by cross-examining the groups against qualitative understanding obtained from 18 months of ethnographic field work (Emtage, et al 2006). For example, the total inertia score suggested an optimum of four clusters but cluster number four only had one factor: a household size of six, which did not make any logical sense within the context. The tree was subsequently cut at three clusters as they described with sufficient detail the nature of octopus fishers observed on the island.

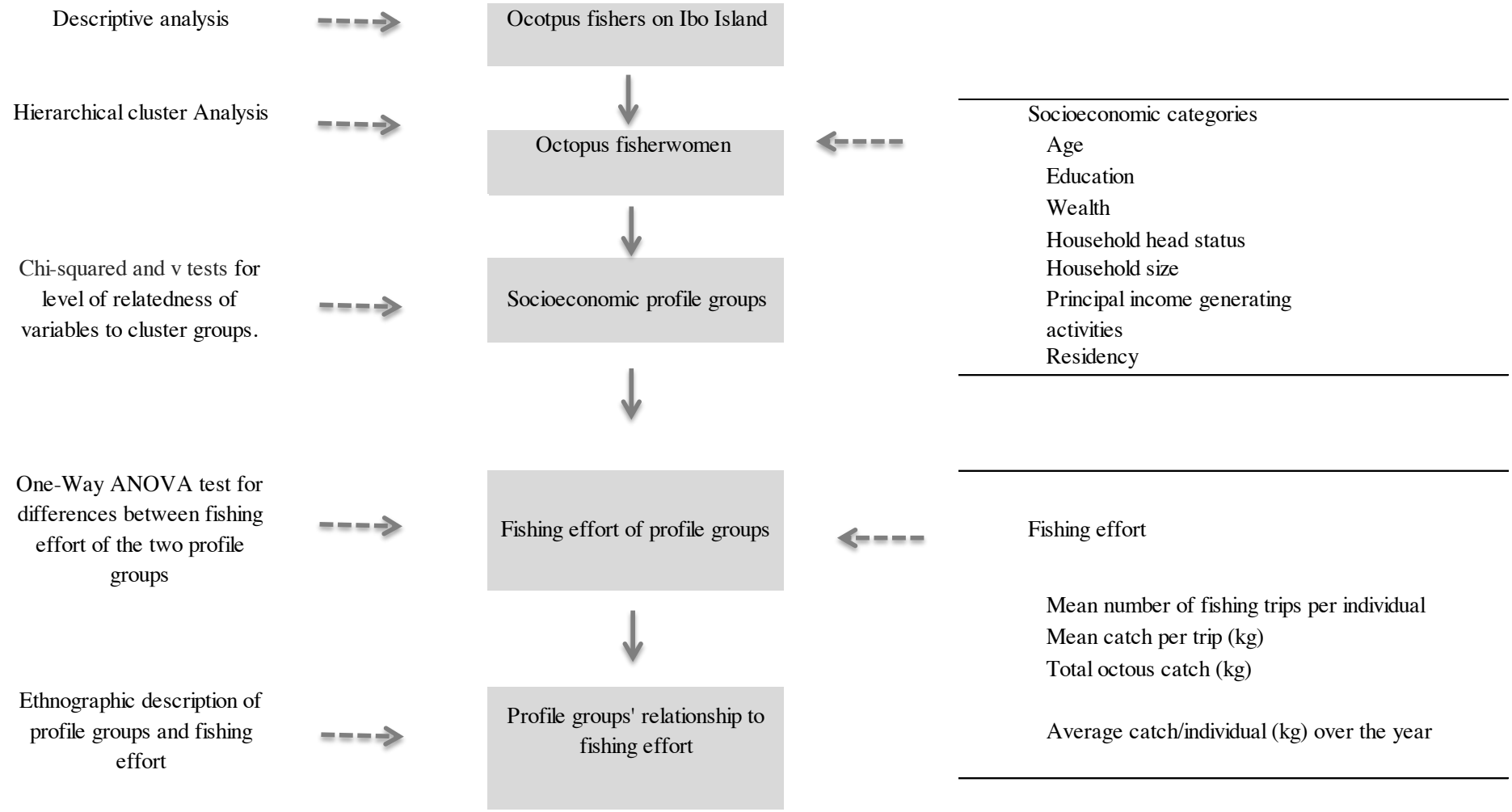
The χ^2 (chi squared) test was used to identify key differences between the clusters in terms of the socioeconomic variables measured, further validating the use of the three clusters (Nguyen et al. 2015). One-way ANOVAs and independent t-tests were used to examine differences between the socioeconomic profiles and their fishing characteristics.

The FactoMineR programme allows one to identify the individuals most closely representing each socioeconomic profile group. These individuals are presented in case studies alongside an ethnographic description of the local significance of their socioeconomic factors.

Table 6.1: Socio-economic factors included in the cluster analysis

Socioeconomic categories	**Socioeconomic characteristics**
Status of household head	Categorical (MHH = male-head, FHH = female-head)
Wealth category	Categorical (poor, normal, good) rich was omitted as n=0
Livelihood characteristics	Categorical (F = fisher, FF =fisherfarmer, FFO = fisher.farmer.other, FO = fisher.other)
Education	Categorical (some and none)
Residency	Categorical (Cumwmanba, Ritutu, Cimento)
Age category	Categorical (young, mature, old)
Household size category	Categorical (small, medium, large)

Figure 6.2: Analytical framework



6.4 Results

6.4.1 General statistics on octopus fishers on Ibo Island and questionnaire respondents

Information on the number of octopus fishers, their gender and residency was collected through the catch survey. The catch survey recorded 1888 trips and a total collection of 6405 kilos of octopus over a period of 12 months. In total 510 individual octopus fishers were recorded, equivalent to 26.7% of the adult population of Ibo Island. Of this, 72.2% (n=368) of octopus fishers were women, and 27.8% (n=142) were men. This equates to 39.1% of the adult female population, and 14.7% of the adult male population of Ibo Island (Table 6.2; Figure 6.1).

All of the women recorded in the catch survey used an iron rod to catch octopus. Men predominantly used spear guns (n=137), and targeted other species in addition to octopus. Only five men (3.5%) were recorded using iron rods to catch octopus, and they did so infrequently.

Information of residency was also obtained during the catch survey, and the results highlighted that the majority of octopus fishers in absolute terms live in Ritutu district (56.2%, n=287), followed by Cumwamba district (41.5%, n=212). Only 2.1% (n=11) of octopus fishers recorded in the catch survey live in Cimento district (Table 6.2).

Although there are marginally more women octopus fishers living in Cumwamba (n=183) than Ritutu (n=174) and Cimento (n=11), there is a fairly even split between these two districts, compared to male octopus fishers who live predominantly (80%, n=113) in Rituto (Table 6.2).

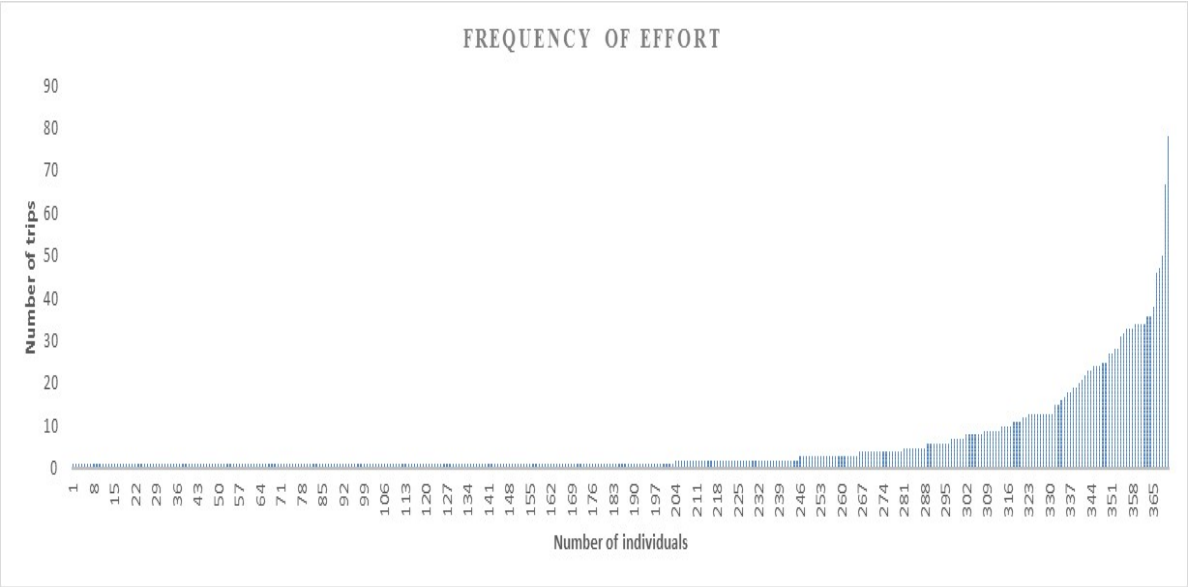
Table 6.2: The number of octopus fishers on Ibo by gender and residency. Shaded cells represent thesis data, non-shaded cells contain secondary data obtained from Sarah Lopus, (2015) which disaggregates population figures by gender but not by district.

	Ibo Island (total)	**Cumwamba district**	**Ritutu district**	**Cimento district**
Total population	4300	1784	1925	591
Female population	2193 (51.4%)	-	-	-
Adult female population	938	-	-	-
Male population	1736 (48.6%)	-	-	-
Adult male population	965	-	-	-
Octopus fishers: male and female (catch survey)	510 (26.7% of adult population)	212 (41.5%)	287 (56.2%)	11 (2.1%)
Female octopus fishers (catch survey)	368 (39.2% of adult female population)	183 (50%)	174 (47%)	11 (3%)
Male octopus fishers (catch survey)	142 (8.1% of adult male population)	29 (20%)	113 (80%)	0 (0%)
Female octopus fishers (questionnaire)	103	43	34	26
Female octopus fishers (linked sample[49])	67	42	25	0

[49] This number is the sample generated from linking individuals in the questionnaire survey to the catch survey

The number of trips made by each individual was recorded during the catch survey. Presented graphically, it is evident that effort across this sample is highly skewed, with the majority of individuals (84%) taking fewer than 10 trips a year (Figure 6.3).

Figure 6.3 Effort of octopus fishers generated from the catch survey



General characteristics

Prior to assessing the socioeconomic heterogeneity among female octopus fishers, it is important to understand the general characteristics of the survey sample. Information on: gender of the household head, age, wealth category, principle income generating activities, education, household size, residency and education of the questionnaire respondents is summarised below.

Gender of the household head Just under half (45.2%) of all women were the heads of their household. Compared to the district level of 7% this percentage is very high (Instituto Nacional de Estatística 2012). A small majority lived in male-headed household (55.3%). Women living in a male-headed household were largely married women, although some of these women (n=3) were living with a parent or uncle.

Age The median age of octopus fishers in the questionnaire survey was 43 years. Mature women (in their 30s and 40s) made up the largest category with 42.6% of individuals belonging to this group. The older category, which constituted 37.5% of respondents, was the second largest group, the majority of whom were in their 50s

and 60s with only one individual in her 70s. The age category 'young' made up 19.9% of respondents, of which very few were in their teens (2.9%), with the majority in their twenties.

Wealth category The wealth categories are emic concepts generated through participatory wealth assessments (see Methods Chapter 3: section 3.4.4 for full details). The majority of octopus fishers fell into the wealth category of either 'normal' or 'poor'. Two-thirds (66.2%) of respondents are in the same wealth category 'normal', just under a third (25.9%) of individuals fell into the wealth category 'poor'. None of the women in the questionnaire fell into the wealth group 'rich' and only 6% were categorised as 'good'. This may be a bias due to a strong desire on the island to be seen as 'normal'. Individuals that were considered 'rich' (usually traders) often had their wealth ascribed to the influence of malevolent spirits.

Principal income generating livelihood activities All of the respondents reported octopus fishing as one of their top three income generating activities. Almost a quarter (24.6%) of women stated that their only source of independent income was from octopus fishing. The remaining respondents, approximately three quarters (75.4%), listed another source of income alongside octopus fishing. The most common combination was fishing and farming (29.3%). The income-generating category 'other' was mentioned by 46.1% of respondents. This category consists of five different activities: i) selling bread or biscuits; ii) weaving coconut husks; iii) collecting firewood for sale; iv) a market garden; v) reliance on other family members. It is interesting to note that no octopus fishers were involved in the tourism sector on the island or trade related occupations.

Household size The questionnaire survey assessed the number of people in the household and the relationship to the respondent. Household size ranged between one and eleven. The average household size was five (5.3). Just over half of all respondents (51.7%) lived in medium sized households consisting of 4 to 7 people. This equates quite closely to the average household size on Ibo Island of 4.9 in 2012, and 4.6 in 2009 (Lopus, 2012). The household category 'large' was the second largest category with 27. 2% of respondents living with between 8 to 11 people. The

category ‘small’ had the fewest individuals (21.1% of the sample). The average number of dependents per household was three. The most common household composition consisted of a husband, children and grandchildren.

Residency Similar to the catch survey the majority of women in the questionnaire survey lived in Cumwamba district (52.4%) with Ritutu being the second most common district (36.7%) and finally 10.9% lived in Cimento, the most affluent district.

Education None of the octopus fishers in the survey had received any secondary education. Only 35.3% had received some level of primary education, of which the most common level was fourth year of primary school.

6.4.2 Octopus fishers' socioeconomic profile groups

To understand the degree of socioeconomic heterogeneity among female octopus fishers, a cluster analysis was performed. The cluster identified three groups of female octopus fishers with similar socioeconomic characteristics, shown in Figure 6.4. The degree of overlap between the three groups was notable as was the variation within them (Figure 6.4).

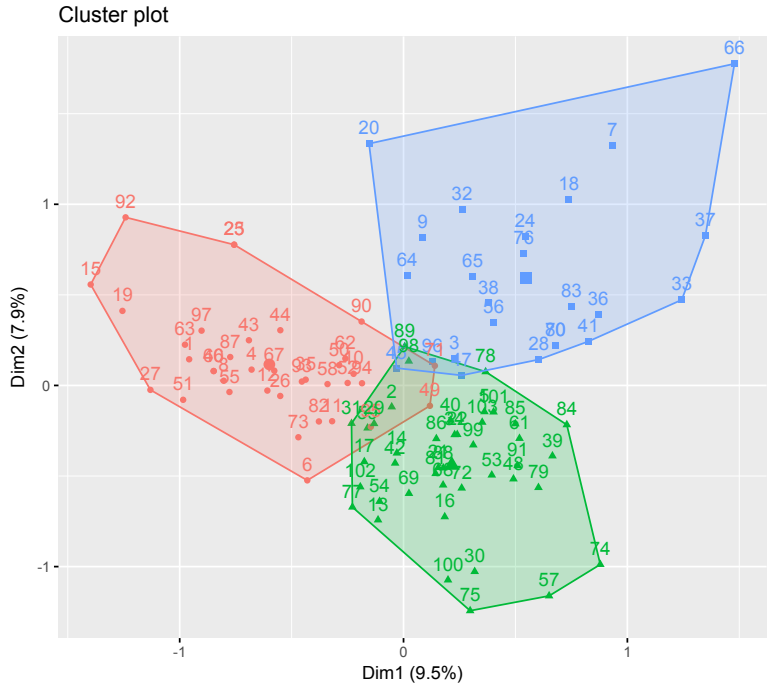
All of the socioeconomic categories were significant in the creation of the groups, however, the Chi squared test showed that the socioeconomic characteristics that most defined the three cluster groups were age (p value 3.71E-09) and household head status (p value 1.81E-06). Age on its own accounted for 9.5% of variation and household head status 7.9%. However, while no individual socioeconomic characteristic defined a cluster group, there are clear differences in the composition of each cluster (Table 6.3). This is explained further in the following section.

The composition of the three cluster groups is shown in Table 6.3 below, and detailed results and significance tests are shown in Appendix S6:1. The clusters names were generated from the three most significant socioeconomic characteristics

of each cluster group[50].

Cluster 1 contained 38 individuals and was the second largest of the cluster groups. The three most dominant characteristics of this group are: its age structure, the household head status and the main income generating activities. This cluster is thus referred to as the 'older female-headed fisher-farmer group'. Specifically this group is dominated by older women (72.6% of the cluster and 78.3% of all women in the sample in their 50s and 60s) from female headed households (86.5% of the cluster and 69.6% of all FHHs in the sample) that practice a combination of fishing and farming as an independent source of income (64.8% of the group, and 80% of fisher farmers). This cluster is also strongly represented by women with no formal education (89.2% of the cluster, but only 49.3% of the sample), half of whom are from Ritutu (51.4%).

Figure 6.4 Output of cluster analysis. Red is cluster group 1, Blue is cluster group 2, Green is cluster group 3.



[50] Assessed using the p values and v.tests generated from the cluster analysis

Cluster 2, or the 'young poor educated' cluster, is dominated by young women fishers (76.2% of the group, 83.3% of the sample) that fall into the 'poor' wealth category (66.7% of cluster, 59.3% of all poor in sample) and have had some education (70.8% of cluster, 47.2%). In addition, octopus fishing is the only income generating activity for the majority of members of this group (50%). Unlike the other two cluster groups, this cluster was not principally defined by the status of the household head, nor did it have a significant relationship to residency. Lastly, members of this group live in either small or medium sized households.

Cluster 3 is the largest cluster group with 42 individuals. It is primarily distinguished from the other clusters by the gender of the age, household head and size. This cluster is thus referred to as the 'mature male-headed large household' group. This group is largely composed of mature women (50% of the cluster is comprised of mature women, and 95.5% of all mature women in the sample) who are members of male-headed households (83.3%, and 61.4% of all MHHs in the sample) and large size households (38.1% of the group composition and 80.0% of all individuals from large households). Interestingly, the majority of these women also reside in the wealthier Cumwamba district (71.4% of the group, and 55.6% of all women from Cumwamba). It is also worth noting that the majority of women who ranked 'good' in terms of wealth fall into this group (87.5%). Education did not appear to make a significant contribution to this group.

Table 6.3: The composition of the three cluster groups are represented by the percentage of that group which is made up of each socioeconomic (SE) characteristic. Shaded cells are the three most significant characteristics for each cluster. Cells left blank are insignificant to the cluster.

SE category	SE characteristic	Questionnaire sample (n=103)	Cluster 1: (n=38) Older FHH Fisher-farmers	Cluster 2: (n=23) Young poor educated group	Cluster 3: (n=42) Mature MHH Cumwamba group
HHH	FHH	45	86.5	-	16.7
	MHH	55	13.5	-	83.3
Age	Young	19.9	2.7	75	4.8
	Mature	42.6	0	8.3	50
	Old	37.5	72.6	17.4	14.3
Wealth category	Poor	25.9	-	66.7	9.5
	Normal	66.2	78.3	33.3	-
	Good	7.9	-	-	16.7
Principal income generating activities	F	24.6	5.4	50	-
	FF	29.3	64.9	8.3	9.5
	FFO	18.9	-	-	31
	FO	27.2	-	30.4	-
Household size	Small	21.1	13.5	16.7	-
	Medium	51.7	-	33.3	-
	Large	27.2	-	-	38.1
Residence	Cumwamba	52.4	-	-	71.4
	Cimento	10.9	-	-	-
	Rituto	36.7	51.4	-	19.0
Education	No	65	89.2	29.2	-
	Yes	35	10.8	70.8	-

6.4.3 Fishing effort of profile groups

As Chapter 5 indicates, the only socioeconomic characteristic to significantly influence fishing effort of female octopus fishers on Ibo Island is the gender of the household head. In this case, it would be reasonable to hypothesize that cluster group

1, the older, female-headed fisher-farmers, fish more frequently than the other two profile groups as it is composed of almost 70% of all the FHHs in the sample. The relationship between fishing effort and the profile groups was tested using ANOVA to compare the mean number of octopus trips per person and the average catch per person, based on data from the catch survey (Table 6.4).

The results show that there is a significant difference in mean number of trips per person and average catch per individual during the year between the three socioeconomic profile groups. Tukey's post-hoc comparative tests indicate that this difference is significant between cluster 2 and 3 for both the number of trips and catch (p values of 0.034 and 0.038 respectively). This indicates that the young, poor educated group fish more frequently than the mature MHH group from Cumwamba. As mean catch per effort per fisher was not significantly different (p=0.868), due to the influence of environmental variables on catch (explained in Chapter 5), this translates as the young, poor educated group also catching more during the course of the year. The older FHH fisher-farmer group was not significantly different from cluster 2 or 3 (which could be related to sample size), but they do appear to fish slightly more frequently than cluster 3 and less than cluster 2, although this was not found to be significant.

In terms of catch, the young poor educated group account for over 60kg/person which represents over 120kg per individual for the 12 months of the survey (when extrapolated for the sampled days). The older FHH fisher-farmers, on the other hand, accounted for less catch per individual (57 kg/individual), while the mature MHH large sized household group accounted for even less (44 kg/individual). When extrapolated over the year this equates to 114 kg per individual and 88 kg per individual respectively. In cash income terms, and when extrapolated for the number of sampling days, this level of offtake represents an average of 128.64 USD/year for the young poor educated group, 114.58 USD/year for the older FHH fisher-farmers, and 88.86 USD/year for mature MHH large sized household. The highest earning women earned 508.50USD/year (42.38USD per month), while the average income of the sampled female octopus fishers was 34.80USD/year (Table 6.5).

Table 6.4: Fishing effort for the three cluster groups.

Fishing effort	**Cluster 1** **Older, FHH, fisher-farmers (n=27)**	**Cluster 2** **Young, poor educated** **(n=11)**	**Cluster 3** **Mature, MHH, large sized HH** **(n=29)**	**P value** **(ANOVA)**
Mean number of octopus fishing trips per person	17.52 (+/-0.57)	21.44 (+/-2.68)	14.24 (+/-0.44)	0.042
Mean catch per trip (kg/trip)	3.27 (+/-0.04)	3.00 (+/-0.09)	3.12 (+/-0.04)	0.868
Total octopus catch (kg)	1546.84	707.52	1288.44	Na.
Average catch/individual (kg) during the year	57.29 (+/-2.37)	64.32 (+/-8.98)	44.43 (+/-1.49)	0.041

Table 6.5: Income from octopus fishing for each of the three clusters. Figures extrapolated from sampled days.

Fishing effort	**Cluster 1** **Older FHH fisher-farmer (n=27)**	**Cluster 2** **Young poor educated** **(n=11)**	**Cluster 3** **Mature MHH large sized households** **(n=29)**
Total average income from octopus fishing/year	3283.20 MZN (114.58 USD/year) (9.54 USD/month)	3704.83 MZN (128.64 USD/yr) (10.72 USD/month)	2559.10 MZN (88.86 USD/yr) (7.40USD/month)
Table note: USD1.00: 28.80 MZN as of 1st October 20010 (http://www.xe.com)			

While there were differences in the catch rates per socioeconomic profile group, which suggest different fishing pressures exerted by these groups, this information

should be treated with caution. On an individual basis women in cluster 2 extract more octopus, but the low number of women in the sample (n=11) meant that despite high average individual catch, they only accounted for 644.9 kg of octopus in the catch survey during the 12 months, whereas the cluster 1 older FHH fisher-farmer accounted for 1427.4 kg of octopus due to their higher representation in the sample.

6.4.4 The relationship between profile group and fishing effort

Female octopus fishers have been grouped loosely into three clusters with similar characteristics. To understand what these socioeconomic characteristics mean locally, and to explain the link between them and octopus fishing effort, qualitative information extracted from the questionnaire and ethnographic material generated from 18 months of fieldwork are used to provide further detail about why certain groups fish more and to shed light on the different motivations behind octopus fishing and the socioeconomic clusters.

On average the fishers within the profile group young poor educated fishers fished significantly more frequently during the course of the year (extrapolated to approximately 42 trips/year). Most of these young poor educated octopus fishers are married and therefore from male headed households (69.6%). However, marital status in the survey included being a second or third wife, which does not always confer the same status, access to resources or marital support provided to first wives. In addition, even those women who were first wives would complain in the intertidal zone about their husband's unreliability in providing for their children and the household, suggesting that they were "always out" ("anda muito!"), leaving the burden to provide the day's food to them. For example, one young woman commented:

> "my husband hasn't lived with me for months now, he has another house on Matemwe [neighbouring island]. He stays there with his wife from there." [*Fisher-follow* 44].

Age on Ibo infers a degree of status within the community. Older women have also had time to build up more of an asset base than their younger counterparts. Hence, due to their age and marital situation, younger women often lacked financial capital

or assets, reflected in the fact that 65.2% of these women were categorised into the poor category. Even though these young women had some level of education (69.6%), and could often speak Portuguese, their lack of capital prevented them from entering into the 'other' livelihood activities cited by women such as bread-making or vegetable farming (52.2% are just fishers without any other livelihood activities). A younger fisher explained the financial cost of entering into other livelihood activities, such as bread making:

> *"Epa! the price of sugar is always changing! It's too expensive and now it is getting worse. It is not only sugar you need, you have to buy flour and eggs, it is too much!" [Fisher-follow number 2]*

Another women spoke of the risk associated with selling bread or cakes in the market place if no one buys it.

> *"You can go to the market and sit all day and no one will buy your cake. There are too many women there and they are too aggressive. I don't want to waste my money, I know I can sell any octopus I catch that day!" [Fisher-follow number 4]*

Many of these younger women also had young children which means that on a daily basis they require a reliable source of cash income. Octopus fishing provided this for them to a greater extent than the risk associated with selling cakes in the market place or the delayed return of farming. As one woman stated:

> *"I have two young kids to feed and my husband is away. I cannot get a job in a lodge [tourism lodge], the only thing I can do is fish." [Fisher-follow 6]*

Residency did not significantly contribute to this cluster, and less than 50% of members of this group belonged to small or medium household size. As a result, women in this group had a higher fishing effort in order to meet short-term needs. Box 6.1 presents an example of one such woman who is a member of this profile group. Central to her story is the lack of support she is receiving from her husband and the futile contribution age makes to her circumstance.

The older, female-headed household (FHH) fisher-farmer group fished almost as regularly as the young poor group (17 trips per individual on average), and more regularly than the mature male-headed household group (although this was not significantly different).

Box 6.1. A young, poor, educated octopus fisher.

The cluster analysis showed Donna A most strongly represents individuals associated with the young poor group. She is 28 yrs old. She lives with her two children who are both still young (5 yrs and 7yrs). She is married. Her husband looked to be in his early thirties and was always dressed relatively well (e.g. shirts and shoes), while she was regularly seen in the same tattered wrapper and worn sandals. He worked as a fish trader and travelled a lot as a result. She lived in a house in Cumwamba district (not far from the market place) made of mud and stone with straw roofing. She is one of the younger women regularly seen octopus fishing. She went on over 60 octopus fishing trips over the 12-month catch survey, making her one of the most regular octopus fishers recorded.

While on initial encounter her marital status would assume a degree of security I later came to discover Donna A's marital situation brought a lot of uncertainty into her life. Her husband was in fact her second husband. He was the father of one of her two children. She divorced her first husband after numerous extra-marital affairs he had. The house she is currently living in was built by herself and her first husband. Counter to popular practice, but in practice with traditions of a matrilineal society, she was able to keep the house following the divorce, due to combined pressure from her family members (mother, father and a sister) who also live on Ibo, and by the fact that her former husband was not from Ibo and so returned to Matemo when they divorced. She married her second husband two years ago. She said shortly after she had married him she learnt of his first wife on the neighbouring island of Matemwe. She complained he spent a lot of time there:

> "He is on Matemwe, I haven't seen him for two weeks. How am I supposed to live!" [Fisher-follow no. 13]

As the younger of the two wives she has less authority and because of this she said she receives less support from her husband. She also blamed the first wife for this situation saying "she does not have a good heart". This made him unreliable and Donna A lived day-to-day unsure of whether or not he would provide any financial support or provisions and, if so, how much. Although she has family on Ibo she said "they help when they can" but that her "sister is ill and all the money anyone has goes towards her medicine". This fragile household structure means securing food on a daily basis is a priority for her which makes octopus fishing as an immediate return activity an attractive option. She had to make sure her children had enough food to eat every day and therefore went octopus fishing more than most other women in the village. Thankfully Donna A is a strong healthy woman, able to fish regularly.

Donna A did not have any other main income-generating activities that she practiced. She has not as yet been able to secure land to farm, which would typically be acquired through spousal support or inheritance. Even if she did have farmland, she would find it difficult because she would have no help on the farm. She said the capital required to start up petty trade was prohibitively expensive for her, even though it would have allowed her to take care of her children and she would not have to spend so much time out of the house.

> "a bag of sugar is more than 70MTZ (over 1 USD$) and every day the price goes up. I have to sell everything or I will lose money. There are already a lot of women selling [bread and cakes] in the market and I see some of them don't sell everything. With octopus I know I will sell everything and get some

The majority of cluster group 1 were FHHs (86.5%), and many had been married at one point in their lives but were now either divorced or had been widowed. Some had divorced and re-married, and some had had children with different husbands and other men, but were too old to re-marry, although they still had children or other dependents (most commonly grandchildren). Not all women that reported being from a female-headed household were unmarried: 37.2% were formally married but because of either second wives or with an unreliable husband they considered themselves as the household head. Part of what contributes to FHH vulnerability is the status and financial burden it perpetuates. In Muslim societies, marriage confers status as one's husband can assume the role of mediator to the wider world, which women are not permitted to do, thus leaving women marginal to political decision making in the community. FHHs are also in charge of securing income into the household, which, in a society where women's role is seen as strictly within the household, this presents a significant barrier. However, despite the disadvantages of being a FHH they were not the poorest group identified. Women reporting being part of a FHH described the burden of managing the household, and being the primary carers and providers. As a group they had almost the same number of dependents as those from male headed households (2.9 and 3.3 respectively) meaning that on a daily basis they still need to be able to provide food for their household, and are unlikely to invest in risky activities.

However, the majority of these women were ranked as normal and their material asset score calculated from the questionnaire was 2.3 times higher that of women in the young poor educated group (cluster 2). Compared to cluster 2 they had more assets, for example land to farm, and were more likely to own their own house. Wealth is in fact a distinguishing feature between these two profile groups but vulnerability is a shared communality.

Many of these women practice a combination of fishing and farming (63.2%). Octopus fishing is a source of relatively reliable short-term income that is complemented through their farming activities. The income from octopus helps to support their day-to-day needs. The two characteristics that did not significantly contribute to this group were the FFO (fishing-farming other) and FO (fishing-

other), the common factor being 'other' livelihood activities. The costs of sugar and flour (which are subject to fluctuations), make them less accessible and more risky in terms of returns. As one woman responded during a follow "*fishing and farming is the only way to live here! There is no work!"* (Fisher-follow no.7). And another fisher explained:

> "*I harvest octopus all the time. Some women make bread or sweets to sell in the market but it does not give [income]. I prefer to harvest octopus*."
>
> [Fisher-follow number 34]

An additional barrier to other livelihood options for these women was their lack of formal education, being of a generation who did not have access to education. This meant that they lacked the language and literacy skills to engage in 'other' livelihood activities. While these characteristics would normally dispose octopus fishers to fishing more, due to their age, and the physical demands of octopus fishing, physical fitness was a frequent topic of discussion. Women insisted that octopus fishing is not for children, or older people. As one women exclaimed during a follow:

> *"*[Octopus] *can climb up your arm and suffocate you!"* she went on to explain,
>
> "*you have to be strong, have strong legs and no fear, children are easily scared*". [Fisher-follow number 21].

Another woman on the same follow stated that:

> "*you have to have strength to fish octopus, you are walking for many hours, you can't do that when you are old, you can only walk a little bit and then you have to stop* (laughs) [Fisher-follow number 21].

As it is tiring, the physical demands dominated conversations. Women from this group also mentioned the toll octopus fishing took on their eyesight, the constant squinting to look for octopus dens under the harsh rays of the sun was a strain on their eyes.

> *'my sister used to come fishing with me, but she can no longer see the octopus clearly, her eyes are weak. So she stays at home now. When she has some money she will make sweets to sell in front of her house'*
> [Fisher-follow number 31].

Box 6.2: An older female-headed household fisher-famer

The cluster analysis identified Donna B as one of the individuals most strongly representative of this group. This case study illustrates one of the many strategies used by older women heads of household.

Donna B is a lively, outspoken and garrulous woman with a lot of energy; she was recorded going on 45 octopus harvesting trips over 12 months. During the course of the fieldwork she regularly went octopus harvesting. She always went to the same harvesting spot in Mwembe with four other women. It was a long walk to get there (approx. 4-5km), equally more impressive for a woman her age (62 yrs), which is just over the average life expectancy for women in Mozambique (UN country profile, website accessed August 2016). She lived through the emancipation from colonial rule and the subsequent civil wars. Therefore it is also not surprising that she has not had an education and cannot read or write, which limits her employment options particularly within the tourism sector. She was born in Pangane (further north) and moved to Ritutu district on Ibo when she married her first husband. She divorced him 'a long time ago'. She chose to stay on Ibo because one of her daughters lives on the island too.

She lives in her own house, made with mud and having a zinc roof. In her garden she has a couple of lemon trees, and a few chickens and ducks. She is a widow following the death of her second husband but I occasionally saw an older man in her back garden. She mentioned he is her boyfriend and 'comes and goes depending'. Donna B receives money from her grandson's mother (her daughter), the majority of which goes towards school fees and buying books and clothes for school. Remittances can be sporadic, as job security in Pemba is unstable; businesses have a high turn over rate due to the relatively unstable economy. Regular octopus harvesting allows her to provide day-to day food for her and her grandson, and on occasion her boyfriend. As she explained:

> "with one octopus I can buy a kilo of rice, or two kilos of chima [corn], if I don't have oil I can exchange some rice or chima for a little oil to make some stew to eat, I try to save the rest of the money when I can. That is the way I eat with the money from octopus" [Fisher follow number 18]

Donna B also has a rice farm situated approx. 1.5 km on the way to Mwembe intertidal zone making it easy for her to combine fishing with farming. She took pride in showing me her farm, explaining the amount of work that went into the seeding and harvesting of the rice crop. Every few days she would stop there on her way to or from harvesting octopus to work on it or check that nothing had been stolen. Rice harvesting provides a harvest once a year. Unusually, she does not sell much of the harvest. She likes to keep as much as she can even though this limits the amount of cash income she receives. It is compensated by regular octopus fishing trips, as she explains;

> "During the harvest season I can combine the rice from my farm with the octopus I harvest to eat every day. I prefer to do this because the rice in the market place is very expensive and it doesn't even taste as nice as rice from the farm" [Fisher follow number. 18]

The third group, the mature male-headed household women living in Cumwamba, included women who had the lowest fishing effort (on average 14.2 trips per person) out of the sample.

These women are mostly married and reported being part of a household with a male head (83.3%). From a women's perspective, reporting being part of a household with a male head means that the head of household is managing the household, contributing economically and socially to the household, and therefore reducing the need for her to undertake an immediate-return and reliable cash income activity such as octopus fishing. One fisher explained:

> "*My husband can buy a sack of maize flour for the household. Sometimes he will give me money to buy fish and ingredients. When he is around the household the children are happy*". [Fisher-follow number 45].

Their marital status and their age – the majority of women in this group were in their thirties and forties – signifies that they have greater leverage over social networks, they have had longer to establish themselves in terms of building up an asset base, and have learnt more practical livelihood skills compared to the poor, young, educated group. Wealth did not have a strong influence in defining this group. Where is was present the highest represented wealth category was 'good' (16.7%) and less than 10% of this socio-economic profile group is made up of women categorized as 'poor'. A number of women in this group had husbands with monthly salaries, something that is quite rare on the Island.

Compared to the older female-headed households (50.0% of whom lived in Ritutu) the majority of this cluster lived in Cumwamba (71.4%). Cumwamba is traditionally a wealthier district of the island compared to Ritutu, mainly due to the district's historic links with the Portuguese administration during the colonial era. In contrast, those women living in Ritutu tend to have weaker historical and political ties to the Island due to the histrocial process through which Ritutu was populated and developed, in which it grew from what was initially a migrant communtiy. Hence living in Cumwamba is considered more desirable. One woman described Cumwamaba as having a more cohesive community structure:

> "*in Ritutu there are many theives and you don't know who they are because people come and go everyday*' whereas in '*Cumwamaba we will always find these people [theives] because everybody knows each other"*. [Fisher-follow number 37].

As members of this group these women were more likely to have another livelihood activity (in addition to octopus fishing) such as making bread or cakes, however it is also a marginal contribution. Nonetheless, this is a distinction between members of this group and members of profile groups 1 and 2 which did not practice 'other' income generating activities. Participation in 'other' livelihood activities suggests members of this group have access to financial capital and may be less adverse to incurring losses in the market on poor sales days. These attributes suggest members of this group are less exposed or susceptible to risk, at least over short periods.

While octopus fishing represents a relatively quick cash income, which women from this group reported was useful for the purchase of household items, or in preparation for a ceremony or festival, observations made it clear that octopus fishing is considered to be a less desirable activity, both in terms of social status, and due to the physical demands of the activity. One woman explained:

> *"When you go octopus fishing you get covered in mud… and when you walk through the village you hope nobody sees you!"* [Fisher-follow, number 41].

In comparison with women from the older female headed fisher-farmer household group whose fishing effort was constrained by physical limitations, women in this category were more likely to fish less frequently due to social status. Their reasons for octopus fishing ranged from a disregard for what people thought. A woman living in a cement house in the most developed district to another woman stated "*this is what I know how to do, I have always done it and I will always do it!*" [Fisher-follow, number 47], whereas another woman explained "*I only go if I need something quickly that my husband can't give me*" [Fisher-follow, number 33], implying it was only for certain expenses that she would go octopus fishing. This said, some women with these socioeconomic characteristics still reported difficulties,

depending on their individual circumstances. As one women explained during the questionnaire survey:

> *"We don't have a farm. My husband doesn't know how to farm. Before this was not a problem but now the fish he brings back is not enough so I try to help him. I make biscuits to sell to the fishermen before they go fishing. But even this money is little."* [Questionnaire respondent 60].

Box 6.3 - A mature, male-headed large sized household fisher

Donna S was identified by the cluster analysis as most strongly representing this group. She is 46 years old and lives in a house on the border of residential districts Cimento and Cumwamba, the two most affluent areas of the island. She went octopus harvesting eleven times during the course of the survey. The house she lives in is made of cement and has a zinc roof. It has a big garden in the back where she grows tomatoes to sell at the front of her house. She also operates a small local food café in the front of her house, called a 'salao de cha' that sells food in the afternoons and tea throughout the day. The house belongs to her father who lives in Pemba. Her father has a house in Pemba, as well as another on Ibo Island. He receives a pension from the government, known as 'antigo combantente' money, which is approximately 6,000Mts a month (US$ 200).

She has three children. Her two daughters were from her first marriage, however, after her ex-husband left her she re-married her current husband and had a son with him. Her husband is a boat captain, which is one of the most lucrative businesses on the island. Her two daughters, in their teenage years, went to school but her son was still too young to attend. She said her daughters did not know how to fish octopus but that they occasionally went to the beach if she required them to collect pen shells, or cockles to make stews to sell in the cafe. Donna S explained that it is not important for her to teach her daughters to fish octopus because she hopes they will continue with their education and get paid employment in Pemba city.

Although she does not fish as often as women in the other two cluster groups, when I asked if she is fishes for octopus she confidently replied 'yes'. On the trip that I accompanied her on she explained she had a wedding to attend and, as part of the tradition, she needed to buy the prescribed kapulana (cloth) in order to participate in the ceremony. Therefore she was going to go harvesting for some extra money to help with the purchase. When Donna S harvests she said she always goes to Cumwamba intertidal zone. She can afford to fish on the most favorable days because this is not a daily livelihood strategy: the day we went harvesting was in the middle of the spring tide period when the tide was out the furthest, exposing the greatest amount of intertidal reef. We went to Cumwamba intertidal area, which was closer to her house than Mwembe. When I asked her why she didn't go to Mwembe zone she replied, as most of the women did, that it was "*baidi*" meaning far in Kimwani.

During the course of the trip she spoke about the decline in her business. She said the number of customers had decreased recently but she wasn't sure why. She thought she may have to go octopus harvesting more. However she found it difficult to find someone to go octopus fishing with as they lived far from her house, and unfortunately her house was not positioned along the main path to the intertidal zones, so she could not call out to other fishers as they walked by to ask if she could join them. On the trip she picked up approximately 10 tulip shells in addition to the 7 octopuses she caught. This demonstrates that she, like many other fishers, also takes advantage of opportunistic fishing of edible shells.

6.5 Discussion

This chapter aimed to present a more nuanced understanding of women octopus fishers on Ibo Island through exploring their socioeconomic characteristics and how these relate to their fishing effort and catch. Female octopus fishers can be described as a resource user group in the traditional sense, as they are homogenous in terms of gear type, gender and target species. However, this study shows that within this traditional grouping there are discernable sub-groupings of women with similar socioeconomic characteristics, and these groups have different levels of fishing effort.

The combination of quantitative questionnaires with longer-term ethnographic methods, such as direct observations and informal interviews, proved a powerful diagnostic tool to understand the degree of heterogeneity among female octopus fishers. These methods also helped to understand what the higher-level socioeconomic characteristics mean in local terms, to cross-reference the socioeconomic profile groups with individuals' stories and observations, and explain how these factors influence women's fishing effort.

The sampling strategy targeted more frequent octopus fishers, which means that the results should be treated with caution. The majority of individual female octopus fishers on Ibo Island do not go fishing more than 10 times a year. While the questionnaire sampling captured both fishers with fewer than 10 trips and those with more the sample was over-represented by women whose trip number sat on the higher end of the spectrum. While this means that the socioeconomic profile groups presented and the link between these groups and average fishing effort are still relevant, care needs to be taken when extrapolating the findings to octopus fishers on the Island and other coastal communities, particularly when extrapolating catch rates.

6.5.1 Socioeconomic characteristics of octopus fishers

The cluster analysis and case study examples of fisherwomen demonstrated that a single category such as age or household status alone does not determine women's personal circumstances. Instead, when combined they draw a picture of women at particular life stages that reflect historical processes that have occurred in

Mozambique and community social-cultural norms. For example the young, poor educated group are generally unable to access the common income generating options women on Ibo employ (e.g. bread making, farming or the relatively more profitable net fishing) due to lack of access to the capital required to obtain them. Many also lack economic support from a husband, yet need to support dependants, which, due to their age, tend to be young children. These conditions make this group particularly vulnerable to falling into abject poverty or experiencing food insecurity or any number of threats to their wellbeing. Whereas the older female-headed fisher-farmers are largely illiterate due to the political and economic instability generated during the civil war periods, yet due to their age they have had time to acquire houses, farmland, machetes or fishing nets which enables them to generate an income.

In this case study, an intersectional perspective was particularly fruitful in understanding the multiplicity and shifting nature of socioeconomic categories commonly applied in SS fisheries' management. Of these, the category of female-headed households (FHHs) presents the most striking example. Within the category FHH there is a degree of commonality – that women feel solely responsible for the other household members – but beyond this, women's personal circumstances may vary considerably. For example women's reporting of FHH status was not always related to marital status: married women who were second or third wives, and even first wives, sometimes self-reported as FHHs. Being a female head of household could be due to being a widow, polygamy, old age, infertility, or a personal will not to re-marry.

While Chapter 5 illustrates that FHHs fish more frequently as a group, this was without any real understanding of the types of women that make up this group, or what it means from the woman's perspective. The results highlight that FHH status can occur at different stages in a women's life on Ibo, from young women who have not yet married and are trying to build up their assets, to mature and previously relatively stable households, through to older women who might have divorced or been widowed. While the majority of FHHs appeared in cluster 1, which was associated with being older, living in Ritutu, and combined fishing and farming to

generate income, this was not the only group of women in which this status appeared. Women of female-headed households did also appear in the clusters dominated by younger poorer (cluster 2) and mature male-headed household (cluster 3) groups. The profiles of FHHs on Ibo can therefore vary considerably.

The category FHH is often equated with vulnerability, indeed numerous studies have shown that female-headed households generally face higher barriers to accessing natural resources (Price and Campbell 1997; World Bank 2001; Barman 2001). Whereas this finding may be broadly applicable in a range of contexts, Djoudi et al warn that a lack of intersectional perspective "*ignores the crucial importance of other social factors and does not acknowledge the specific social context of female-headed households*" (Djoudi et al. 2016: 11). This is to say, any blanket assumptions linking vulnerability to FHHs may ignore the actual causes of such vulnerability. As demonstrated in this case study the supposition that FHHs are more vulnerable than MHHs can be questioned.

This case study showed a degree of homogeneity among female octopus fishers due to the fact the cluster analysis showed no one socioeconomic category dominated the sub-groups (clusters) formed. However, once the three groups were defined there were substantial differences in the composition of the groups. This finding highlights that heterogeneity does exist within quite a narrow and specific resource user group. While acknowledging the pragmatic approach of disaggregating fishers by higher-level socioeconomic categories by managers (Price and Campbell 1997; World Bank 2001), this case study emphasizes the importance of understanding within categorical differences that exist among quite specific resource user groups.

6.5.2 Fishing effort among female octopus fishers and relationship to socioeconomic profile groups

The findings showed a highly skewed fishing effort (number of trips), with the majority of individuals (84%) recorded taking fewer than 10 trips a year. As the sample population of octopus fishers was biased towards more regular fishers, the cluster groups did not fully capture this skewed effort. However, with an average of 14 trips a year cluster group 3 – mature women living in male-headed household in

Cumwamba residential district – most closely represents the cohort with lower fishing effort. As case study 3 illustrates, low fishing effort is associated with motivations to fulfil a specific need with a high social value – it allowed her to participate in a wedding ceremony – but not to satisfy short-term daily needs as exemplified in case studies 1 and 2.

Chapter 5 showed that FHHs as a group fish more frequently on average during the course of the year (20.4 trips versus 12.9 trips on average) and that no other individual characteristics significantly affected effort. Despite this, there was some indication of the influence of other socioeconomic characteristics (although these were not statistically significant). Fishers and fisher-farmers appeared to fish more frequently than women with other livelihood activities, as did women in the poorer category, women with some education, and younger fishers (Appendix S5:I) This chapter builds on these findings and shows that when women with similar socioeconomic characteristics are grouped together (profile groups), these sub-groups have significantly different levels of fishing effort.

The fact that the younger fishers fish more is consistent with other studies examining socioeconomic predictors of resource use showing age to be an important determinant (Muallil et al 2013). However such analyses depict linear relationships, whereas the relationship between age and resource use here more closely resembles one of an upside down bell shaped curve: younger women and older women are more frequent users, with a dip among middle aged women. The reason that young and old women appear to fish more octopus cannot be attributed solely to age. For cluster group 2 (the poor, young, educated), age is most strongly associated with wealth (i.e. being in the 'poor' category) and for the older group it has a stronger association with their household head status.

This research shows that there appears to be a certain combination of factors that when combined, pre-dispose women to fish more frequently. These factors are all related to women's need to self-support, to make cash on a daily basis, and a lack of other sources of cash income. Together, these factors are all associated with women's vulnerability.

Not only does this study illustrate the importance of breaking down our understanding of these higher level and sometimes generic socioeconomic categories, but reinforces the need to understand what these factors – which are embedded in the local socio-cultural context – mean (Jentoft et al. 1998). So, for example, while the meaning of being a FHH as described above might be applicable to other coastal communities in the Quirimbas Archipelago, other factors, such as district of residency, are inextricably linked to the island's social history and potentially vary from village to village. In Ibo Island's extensive pre-colonial and colonial development, Ritutu district developed through the arrival of itinerant fishers, who were never as integrated into the colonial economy as those people residing in Cumwamba. On the whole, households in Ritutu are poorer, and less likely to gain employment in tourism or other formal employment, represented for example by the higher number of male octopus fishers. Other socioeconomic factors, such as age and education, also take some understanding. While women with a higher education appear to fish more (although not statistically significant), this is not related to education but age, which is a proxy for education on Ibo where the older generation did not have the same level of education as the current generation.

This research shows that there appears to be a set of factors that, when combined, pre-dispose women to fish more frequently. These factors are all related to women's need to self-support, to earn cash on a daily (or near daily) basis, and a lack of access to 'other' income generating activities.

6.5.3 Implications of the relationship between socioeconomic profile and fishing effort

This study further supports the need to disaggregate 'communities' or resource user groups along socioeconomic axes such as age, gender, and wealth (Cinner, et al. 2009, Cinner 2014), and takes this a step further by illustrating the heterogeneity inherent within groups with the same socioeconomic characteristics, such as MHHs. Many studies on small-scale fisheries carry the implicit assumption that effort is equal within groups of people targeting the same species or using the same gear. And they use this as the unit by which to predict potential impacts or to administer management measures (Wallace et al. 2015). The reality, illustrated by this case

study, is that there is complexity inherent in these links between socioeconomic profiles and resource use (Walker and Robinson 2009). And so while using socio-economic profiling can improve explanatory power (Branch et al. 2002; Harrison et al. 2015), it is important to understand whether this actually has practical implications for fisheries' management.

The first implication of this study is the importance of selection of, not only fishers, or women more generally, but also of defining the different types of fishers and recognizing that they will have different perspectives on fisheries' management, whether they are fishers who most frequently fish, or those who might not fish frequently but make up the majority of the resource user group. Female octopus fishers have a range of socioeconomic characteristics and individual and household circumstances. This variation in personal circumstance could be taken into account by engaging not only female octopus fishers in octopus management initiatives, but also the most frequent and dependent users – profile groups 1 and 2. Recognizing that female octopus fishers have different dimensions of vulnerability will also help with the design of development interventions, such as savings groups and alternative livelihood initiatives, ensuring that these are tailored to the root causes of their vulnerability.

The second implication of this study is related to who is likely to be affected by the introduction of octopus management measures, or marine management measures that affect women's access to the intertidal reef flat. Whilst women have been identified to be disproportionately affected by management measures, this study indicates what sort of woman would be most affected by management measures (Walker and Robinson 2009). In this case study, it is clear that there is a link between a group of characteristics often linked with vulnerability (marital status, age, alternative livelihood options, and wealth) and frequency of resource use. Therefore changes in women's personal and household circumstances are likely to influence their individual fishing effort, and therefore pressure on the resource. This was observed whilst living on the Island as women moved in and out of octopus fishery as their circumstances changed. These findings are encouraging for those co-management interventions that include development activities targeted at improving fishers'

wellbeing as a means to reduce pressure on resources. However, octopus fishing is clearly embedded within the broader village and district economy, and to changing social and intra-household gender relations. Therefore any broader changes that affect women's vulnerability status, such as climate change impacts which have been reported to affect agricultural production in Ibo District (Riddell and Rosendo 2015), my also have a knock-on effect on fishing pressure.

The role of institutions in octopus fishing: a gendered perspective

Chapter 7

Octopus fishers beating their catch before sale to a local trader

Chapter summary

Research on institutions in small-scale fisheries aims to understand the rules and power dynamics behind fisher behaviour, often in relation to rule breaking or participation in co-management. Exploring the range of institutions surrounding a fishing strategy can reveal the dominant rules fishers prescribe to and how flexible certain behaviours are to changes such as management measures. Combining ethnographic fieldwork and a conceptual framework, called an institutional access map, this chapter examines the role of formal and informal institutions in structuring access to and providing the benefits from octopus fishing for women. The results show how various institutions structure how it is organised and how it is performed. The access map reveals the dominant role local normative institutions play, which is above that of the national park, in influencing how women secure the benefits of octopus fishing. It means that women cannot carry out this activity in isolation from broader community relations. Purdah, the religious norm of securing a woman's honour, is identified as a key restraining institution for octopus fisherwomen enforced through unequal gender relations. Drawing on observations and participatory fisher-follows, the results highlight instances women interact with various actors to challenge institutional constraints associated with octopus fishing. Finally, this chapter encourages an understanding of the institutional context of fishing practices. In particular, for fisherwomen, it argues that local social institutions operating through unequal gender relations, dominate resource use behaviours for fisherwomen on Ibo. In addition a greater appreciation of power relations – captured in this study by gender relations – is required to further develop the application of institutional theory in small-scale fisheries management, to encourage greater participation by women in fisheries management.

7.1 Introduction

This chapter examines the role of institutions and the way in which they structure octopus fishing. By explicitly focusing on fisherwomen the aim is to extend research into the nature and diversity of institutions in small-scale fisheries that has typically focused exclusively on male fisheries. The specific objectives of this chapter are to highlight the range of institutions involved in octopus fishing; to analyse what influence these behaviours have on women's ability to benefit from octopus and to critically assess gender relations in octopus fishing.

In the context of women's octopus fishing in Mozambique, institutions cannot be narrowly defined: they incorporate a wide range of rules, values and shared conceptions of the world, which pertain to how the local community functions. The definition of institutions applied here follows that of Scott (2014: 48) who describes institutions as "*comprised of regulative, normative and cultural-cognitive elements that, together with associated activities and resources, provide stability and meaning to social life*". Institutional theory attempts to explain the processes through which behaviours – embracing a range of phenomena including norms, conventions and social relations – become entrenched as principles by which people self-organize and interact. Approaches that utilise institutional theory to study fisher behaviour have proved fruitful in beginning to untangle the wide range of formal and informal rules surrounding behaviours such as law breaking or monitoring in fisheries projects (Wickramasinghe and Bavinck 2015; Alonso et al. 2016) .

Approaches to studying institutions

There have been two main strands of theoretical analysis used to discern what shapes people's interactions with their environment. One approach is concerned with determining institutional forms, functions and arrangements that lead to sustainable use (Wickramasinghe and Bavinck 2015; de la Torre-Castro and Lindström 2010). Such studies have shown that 1) externally introduced fisheries management measures tend to rely heavily on introduced formal regulative frameworks to regulate fishing effort in space and time and 2) rules and regulations are often created without prior recognition or thought of what already exists, creating new

institutional arrangements and forms of legal pluralism (see Bavinck and Gupta 2014 for a history of legal pluralism in aquatic systems).

The second strand focuses inwards, on the internal dynamics of institutions, the way power and agency shape who benefits from resource use, and how these benefits occur (Nunan et al, 2015; Ngwenya, et al, 2012). Its more critical approach proposes that the existence of an institutional arrangement does not necessarily imply that it is equitable, fair or just and indeed that to develop towards greater lack of bias requires an analysis of an institution's internal dynamics (Cleaver and De Koning 2015). By doing so, researchers have highlighted the enabling and constraining influence institutions may have on individuals or groups. This is a particularly beneficial way to examine issues of access. The assumption that external institutions are intrinsically constraining and local institutions are intrinsically enabling does not reflect the complexity of institutional behaviour, which both restricts and empowers. Hence one can argue that a real picture of the complexity of institutions surrounding resource use can be revealed only if both these analyses (deterministic and internal) are used in conjunction with each other.

This chapter recognises both approaches, in that it maps out the institutions and their interactions but also captures some of the power imbalances within them through observations at keys points of interaction. To do so it employs a conceptual framework inspired by Ribot's access map which he used to assess the processes, outcomes, and beneficiaries of a charcoal commodity chain in Senegal (Ribot 1998). In order to implement this access map it is reconfigured to reflect the realities of octopus fisherwomen on Ibo Island. Through such an approach, this chapter identifies the mechanisms and agents (including the women themselves) that shape this livelihood activity and the outcomes on the fishing strategies of women. The discussion embraces both approaches to institutional form and functions alongside those of the power relations that make these institutions dynamic.

Study site: broad institutional context

The Quirimbas National Park (QNP) is the first formal marine management on Ibo

Island since Portuguese colonialism. During the almost 400 years of colonial rule, formal resource management on Ibo was controlled by the Portuguese. The Portuguese did not fish the waters of Mozambique commercially, or locally around Ibo, and the Mozambican fisheries remained undeveloped during this period. Community members from Ibo do recollect that fishing was restricted in the harbour, and the customary rules that survived colonialism are the ones in operation today. These include not fishing during the neap tide, and the gendered segregation of fishing activities. The way in which these institutions operate and interact with the formal QNP regulations is unknown. QNP regulations don't specifically address octopus fishing as a target of conservation measures, nonetheless, fishers operating on the Island are affected indirectly by rules regulating the fishing grounds under different QNP management categories, and the commercial use of marine species[51]. Property rights are held by the state, and local communities are afforded the right to use the land and associated resources on which they live under the principles of management laid out in DUATs[52] – the right of use and benefit from land as long as this use is according to customary practice. However, harder to identify, are the less visible institutions that operate through everyday praxis.

7.2 Conceptual framework and methods

7.2.1 Conceptual framework: an institutional access map

The institutional access map follows a similar framework to the access map that Ribot (1998) used to investigate the benefits accrued during charcoal distribution (Figure 7.1). An advantage of the access map framework is its attention to the range of actors, and the mechanisms used at different points along a 'chain' of access (Ribot 1998). The approach taken in this chapter differs from Ribot's in that it applies this method along a chain of access associated with a particular fishing activity. Additionally, instead of a focus on profits, this map identifies the

[51]Most notable the no-take area surrounding the harbour.

[52] Mozambique's 1997 Land Law established a right to use land which is inheritable and—subject to certain restrictions—transferable. This right is known by the acronym DUAT, from the Portuguese Direito de Uso e Aproveitamento dos Terras

institutions involved in women's octopus fishing and how those institutions influence women's ability to benefit from octopus. Another deviation from Ribot's access map is the splitting up of the process into what are termed 'nodes of access', in order to demarcate key features of octopus fishing.

The steps involved in the analyses of institutions surrounding octopus fishing are: (adapted from Ribot and Peluso 2003)

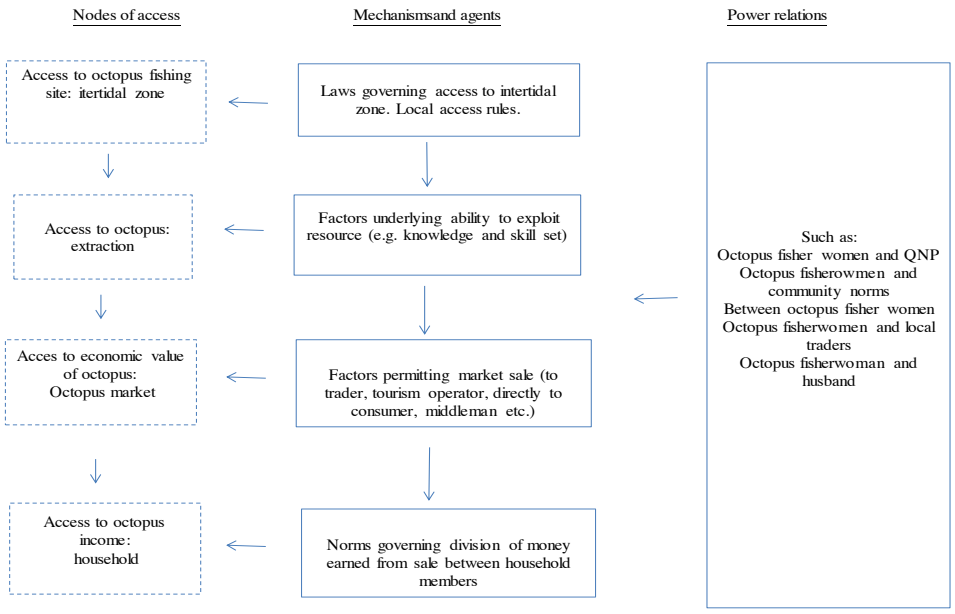
1. Mapping the process of octopus fishing – 'nodes of access' – from the intertidal zone to the household (Figure 7.1, first column)

2. Exploring the mechanisms and agents that influence the process (Figure 7.1, second column)

3. Documenting the power relations that operate within the mechanisms (observations carried out throughout the process documented in Figure 7.1, third column).

The conceptual framework provides the overall structure for the results section. The sections which have been written up as sub-headings were generated through a thematic analysis of the notes made during fisher-follows, observations, informal discussions and semi-structured interviews with key informants that took place over the study period (Aronson, 1994; Braun and Clarke 2006).

Figure 7.1 Conceptual framework: an institutional access map



Identifying institutions

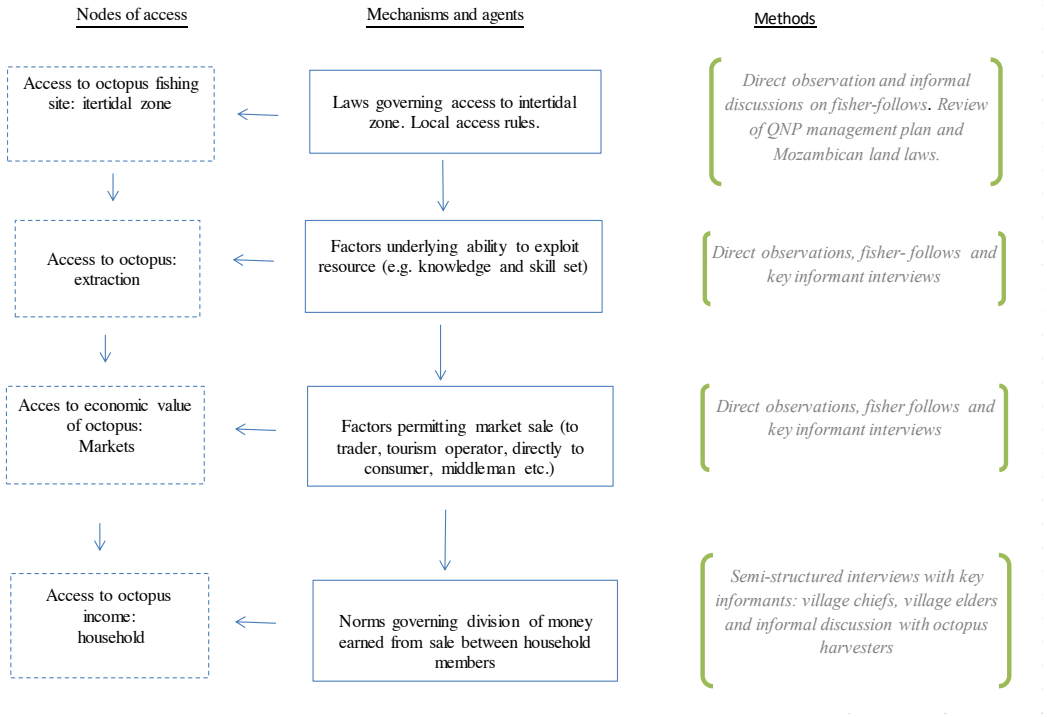
Scott's (2014) typology of institutions, known as 'the three pillars', was used to categorise the institutions observed along the chain. Each pillar is distinct from the other in its 'basis for compliance, mechanism of diffusion, type of logic, cluster of indicators, affective response and foundation for legitimacy claims'(Scott 2014 page 84). The three pillars are: (1) the regulative pillar i.e. formal and informal rules and regulations that dictate when, where and how much of the resource to take; (2) the normative pillar that defines the values associated with the activity and infer not only rights but the morally binding codes associated with particular behaviours, and 3) the cultural-cognitive pillar which refers to the shared conceptions of the real world often embedded in modes of behaviour which are rarely questioned because they are perceived as true e.g. how local people value marine resources.

7.2.2 Methods

Typically a combination of qualitative social science methods such as observations, informal discussions, and participatory techniques are used in an access analysis. The methods used include: participatory fisher-follows; informal discussions; observations and key informant interviews. The third column in Figure 7.2 below

illustrates how these methods were used at different points of the access analysis.

Figure 7.2 Methods applied to the conceptual framework



The power relations governing access were traced over the course of the fieldwork using informal discussions to understand exchanges, social relations and perceptions of issues surrounding octopus fishing. This, combined with observation and discussions during fisher-follows, provided an understanding of the dynamics of access to this resource. Towards the end of the fieldwork period, key informants were consulted to answer final queries and discuss findings. The formal regulatory framework surrounding octopus fishing was examined by reviewing the national laws governing resource use, particularly the Mozambican Land Law and the Quirimbas National Park management plan.

7.3 Results

Figure 7.3 presents the institutional access map applied to octopus fishing by women on Ibo Island. The figure shows the range of institutions (column 2) surrounding each of the nodes of access (column 1). The mechanisms and agents (column 3 and

4) used to enforce institutional practices and an additional column to show the specific outcomes on women's fishing strategies (column 5).The framework is explained in greater detail in the sections below.

7.3.1 Access to octopus fishing sites

Access to the intertidal areas on Ibo is the first node identified in the access map. 5 institutions were identified to operate at this node.

Octopus fishing limited to two areas on Ibo Island

The review of the Quirimbas national park (QNP) management document highlighted that formal regulations governing fishing sites within Quirimbas National Park are based on a zoning system. The zoning system includes four types of use zones: i) total protection zones; ii) specified use zones; iii) community development and use zones, and; iv) a buffer zone.

The total protection zone (TPZ) is where extractive activity of any kind is prohibited, and the QNP management plan states that in Ibo District this covers '*an area of 20 square kilometres lying between the villages of Tandanhangue and Quirambo (50% of the total Ibo [mangrove] Stand*) (QNP Management Plan, 2004-2008: 45). This total protection zone (TPZ) also affects octopus sites in neighbouring intertidal areas, namely the islands of Sencar and Quilelia to the south of Ibo Island (Figure 4.2 in Chapter 4 shows this). Regulations within these zones are enforced by QNP rangers, under the jurisdiction of the Ministry of Tourism.

The octopus intertidal sites on Ibo Island currently used (Cumwamba and Mwembe) are not included in the zoning system. At the time of the study there were no QNP regulations affecting fisher's access to these areas.

Figure 7.3 Institutional access map of octopus fishing on Ibo Island

Nodes of acces	Institutions (*Scott's classifications*)	Mechanisms	Agent	Outcome
Access to octopus fishing sites	Women can only fish in certain areas (*regulative*)	Zoning	Quirimbas National Park	Fishing limited to two areas on Ibo Island
	Women cannot fish without perission from husband (*normative*)	Consent	Husband	Octopus fishing done by single women or by women whose husband break from the customary norm
	Octopus fishing occurs during the spring tide (*regulative*)	Social shaming	Influential community members	Octopus fishing occurs approximately 15 days a month
	Women fish in groups (*normative*)	Trip opporutnities	Octopus fisherwomen	Individuals with no link to the community will not be able to fish
	Octopus fishing primarily occurs on Ibo Island (*normative*)	Transport	Boat owners	Limited use of octopus harvesting sites outside of Ibo Island
Access to octopus: Extraction	Women use iron rods to extract octopus (*normative*)	capture and kill octopus	Iron rod	Access to a rod is a barrier to some women wishing to enter into octopus fishing
	Women capture octopus in dens found along the intertidal flats and reef edges (*cultural-cognitive*)	Teach skill of extraction	Local knowledge	Many women involved in octopus fishing come from a lineage of harvesters
Access to economic value of octopus: Octopus market	The sale of marine species within the national park is prohibited (*regulative*)	Commercial trade prohibite	Quirimbas National Park	Traders are people with good socio-political ties: a form of elite capture
	Women do not trade octopus (*normative*)	To trade one must purchase octopus in bulk	Financial captial	Women remain at the bottom of the value chain
	Women do not receive a fair price for octopus (*normative*)	Leverage over prices, Manipulation of scales, Debt relations, Processing: beating	Traders	Reduced income from sale
Access to income from octopus: The household	Women do not keep the money from the sale of octopus (*normative*)	showing of money	Husband	Income from octopus harvesting is appropriated.

A woman cannot fish without consent from her husband

Prior to leaving the household to fish octopus, women need to seek permission from their husbands. This is based on the Islamic custom known as purdah. Purdah establishes physical boundaries between men and women. It manifests as forms of female seclusion or segregation considered necessary for the protection of the woman's and her family's honour (Kevane 2004). Purdah is practised throughout Muslim societies to various degrees. On Ibo the more one adheres to this practice the greater esteem in which the individual and family is held. Therefore it is desirable, at least for the man, to practise this norm. For example, the chief of Cumwamba explained:

> '*Religious custom expects women to remain within the household under the watch of her husband, and all household necessities are to be purchased by the husband, therefore she does not need to leave the [household] compound'*.

Similarly, a local religious leader also commented:

> *'when I was a boy, the woman made her request to her husband, sometimes by showing him the empty sac and he will go out and buy what is needed'*.

Although this practice has weakened, nonetheless a woman's choice of livelihood activity that requires her to leave the household compound for long periods, like octopus –fishing, must be sanctioned by the husband first. Some husbands do not like the idea of their wife working or spending too much time outside of the household compound. Married octopus fishers explained that they had to negotiate access to the intertidal zone by persuading their husbands to permit the activity. As one octopus fisher explained:

> *'My first husband did not want me to spend so much time out of the house: once I divorced him and married my second husband I was able to start fishing again'*. [Participatory fisher-follow number 8]

Another frequent octopus fish explained the way she was able to negotiate a trip to fish was if her mother, who was also an octopus fisher, goes with her:

> *'that way he knows that I am safe all the time and no men will try and*

> *take me away'* she laughed. [Participatory fisher-follow number 9]

Gaining a husband's permission is not confined purely to octopus fishing, but other activities too and was experienced when hiring research assistants for this study, and was also reported by tourism operators hiring women from the community. Another woman fisher explained the reason she thought some men are reluctant to give their wives permission to fish:

> *'some men don't like their wives fishing [octopus], if a woman has her own money she becomes too independent and she can leave him'.* [Participatory fisher-follow number 14]

Octopus fishing only occurs during the spring tide

Customary rules prohibit men and women from fishing during the neap tide. This period is referred to locally as *maji mana*[53]. Fishing is only locally permitted during spring tide, when there is the greatest difference between tides and the previously covered intertidal area is exposed. The reasoning behind this is to allow the sea time to rest. However, the maintenance of this system relies on social pressure to influence other fishers' behaviour. The main mechanism women use to enforce this customary rule was observed during fisher-follows. During follows women were observed using derision to shame other women out of certain behaviours. In a key informant interview with an experienced octopus fisherwoman she explained how she calls out from her garden if she sees anyone walking past her house with a rod (to catch octopuses) during neap tide: '*Why are you going to fish? You should be at home like the rest of us*!'. This particular woman lives on one of the main routes to the intertidal zone, and is well placed to observe people. In addition, over the course of the fieldwork an elderly woman was observed in her compound shouting at passing women during the neap tide '*Are you trying to cheat us?*'

Another octopus fisherwoman admitted that her derision is effective because she is an older woman who has been fishing all her life. Her derision is meant to shame

[53]Maji mana literally translates as 'small water' in Kimwani.

those individuals spotted into not doing it again. Despite women's awareness of these customary norms governing the timing of fishing, key informant interviews on Ibo suggested that these norms have weakened over the last three decades. A Bairro chief explained that he had noticed two principal changes immediately after independence:

> *'Fishermen started to use the area in front of the port [the bay] which had previously been a non-take zone [enforced during Portuguese colonial rule], and more people went out fishing during the neap tide'.* [Key informant interview with Chief of Rituto district]

Octopus fishers themselves also admitted the weakening consideration for tidal patterns, for example as one woman commented:

> *'people are showing less and less respect for the small sea. As a child I could look out to the sea during maji mana and see no one! Nowadays you will always see someone!'*[Key informant interview with octopus fisherwoman].

These key informant interviews and observation showed a similar trend to the catch dataset which recorded 37% of women fished during the neap tide.

Women go octopus fishing in groups

While the distance and transport options act as obvious physical barriers to octopus fishing sites, there is also an understanding among octopus fishers that it is dangerous to go out to the intertidal zone on one's own due to possible injuries from coral or poisonous fish which may result in one stranded far from the village. To overcome this barrier, women are obliged to form social relations with other octopus fishers. Often fishers go out in groups made up of family members, and often neighbours. On several occasions it was observed that the lack of a companion was prohibitive, and the woman was forced to remain at home. More frequent fishers had a large network of other fishers and would go out in groups of 6–8 (Figure 7.4), while others would have to spend a bit more time asking around for a partner or rely on impromptu arrangements by calling out from their garden as they see someone they know waking past with an octopus rod. A group, once formed, tends to stay together thereafter unless there is a conflict between individuals or conflicting arrangements in the home.

Figure 7.4 A group of octopus fisherwomen returning from a trip to Mwembe intertidal zone.

The majority of octopus fishing occurs on Ibo Island

The Islamic practice of purdah continues to operate when women are permitted to leave the house; it sets the rules that govern how women are expected to behave in public. The main rule on Ibo that is followed is the interaction between men and women. Men and women are to remain segregated in public life and purdah states that in instances where there is an interaction between a man and a woman an independent party should witness it in order to assure the woman's honour. Women can walk directly to the two principal fishing sites on the Island (Cumwamba and Mujaka) however they are restricted in accessing sites off the island. In particular, the sandbank is known to have good octopus catch rates but it only occurs when the coral reef is exposed by the highest spring tides (approximately 2–3 days a month). Fishing at the sandbank first requires access to a boat, which needs to be negotiated through male boat owners. Direct observation during fisher-follows and informal

discussions with male boat owners indicated that there is no strong social obligation to take women in boats to the sandbank. Women often use kinship relations to leverage access to the boat, but even this appeared unreliable. On several occasions women octopus fishers were left on the beach in the morning as the boats sailed off, refusing to take them to the sandbank. Even when women were able to negotiate a ride to the fishing site, the customary practice is to give one octopus (or approximately 1kg) to the boat owner. The octopus catch data showed that the average catch was 6kg, meaning that the boat owner received approximately 17% of women's fish.

7.3.2 Extracting octopus

Once women have negotiated permission to leave the household, selected a zone outside of the total protection zones, become part of a group of a minimum of two people and overcome the physical distance and institutional barriers to access the intertidal zone, their focus is then on finding and extracting octopus. To find and extract octopus, women need i) the tool (an iron rod) and ii) the know-how (skill). To do this women rely on social networks to access an informal market for rods.

Women use iron rods to extract octopus

Women use an iron rod to extract octopuses from the hole in the coral in which they hide. There isn't a market that sells these rods on the Island. Instead they are accessed through ones social network. Some women reported procuring their iron rods through cast-offs from construction sites where men that they knew worked. Men are able to obtain rods on construction sites for free, and are then known to sell them on to women for approximately US $0.66[54]. Figure 7.5 shows one fisherwoman using her rod to check for an octopus.

[54] Exchange rate of USD 0.40 for 20 Mts. Source: XE Exchange: http://www.xe.com/currencyconverter/

Figure 7.5 A woman using an iron rod to extract an octopus in Cumwamba zone.

Women capture octopus in dens along intertidal flats and reef edges

The majority of octopus fishers are taught to fish by a family member, usually their mother, but some women reported learning from a neighbour or friend. Through fisher-follows, which combined participant observation, it became clear that knowledge of capturing octopus can be split into the ability to find octopus, and then to extract it from the coral rock. Locating the octopus requires sharp eyesight a good memory and familiarity with the landscape. Women need excellent eyesight to spot live octopus dens, usually evident by the pile of small stones or broken shells covering its entrance, or bubbles or jets of water created by the octopus dwelling inside.

Extracting the octopus is a relatively quick procedure. Notes from the fisher-follows showed it rarely takes more than five minutes. Extraction requires speed and accuracy, as one has to hook the octopus before it has a chance to squirt out ink in defence – making locating it a near impossibility. Often women new to octopus fishing would call out to someone more experienced in her group, and receive help to remove the pebbles with one hand, and extract the octopus with a rod in the other hand, which is a tricky procedure. Women then kill the octopus as soon as it is extracted. Knowledge of finding and then extracting octopus is passed on slightly differently. Learning to extract octopus is taught through direct observation and some instruction. As one fisher explained during a follow:

> *'I started to learn to fish from a very young age, first by following my mother on trips and observing her whilst I collected edible shells and then as I got older she would say "come and remove this octopus" and she would hand me her rod and direct me'*. [Participatory fisher-follow number 17]

Compared to extracting octopus, locating the octopus is more an autodidactic process. Participant observation during the fisher-follows revealed that certain women had a preference for certain areas on the intertidal zone. For example, Donna B and her group showed a preference for the stretch between Ritutu beach and neighbouring Quirimba Island, whereas Donna M could always be found along the jagged coral edge along the Cumwamba beach. However these areas were not used exclusively by each woman, and there were no formal or customary rules surrounding where women could use the fishing zone, only casual talk by the women and the preference to stay within familiar areas[55]. Once an individual was taught how to identify a live hole and extract the octopus she was left to practice on her own and essentially carve out her own preferential area.

7.3.3 Octopus market

Negotiating access to fair prices in the market place is a challenge for octopus fisherwomen who have to operate within the realm of gender norms. Here power is biased in favour of traders who are male and local. Fisherwomen need to be assertive with traders in which is more challenging for younger women than older and more established ones.

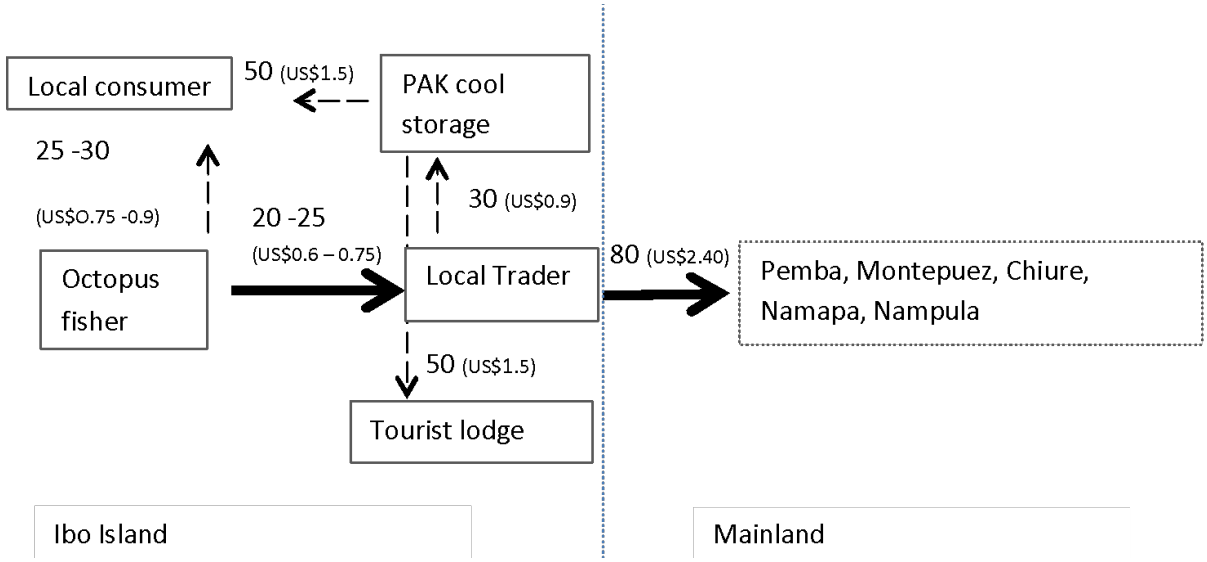
Interviews with traders revealed, that they usually salt and dry a minimum of 50kg of octopus before it's transported to mainland markets in Pemba, Montepuez, Chiure, Namapa and Nampula. There they are sold for approximately 80Mts a kilo (US$2.40). There is one cool storage facility on Ibo called Pak that is operated by an islander. The tourist lodges often use it as their clients prefer to eat fresh octopus rather than salt-dried. Figure 7.6 depicts the market on the Island.

[55]Talk is a powerful tool women have at their disposal; it is frequently used to bring shame upon (misbehaving) husbands, neighbours or relatives.

The sale of marine species within the QNP is prohibited

The QNP regulation stating the capture of live organisms for sale technically applies here at the octopus market. However this is overlooked in everyday practice, particularly for species such as octopus.

Figure 7.6 Octopus market on Ibo Island. Price of 1kg of Octopus: in bold, Mozambican Metical, in brackets US dollars.



Women do not trade octopus

The financial capital required to enter into trade is a barrier for octopus fisherwomen. Fishers access the octopus market through a local trader to whom they sell their daily catch (Figure 7.6). Although it was never observed, on fisher-follows a few women (n=4) said on rare occasions, at a special request from someone they knew, they sold their octopus within the village at between 5–10Mts more per kilo than the price traders pay for it (US$ 0.20–0.30). This was rare because of a local preference for fish.

Women do not receive a fair price for octopus

Observations revealed buying octopus required assertive interactions that pitch the buyer against both the sellers (octopus fishers) and other traders. Four mechanisms were identified that operate in the market place that illustrate this: i) leverage over prices; ii) weighing the catch; iii) debt relations; and iv) beating the octopus.

i) Leverage over prices

Observations during fisher-follows showed a subtle dynamic enacted between traders and octopus fisherwomen. Traders would try to buy octopus for the lower wet season price (15-18Mts a kilo[56]) for as long as possible. In the dry season it goes up to between 20-25Mts per kilo[57]. Octopus fishers were observed on numerous occasions trying to instigate a price hike with complaints such as, 'it's the dry season now', 'it's been dry for weeks', 'this is not the dry season price you are giving me'. These individual complaints fell on deaf ears but as a group fishers were more successful at securing a fairer price (Box. 7.1). Fishers often attributed this reluctance on the side of the traders to give a fair price to their gender 'cause we are women '*they think 'women's work is not good work'* [Participatory fisher-follow number 29]. In general fishers were unhappy with the price of octopus year round, the reason being as one woman put it '*fish is 30Mts a kilo but octopus is only 20Mts a kilo (fresh)…octopus should be 25Mts a kilo at least*!' [Participatory fisher-follow number 22].

[56] US$0.5–0.6, XE Exchange
[57] US$0.7- 0.8, XE Exchange

Box 7.1 Securing a fairer price

Securing a fairer price

Between November and December 2010, a number of octopus fishers from Cumwamba district became unhappy when traders reduced the price of octopus to the wet season price. The rains had not yet arrived to signal the start of the rainy season so women considered the switch premature and thus unfair. There were six key women involved in persuading the octopus fishers of Cumwamba not to accept this. Over a period of a few weeks, during fishing trips each of them persuaded the rest of the fishers not to sell their catch to the traders at the wet season price. They encouraged women to decide on a price and all stick to it, the idea was that when they arrive at the trading spot and ask the price, if it is under 20Mts they all walk on together. A comparison between the price of a kilo of octopus and that of a kilo of rice was often used to argue the need for a higher price Donna T, one of the leaders of the movement explained the issue '*15 meticais can only buy flour but we want to eat rice too!*'. Initially they were met with some resistance among other fishers. One fisher explained why '*Donna T can afford not to sell her daily catch, I have no food in my house today, I have no choice I have to sell my catch!*'. But Donna T would explain '*tiwapomoja*' - we are just like you. The first day a group of fishers refused to sell at under 20mts a kilo no sale was made. The next day they were successful as a trader bought the octopus from the women for 22mts.

It is interesting to note that the fishers from Ritutu that used Mwembe intertidal area did not respond to the change in price the same way. They heard about what happened among the Cumwamba fishers but a lot of the key elder and more experienced fishers living in Ritutu were in debt relations, which cut off their ability to negotiate with traders at that point in time.

ii) *Weighing the catch*

Women are suspicious of the scales traders use. As was observed often during fisher-follows, whether the weight of a catch sits just above or below a whole kilo it is rounded down. Women often complained in the absence of the traders 'they are robbing us'. Fishers would prefer to know the weight before they encounter the traders but none of them own a scale. Nonetheless the trader always has the final say regarding the weight of the catch. Figure 7.7 shows a trader weighing a fisher's catch.

ii) Debt relations

Traders will lend money to some octopus fisherwomen on the understanding that it will be repaid through octopus sales at a fixed price which is lower than the market price. This was most notable among the Ritutu fishers that used Mwembe intertidal zone. These debt relations were observed on a fisher-follow when a couple of octopus fishers were unable to take advantage of the increase in octopus prices brought on at the start of the dry season. They were indebted to a regular trader who is also her neighbour. The two women (who were sisters) complained of this trader they are in debt to. They lamented that he should be a good person and match the price of the other traders at that time of year. Such debt relations mean women lose out on opportunities to sell their octopus at a higher price. Another woman in the group warned the sisters during a follow ' do *not take more than 50 Mts* (US$1.7) *credit from him* [referring to the trader with whom she has debt relations] '*if the traders raise the price soon you will lose out'* [fisher-follow no 26]. However, one of the sisters lives alone with her three children, one of whom is still breast-feeding. Under these circumstances it is not surprising she participates in debt relations with local traders.

iv) Beating the octopus

Local traders demand fishers beat the octopus themselves prior to sale (Figure 7.7). This adds on another 15-30 mins at the end of a fishing trip (depending on the size of the catch). Women find this an extra burden on their time and energy and wish for

the days they could sell octopus without having to beat it first. On one occasion during a follow an octopus fisher sold her catch to a non-local. It was an opportunistic sale, which occurred when a boat of migrant fishermen stopped next to a group of octopus fisherwomen as they returned to the shoreline. A fisherman of a different ethnicity (Makua) walked onto the intertidal zone and bought a woman's catch for the day at 5meticais higher than the local price and without her having to beat her catch. She was the envy of the other fishers that day.

Figure 7.7 Left: A local trader weighing a fisher's catch; Right: a fisherwoman beating her catch.

7.3.4 The household

Women do not keep the money from the sale of octopus

Resource division within the household is predicated on local cultural norms. During the course of the field research a dissonance was observed between expected traditional norms and actual practices resulting from the pressures of modern day life.

Traditional vs. modern approach

The chief of Cumwamba explained the customary rules of resource division within the household. Traditionally the male and female household heads are expected to

share resources coming into the home, or at least be open about the amount they are bringing in. If a man has more than one wife he is expected to share out the money, not equally but equitably, according to the requirements of each household. The district chief of Cumwamba called this practice the showing of money and said this is practised more widely on Matemwe Island – next to Ibo – than on Ibo nowadays. It is a mix between local Kimwani culture and the Islamic religion, which is the dominant religion on the island (approx. 90% say they are Muslim). The traditional practice of showing money was what women referenced when talking about household division of resources:

> '*my husband does not show me anything!' ..."he keeps what he earns and only gives me enough to buy small, small food*' [fisher-follow no 23].

It was used as a marking stick by which to deride their husband's behaviour as not only personally unfavourable but socially unacceptable. Men nowadays have 'forgotten' how to be a real Kimwani man they would say. Women who experienced this said the money was being spent on 2nd or 3rd wives and their families, alcohol, and personal stuff for the man (e.g. mobile phones, petrol for motorcycles, and transport), as a fisher in the same follow group remarked:

> '*I have to fish today because my husband gave all the fish he bought to his other wife'* [fisher-follow no 23].

In order to secure the benefits from octopus fishing women said they hide the money they earned from their husbands. As a couple of women revealed *'I keep it in a secret place in the house and only take it out when my husband has gone out'* and *'I count it every day to make sure my husband has not discovered it*'. [fisher-follow no 33]. It was quite clearly and defiantly acknowledged as their own by comments such as '*this is my money'* and '*my husband doesn't give me anything so I owe him nothing'* [fisher-follow 15 and 16].

The importance of income from octopus fishing as a source of financial independence and livelihood security has grown. Access to income from octopus fishing is increasingly secured through covert means of hiding the cash from sales. It is not a practice that many would openly admit to, which would make empirical data

collection on the frequency and amount of income from octopus particularly challenging.

The predominant benefit of octopus fishing is the economic income derived from sale. During the questionnaire (octopus) fishers were asked to list their top three expenditures from the income earned from fishing. All of the octopus fishers (n=103) said their primary expenditure went towards fulfilling the day's food needs, (e.g. typically this would be some cassava, salt, fish and sometimes a coconut). A third of the octopus fishers interviewed listed food as their only expenditure. Of the remaining two thirds that listed a second expenditure, 48% said the money went towards clothes for children and 31% said it went towards hygiene products such as soap. Just over half listed a third expenditure. In this category, petrol for lamps was listed as the most common purchase (61%) and 13% said any extra money is spent on childcare, namely health and education costs.

It is also important to note that women were able to use octopus to access other benefits. Other uses of octopus were as a source of protein from direct consumption in the household and as part of a gift and exchange relations. Women often establish and maintain important social relations through gifting and exchange and octopuses are a useful item to do this with. This was observed in the village and informally reported by fisherwomen themselves. Examples given were gifting to members of one's extended family particularly if they were experiencing a hardship, such as a sick child, or to a fellow fisher who could not fish that day, which was often the case for fisherwomen who were nursing babies. Octopus were also used to repay favours such as free trips to the mainland. In times of need if a woman has a few pen shells, an octopus or some tiger cowries she may exchange them with her neighbour for some oil, salt or firewood to meet the day's food requirements; these exchanges occur with quantities not viable in the market place (often small octopus less than a kilo). These exchanges allow women a degree of freedom to exert their own influence over social situations and to invest in social relations in order to gain access to other resources. These contributions allow her to build and maintain social relations that make her less vulnerable to unexpected hardships.

7.4 Discussion

The objective of this chapter was to examine the range and role of institutions in a female octopus fishery. Specifically it aimed to explore the type of influence these institutions have on women's ability to benefit from octopus and to critically assess the how embedded gender is in octopus fishing.

This research is unusual on its focus on one particular fishing activity – octopus fishing – and this focus has been effected in order to demonstrate that institutional analyses can occur at finer scales than previously applied in small-scale fisheries research. The focus highlights that access to the benefits of octopus fishing can be mediated at several points. These points are the four nodes of access identified in the access map, i.e. access to octopus fishing sites, extraction of octopus, octopus market and the household. As this case study shows, small-scale fisheries management tend to focus on some but not all nodes of access. The QNP is conventional in its focus on access to marine resources and markets. This may be one reason why legal pluralism exists in the form it does, as discussed below.

7.4.1 Legal pluralism in the octopus fishery

Legal pluralism is common in many small-scale fisheries (Jentoft et al. 2009). This study found that women's octopus fishing on Ibo Island is no exception. There is a clear overlap and incompatibility between the QNP regulations on trade in marine species, and local customary norms in which the use and trade of marine resources is the right of local community members. This is because it creates a conflict between women (or people) practising what is seen as a right within customary law but perceived as rule-breaking behaviour within the national park. The same is true of access to the octopus sites, the second overlap identified between de jure and customary institutions on Ibo. Again here, restriction to certain spaces contradicts the customary norms of allowing access to all areas surrounding the island to community members. Using Bavinck's 2013 typology of relational forms between institutions, these two institutional forms are conflictual and because of this the QNP rules will be harder to implement (Bavinck et al. 2013; Wickramasinghe and Bavinck 2015). As de la Torre-Castro and Lindstrom (2010: 83) suggest in such

cases, these types of externally generated regulatory institutions that conflict with local norms may "*not be sufficient to underpin management*".

7.4.2 Institutions surrounding octopus fishing are (locally) legitimate but not equitable

The results identified twelve different institutions that influence women's access to the benefits from octopus fishing. These institutions were shown to operate all along the chain of access, from departing the house to fish to returning to the house with the money from the sale of octopus. Using Scott's (2014) categories, the institutions identified were predominantly normative (eight), then regulative (three), and then cultural-cognitive (one). The normative institutions are: fishing is only with the permission of one's husband; fishing trips are done in groups; fishing occurs mainly on Ibo island; rods are used to catch octopus; women do not trade octopus; octopus have a less favourable market price than most fin fish, and women hand over money from fishing to their husbands. Normative institutions were present at all nodes of access (that is: access to octopus fishing sites; extracting octopus; the octopus market; and the household). Regulative institutions that restrict fishing in certain areas, prevent fishing during the neap tide and prohibit the sale of octopus, were present at two nodes: access to octopus fishing sites and the octopus market. The cultural-cognitive institution of capturing octopus in dens along the reef flats was present at one node, that of extracting octopus. These findings indicate that to a large extent it is local normative institutions that determine how women interact and benefit from octopus fishing. Therefore women who fish octopus do so in a manner that reflects the social norms and values held on Ibo, over and above what may be in their own self-interest.

However, as Cote and Nightingale warn '*there can be trade-offs between equity and legitimacy where legitimacy emerges from the maintenance or enactment of highly hierarchical and exclusionary social relations'* (Cote and Nightingale 2012: 479). Women's octopus fishing on Ibo reflects this, i.e. it is legitimate, as the institutions surrounding octopus fishing are dominated by the normative pillar, however, adopting a broad institutional approach falls short in recognising the inequity embedded within these institutions. For women, what the community may consider a

legitimate institutional arrangement will not guarantee increased access to, and benefits from, octopus fishing. The sections below illustrate this point further.

7.4.3 The majority of institutions that structure octopus fishing were not designed for octopus fishing.

Institutions can have two types of influence on fisherwomen's behaviour: direct and indirect. In the first instance of direct influence, the findings suggest that only three of the twelve rules, norms and cultural cognitive behaviours, explicitly regulate when and where women may go fishing and how they may use the resource. These are the two QNP rules relating to the sale of marine resources and access to fishing areas and the customary norm that restricts fishing during the neap tide.

In the latter case of indirect impact on women's resource use, the nine other institutions identified are part of broader societal norms that structure community relations, which were not explicitly designed to influence octopus fishing. To illustrate, access to octopus fishing sites is tied to: a range of institutions including a) purdah restricting women leaving the house and their transport opportunities; and b) social networks that allow women to fish in groups. This finding illustrates what Wickramasinghe and Bavnick's (2015: 10) observe, that "although *an institution often possess a direct function, there are indirect functions too*". Purdah, which informs the normative practices associated with octopus fishing, is pervasive and influences octopus fisherwomen indirectly through its effect on gender relations.

An institution can have an effect at multiple points in the process of octopus fishing, and this influence can be manifest at each point in different ways. This concept provides a further elaboration on Wickramasinghe and Bavnick's observations about the direct and indirect influence of institutions. The most obvious example of this is the effect of purdah from public space that operates at several nodes along the chain of access. To illustrate, purdah not only influences women's ability to access fishing sites unaccompanied on the island, it also restricts women's off-island transport options, as male boat captains are reluctant to take non-kin related women. Further along the chain, it disadvantages women (in another way) at the point of sale, with mechanisms used to secure unfavourable prices and adding to women's labour

7.4.4 Gender relations power the enabling and constraining influences of institutions surrounding octopus fishing.

The fourth column in Figure 7.3 entitled 'outcome' gives an indication of the influence that the principal institutional practices associated with octopus fishing have on the activity. There are nine instances where the outcome can be seen to be restrictive. Apart from the more obvious QNP regulations, the majority of these restrictive practices pertain to purdah from public space but also include the showing of money in the household. What makes these acts restrictive are the power relations between men and women that play out within these interactions. To secure the income from octopus fishing, women must negotiate these uneven power relations at the point of sale through which prices are secured, and at the level of the household when negotiating access to the intertidal zone (permission to fish). After which the custom (i.e. institution) of showing money must then be negotiated if the woman is to maintain the benefits from the sale of octopus. An intervention to increase the benefits to women that focused solely on enabling women to secure a higher market price will have no benefit if she cannot access the money within the household. This finding is corroborated by Nunan (2015) in her review of fishing institutions in Malawian fisheries. She shows that gender relations influence how institutions shape benefits. The example she gives is from Bene and Merten (2008) who observed that it is not enough for women to have a licence to trade fish as they may also be obliged to exchange sex for access to buying (Béné and Merten 2008).

On the other hand behaviours may exist that allows an individual or group to benefit from the resource: these are referred to as enabling institutions. Enabling practices have qualities that may be harnessed to decrease the restrictive nature of institutions. In this case study it can be seen in the practice of group fishing. Women formed social relations with other women to enable them to go octopus fishing. Women's inclination to work in female only groups to go octopus fishing suggests that solutions to restrictive gender norms may be through group work. Same-sex group fishing is a characteristic favoured by adherents of purdah, which is chiefly

concerned with maintaining women's honour through constant supervision in the public sphere. Nonetheless, these findings suggest that women have to face more constraints than opportunities to obtain the benefits from octopus, and that the practice of octopus fishing requires a degree of initiative.

For fisherwomen, particularly in northern Mozambique, gender relations permeate nearly every aspect of their behaviour. Therefore research cannot rely on, nor should it expect to find, well-structured or locally legitimate institutions that increase the benefits women receive from natural resources. Hence it is essential for scholars to deal explicitly with gender relations within any institutional arrangement in small-scale fisheries.

Discussion

Chapter 8

Fisherwomen on the intertidal zone, Ibo Island.

Chapter 8 - Discussion

8.1 Synthesis

The poor understanding of fisher behaviour has contributed to failures in fisheries' management that many believe has significantly contributed to the global fisheries' crisis (Wilen et al. 2002; Salas and Gaertner 2004; Fulton et al. 2011:5; Jentoft and Eide 2011). Fisherwomen stand to be disproportionately affected by poorly adapted and inappropriate interventions and policies that have not taken into account their fishing practices and needs. Following on from the increased recognition of the importance of women in SS fisheries (Kleiber et al. 2015; Baker-Médard 2017) this study makes a contribution to the evidence base needed to improve the outcomes of SSF interventions for fisherwomen.

In order to reflect fishers' perspectives as accurately as possible the research used participatory and anthropological methods to draw out fishers' knowledge of the social-ecological system. This helped to boost the explanatory power of more quantitative approaches that highlighted general trends (Flyvbjerg, 2005).

The intertidal ecosystem is known to be of great importance to fishers in Mozambique, and the wider WIO region. However intertidal fisheries are poorly understood systems, under a range of threats, and in urgent need of management approaches that, above all, include local people (Nordlund et al. 2014). To address the need for approaches that incorporate the 'human dimension' (Fulton et. al, 2011) this research focused on the social dimensions of the four sub-systems of the social-ecological system framework, using a female intertidal fishery as a case study. This included:

1. Social political and economic setting of the intertidal fishery (Chapter 4). This chapter illustrated how setting can act as an indirect (ultimate) driver that impinges on catch size, target species and fishing grounds.
2. Social-environmental elements of the resource system (Chapter 5). This chapter explored how environmental (resource system) and socioeconomic (user) characteristics of an intertidal octopus fishery influence women's daily decisions on how often and where to fish octopus.
3. Social-economic characteristics of fisherwomen (users) (Chapter 6). This

chapter explored the relationship between fishers' socioeconomic profile and fishing effort, measured as number of trips a year, in order to understand if fisherwomen's personal circumstances vary, and if this had any bearing on how often they fish and how much they catch.

4. Social institutions governing resource use (Chapter 7). The final layer of analysis assessed the behavioural rules that govern octopus fishing and income. The analysis explored institutions at the local level in order to understand the most dominant modes of behaviour associated with this activity and which ones enabled or constrained fisherwomen's access to and benefits from octopuses.

The remainder of this chapter discusses the dynamics of this particular social-ecological system and revisits the original research themes introduced in the introduction chapter; women in small-scale fisheries; the drivers and dynamics of fisher behaviour, management considerations and concludes with future research directions.

8.2 Socio-ecological dynamics of female-dominated intertidal fisheries on Ibo Island

This research follows the shift towards studying SSFs as complex social-ecological systems, and in particular calls for a 'broader understanding of human behaviour into the study of SES's' (McClanahan et al. 2009; Nordlund et al. 2010; Cullen-Unsworth et al. 2014; Schlüter et al. 2017: 33). The SES approach provides a framework in which to i) investigate fishing behaviours i.e. the interaction between users (fishers) and resource units (intertidal resources) ii) understand how factors (or drivers) interact with each other to produce different social and ecological outcomes, and the implications for the sustainability of the system, and iii) create interventions specific to the characteristics of the system (Ostrom 2009; Kittinger et al. 2013). Key insights that have emerged from the research into the SES dynamics of female intertidal fisheries are summarised below.

This research highlights some of the complexities of a female dominated intertidal fishery system in the Quirimbas Archipelago. The 'resource system' is characterised

by daily, monthly and seasonal variability due to changing tides, winds and seasons, all of which strongly influence catch and therefore fishing effort. The intertidal 'resource units' are not distributed equally in space or time, and fishers display a good knowledge of resource abundance and location during the year. Fisherwomen's resource use shows a degree of inter-dependence, with fisherwomen switching between different resources through the course of the year as abundance and conditions change, and through the course of their own life time as the broader 'setting' changes. However, fisherwomen's effort and site selection is not only influenced by the characteristics of the 'resource system' and 'resource units', but also by the 'governance system' in which their fishing is placed, and by their own 'user' circumstances. For example, while fisherwomen desire to maximise catch - which is conditions-dependent - their effort is constrained by prevailing gender norms and social taboos. Their site selection is also affected by social, political and economic factors, many linked to broader changes in the social-political 'setting' in which fishing is placed.

Despite the role of non-environmental factors in influencing fisher behaviour, on aggregate octopus fisherwomen's daily effort is relatively predictable over the course of the year, due to the link between daily effort and environmental factors. However, despite this, within this 'fisher group', there is a high degree of variation in frequency of fishing during the course of the year, which can be linked back to the characteristics of the 'users' with fisherwomen showing characteristics of vulnerability appearing to fish more. Not only do the most frequent fishers have limited other livelihood activities, but on aggregate fisherwomen as a group are constrained in the types of fishing they can do due to gender norms dictating the types of gears they can use.

In light of the above mentioned points the outward aspect of this female intertidal system on Ibo Island appears to be that it is increasingly more difficult for women to access the economic benefit from intertidal fisheries for various reasons. The social political and economic setting (e.g. changing markets and coastal developments) has increased fishing pressure on women's intertidal fishery resources. Operating within this setting are local and non-local institutions that are severely limiting women's

ability to distribute their effort more sustainably (e.g. to harvest less depleted sites off island or switch to other activities) through placing restrictions on their movements and livelihood options. The interaction between external drivers and internal institutions operating on the female intertidal fishery has had a detrimental impact on the abundance and diversity of its resources.

Critically few alternative income-generating options for women exist and due to institutional barriers women feel that they cannot consider alternative fisheries by travelling further or switching gears. The interaction between the setting and governance system reinforces and exacerbates pressure on marine resources targeted by women. This is because the more fisherwomen are limited in their choice of fishing grounds, the more they will continue to fish what are already depleted areas, and the more they fish depleted areas the more the sustainability of the fisheries is threatened, and their livelihoods too, as the income from these resources diminishes. Kittinger et al (2013) describe such a phenomenon as a social-ecological trap. Social ecological traps arise when social process and ecological dynamics interact to reinforce the negative situation the system is already experiencing. However this trap does not apply to the system as a whole but to fishers who are most exposed to the social processes and mechanisms outlined above. The socioeconomic profiles of octopus fisherwomen indicate that those women who exert the highest fishing effort, are more likely to be caught in this social-ecological trap. This is because these women have socioeconomic characteristics such as a limited education, a lack of other income sources, a lack of capital, young dependents (either children or grandchildren) that restrict them from leaving the fishery to pursue other livelihood activities. The octopus fishery, in its relatively open access and immediate return nature, is able to provide this essential service for a core set of women. This is a similar finding to that found in Cinner et al.'s (2009) investigation of socioeconomic factors that affect fishers' willingness to exit a fishery. The authors showed that poorer fishers were less willing to leave a declining fishery. In the case of fisherwomen on Ibo it may be that more vulnerable women are less able to leave the fishery.

To conclude, the emergent properties of women's intertidal fisheries on Ibo indicate that it is unlikely to be sustainable from a social, ecological or economic perspective. Ecological sustainability: there appear to be some intertidal species, such as octopus and fin fish that are more resilient to fishing pressure, however in light of the depletion of seemingly less resilient intertidal resources, namely oysters, cockles and pen shells, octopus and intertidal fin fish fisheries are likely to be threatened by increasing fishing pressure. Economic sustainability: women reported that overall their catches are declining, meaning their income is reducing at a time when food prices are rising, and their access to alternative income sources remains relatively unchanged. Social sustainability[58]: women's lack of flexibility in the range of fishing strategies and tactics they can employ limits their ability to adapt to a changing SE system. Women's participation in the octopus fishery may come under threat (as has already happened in parts of Tanzania) by the expansion of invertebrate fisheries in response to declining fin fisheries in the WIO region (Porter et al. 2008). This may lead to conflicts between fishermen and women on Ibo as male fishers are able to free dive, travel further offshore and harvest longer, outcompeting women for local resources[59].

8.3 Fisherwomen in SSFs

This thesis used both quantitative and qualitative methods to address the gap in knowledge on fisherwomen in SSFs. As section 8.2 shows, fisherwomen are an integral part of the social-ecological system with distinct system characteristics and links, the outcomes of which capture women's unique positioning in the fishery and community as a whole. Under the theme of fisherwomen in SSFs, this section will discuss some general observations on women in fisheries that emerged from the thesis, specifically catch data and local knowledge and before moving onto discuss the key findings on the drivers of fishing behaviours.

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[58] As viewed in terms of women's engagement in fisheries

[59] The vignette in chapter 7 illustrated this when women were observed complaining that men were in their space

Fisherwomen's catch

Women's octopus catches were quantified over the course of a year. Although this data is a snapshot, it is the first comprehensive survey of women's octopus catch and fishing behaviour in the Quirimbas region. The catch data showed that on average women catch 3.5kg per trip and that this could fluctuate by about 1kg over the seasons and between fishing sites. This could provide useful baseline information for ongoing initiatives in Quirimbas national park. The catch survey showed fisherwomen extracted approximately 7085.6 kg of octopus in the year. The highest earning women earned 508.50USD/year (42.38US$ per month), while the average income was 34.80USD/year (Chapter 6). Although it may not seem much, and in a sense it is not, it does illustrate that it does make a much needed economic contribution in a context of increasing poverty levels in Cabo Delgado[60] (Ministério De Economia e Finanças 2016).

Local knowledge

As management of small-scale fisheries in developing countries largely takes place in 'data poor' contexts it is important to acknowledge the value of women's local knowledge in providing new insight into the challenges faced by fishing communities. Fisherwomen's knowledge of social and ecological changes to their intertidal fisheries helped to identify longer-term drivers of change and how they influenced their fishing strategies and, perhaps most importantly, what this means in the context of their lives. Specifically, women provided detailed information on the state of decline of ornamental shell fisheries, the relative resilience of fin fisheries

[60] Cabo Delgado, where Ibo Island is situated, has seen an increase in the level of poverty between 2008/09 and 2014/15 from 55% to 60%.

and the growing economic importance of the octopus fishery. Women's reported change in the seasonal productivity of their intertidal fisheries from the dry to the wet season provided new insight into what changes in the intertidal fisheries mean to fishing based livelihoods. On many fishing communities in the Quirimbas Archipelago the dry season months (June-September) are an opportunity to stockpile intertidal marine resources (Riddell and Rosendo (2015). Riddell and Rosendo (2015) showed that fishers' income is seasonal and that in the dry season there is a preference to sell stockpiles of dried marine resources. Income derived during the dry season therefore often occurs in bulk, which provides some savings to rely on through the early wet season months when fishing returns were less reliable and when farms were yet to yield a crop.

8.4 Drivers and dynamics of fisherwomen's behaviour

Studies of large-scale, male-dominated fisheries still dominate our understanding of fisher behaviour (Wilen et al. 2002; Salas and Gaertner 2004; Tidd et al. 2015) and studies often focus on one component of behaviour rather than considering resource use as part of a complex social-ecological system. There is also a tendency to examine the links between resource abundance and fisher behaviour, ignoring the broader social and political drivers of behaviour. This thesis aimed to address this imbalance by providing empirical case study evidence on the drivers and dynamics of fisherwomen's behaviour, within the framework of a socio-ecological system. The findings of this research can be summarised in relation to the different aspects of fisher behaviour examined, which included fishing effort, choice of fishing location, target species, and gear choice. Whereas the drivers and dynamics occurring in this system are numerous, and not all captured by this thesis, the dominant ones captured reveal a lot about the SES and are summarised as follows.

- Fishing effort (long and short-term): fisherwomen's daily fishing effort is influenced by environmental factors, namely tide, winds and season, and one socioeconomic variable, household head status (Chapter 5). Considered across the course of the year, a fisher's socioeconomic profile also influences their effort allocation in this octopus fishery (Chapter 4), and there are a number of direct institutional influences on effort, including taboos

surrounding fishing in the neap tide, requirement of consent from one's husband to go fishing, and changes in octopus demand between seasons (Chapter 7).

- Fishing location (short-term): fisherwomen's choice of where to fish on any given day was influenced by a number of factors, the most important being travel time, familiarity, suitability, proximity to agricultural fields, and resource abundance (Chapter 5). Fisherwomen's access to intertidal zones is also affected by the presence of a no-take zone in Ibo bay, and their very limited access to transport, which is mediated by men (Chapter 7).
- Fishing location (long-term): fisherwomen's access to fishing grounds over the longer-term (Chapter 4) was significantly limited due to access and transport issues, linked to the broader social-political setting including a shift towards exclusive conservation and tourism, government fisheries policy, and fishers' changes in personal circumstances (age, health and residency).
- Target species: fisherwomen's choice of target species was largely influenced by resource (species) abundance, markets (for species with a cash income value), and personal circumstances (age, health and residency) (Chapter 4).
- Gear choice: gear choice is largely affected by gender norms, and prices of different gears, which can prohibit purchase (Chapter 7).

While it is clear that there are a number of factors that drive fishing behaviours, breaking down fishing behaviour into its component parts was useful to compare how drivers affect different aspects of behaviour. A confounding factor of many studies on fisher behaviour is that they examine multispecies fisheries, and capture different time scales, and so the identified drivers of effort will be determined by the scale of analysis (Guest, 2003; van Putten et al. 2012). In some cases the same aspect of fisher behaviour was influenced by different drivers when considered over different time scales: for example, fishing location has been influenced by conservation and tourism and fisheries policy over the last 15 years, while choice of fishing location on any given day (essentially a snapshot) is influenced largely by local social factors. What follows is a summary of how the different sub-components of this system were shown to influence fishing behaviours.

8.4.1 Social-political setting influencing fisherwomen's behaviour

Social-ecological frameworks illustrate that the sub-systems all operate under the influence of social, economic and political settings . In the context of SSFs research, Kittinger et al (2013) highlight that a number of external drivers present significant challenges to fisheries' managers, due to their influence on local drivers of change. In this study, social-political setting, or longer-term drivers, influenced women's fishing behaviour both directly and indirectly. Directly, women's choice of fishing location was influenced by policies surrounding conservation, tourism and fisheries, while women's target species for cash income was influenced heavily by changes in the wider marketplace. Indirectly, broader changes in the social-political setting influences all aspects of women's fishing behaviour.

The focus of this research was on what Kittinger et al (2012) refer to as 'proximate' drivers – those direct relationships between the users and the resource system and units. Despite this, when fishing behaviour is considered over a longer time period it was clear that women's choice of location was most significantly influenced not by resource abundance, but by access and transport issues related to the shift towards tourism and conservation, and changes to fisheries' policy reducing women's access to transport options. This has effectively 'enclosed' fisherwomen's fishing grounds to those that are on the island itself, leading to the current spatial-temporal fishing patterns described in Chapter 5. Elsewhere coastal developments have been shown to be a dominant force affecting local communities (Duffy 2006b), and it is not uncommon for the conservation-tourism nexus to restrict access to natural resources in this way (Brockington and Duffy 2011). In northern Mozambique, this type of fisheries' enclosure is projected to increase as there is a growing presence of oil and gas companies and tourism operators, underwritten by supportive government economic policy.

In addition to access issues due to coastal development, the social, political and economic setting has also influenced the market for marine resources. Crona et al. (2015) and Aguilera et al. (2015) both illustrate how coastal developments – mainly markets – produce 'social-ecological syndromes' or 'regime shifts' that change the nature of SES significantly. In this case study, the longer-term changes to the

seafood and ornamental market on Ibo was a major factor influencing women's selection of target species for income, but not for subsistence. This market place was also affected directly by the establishment of Quirimbas National Park, which banned external traders thereby creating a niche for local traders, which altered the trader-fisher dynamics, as illustrated in Chapter 7. Both these social-political drivers directly influenced women's choice of fishing location and target species over the long-term.

8.4.2 Social-environmental elements influencing fisherwomen's behaviour

This research illustrated that environmental aspects of the resource system, such as tide, wind and seasonality, and aspects of the resource units, namely resource abundance strongly determined fisherwomen's daily fishing effort and, to a lesser degree, fisherwomen's choice of fishing zone and their target species. Interestingly, while previous thinking and research has focused on resource availability or potential profit as a way of predicting fisher behaviour (Tidd et al. 2015) – particularly in how they allocate their effort in space – this case study illustrates that, despite the influence of environmental and resource availability factors, a number of social factors more strongly influenced daily decisions on where to fish.

Hence, although the results reiterate the importance of resource availability on fisher effort, the findings also caution against conceptualising fisherwomen as 'profit maximisers' driven by a singular dominant economic (or ecological[61]) factor[62]. The empirical data presents a more nuanced perspective to this debate, and this is most clearly demonstrable when fishing effort in time and space is viewed distinctly and when distinguishing between aggregate behaviour and individual behaviour.

On aggregate, octopus fisherwomen are less likely to go fishing on days when the environmental factors, wind or tide are not favourable, or during the rainy season

[61] If seen as a proxy for profit

[62] as depicted in the IFD model

when there is less demand for octopus in the market. This finding suggests that fisherwomen employ strategies to fish only during the most favourable times, indicating that there is a profit nexus to their behaviour. On the other hand, on examining individual level behaviour the catch data showed there are some women who do continue to harvest on these less favourable days (Chapter 5). This phenomenon was not systematically studied in the thesis but is likely due to fisherwomen's personal circumstances as described in Chapter 6. It is likely that fisherwomen who are more vulnerable to daily food insecurity, have to prioritise securing something (any catch) over any desire to maximize catch rates. Thus it is possible that more vulnerable women show less of a profit nexus to their behaviour on a daily basis due to their personal circumstances.

Women's short-term site selection showed a profit nexus (Chapter 5) in that the main reason they did not distribute themselves 'optimally' i.e. maximising their profit, was due to travel time – an economic cost. The social factors: fishing experience in the area, social networks with other fishers and proximity to the farm featured less often as a reason for site selection. Chapter 4 indicated that over the longer-term resource abundance had a more salient relationship to target species as the majority, circa 60%, of women mentioned this as a reason for targeting resources. At this scale, fishing location choice was influenced by other social factors, for example if they married and moved they may switch intertidal zones, or if they became ill or old they may opt for a closer site.

Preliminary conclusions from this, and worth exploring in future research, suggest that fisherwomen may in fact desire to be profit maximisers but certain social and environmental elements of the resource system prevented them from fully achieving this objective.

Finally it is worth noting that preliminary evidence from chapter 5 suggests that there may be subtle but important differences in the indicators that drive men and women's location of fishing trips. Whereas the categories of drivers, e.g. economic and social, are universal and have been recorded in male-dominated fisheries. In this case the factor dominating women's spatial decision-making are non-cash based economic indicators of travel time and proximity to the farm. Chapter 5 shows that

even what seems like a relatively small additional travel time of 15–20 minutes is significant to women, who have a number of domestic duties to attend to. Lactating women for example are particularly pressed for time when fishing and often have to leave their child with someone en route to the intertidal zone, and rush back from their fishing to attend to them. Research suggests that in male-dominated fisheries spatial choice is more related to cash inputs into fishing, probably due to the need to purchase and renew fishing gears, and the more remote nature of fishing grounds requiring transport investments (Daw, 2008; Béné and Tewfik, 2001; (Pet-Soede et al. 2001).

8.4.3 Social-economic attributes influencing fishing behaviour

As the above section showed, fisherwomen's' socioeconomic attributes influenced when and where to go octopus fishing on any given day, and also longer-term changes in fishing location (due to age, health or residency). The construction of socioeconomic profile groups helped to make understandable the influence of women's personal circumstances on fishing effort over the year. Fishers' activities are known to be embedded in the local socioeconomic context (Jentoft et al. 1998), and is this evident in the female octopus fishery on Ibo.

It is not surprising that the socioeconomic characteristics of fishers influence their fishing effort, and Ostrom (2009) notes that these 'resource user attributes' can influence extraction levels. However rather than considering socioeconomic factors individually and their influence on fishing behaviour this research considered these factors together as a socioeconomic profile. This approach helps unpack the variation in women's personal circumstances. Chapter 6 illustrates that within fisherwomen there appear to be three groups with similar socioeconomic characteristics. One group were under 30, had few material assets and an education. Another group were in their 30s and 40s, were married, and came from large-sized households. The third group were in their 50s and 60s, lived without a male head[63] and combined fishing with farming. In this case study offtake of octopus between fisherwomen was highly

[63]which is socially more acceptable for older women

variable over the course of the year, with 13% of women recorded in the catch survey accounting for 59% of octopus offtake. This research showed that there is a link between these socioeconomic groups and the frequency at which women fish for octopus. The ethnographic methods used in this research suggest that the women in the younger and older profile groups have to go fishing often in order to buy food for themselves and their dependents. Interestingly the livelihood options of these two groups is different with the younger group being educated but not yet having the material assess to enable them to carry out other livelihood actives. Whereas the older group are from a generation that was not education yet they have been able to accumulate assets to allow them to carry out other livelihood activities, mainly farming. Neither the younger or older group appear to have to capacity to exit the octopus fishery and are essentially locked into a social-ecological trap.

Not only do women's personal circumstance affect their frequency of fishing but Chapter 4 showed that over a longer time period, women's circumstances – for example their health, age and residency – all influence the sites women choose to fish and their target resources. These findings point towards the importance of women's individual circumstances on their fishing behaviour.

8.4.4 Social-institutional elements influencing fisherwomen's behaviour

The social-institutional setting, referred to as the governance sub-system by Ostrom (2009), both directly influences women's fishing behaviour, and underlies many other aspects of fisher behaviour.

Directly, there are institutions influencing women's fishing effort and fishing location. Fishing effort is largely influenced by normative institutions, such as social taboos that reduce the likelihood of women fishing during the neap tide, and the fact that married fisherwomen require consent (*purdah*) from their husbands in order to go fishing (Chapter 7). Chapter 4 also shows that regulative institutions of QNP influence where fisherwomen can fish due to both the existence of the no-take zone on Ibo Island and tourism lodges on neighbouring islands.

Indirectly,gender norms and relations underlie many aspects of fisherwomen's behaviour on Ibo. Culturally, women do not own or use boats themselves, and their

social-cultural fishing space is limited to the intertidal zone which they can access on foot. Women do not use the same gear types as men, and although they fish with nets, these are of a different type than those used by men. This social-institutional context therefore restricts women's access to other fishing sites, means they are dependent on men to access these other sites, and supports other studies that have shown this is the case elsewhere (Harper et al. 2013; Weeratunge et al. 2010). Interestingly, in a male-dominated declining drag net fishery in Tanzania, Wallner-Hahn et al. (2016: 206) illustrate that gear choice is influenced by "deeply rooted normative and cultural-cognitive factors like comradeship". Hence the fishermen's decision to continue using a destructive and less productive gear can be understandable from a longer-term social-institutional perspective.

Gender norms on Ibo, and in surrounding Mwani coastal communities, dictate that women are responsible for the reproductive and household duties, and for economically productive activities such as agriculture. This context leaves women with a high charge of duties, and underlies their relatively restricted time, and, therefore, indirectly influences their fishing behaviour. Fisherwomen's need to request consent, and their dependence on their husband, means that their behaviour cannot be considered as individual behaviour, or at least it needs to be considered in relation to the broader household economy. This intricate link between fisherwomen's behaviour on Ibo and gender norms supports the call for gender relations to be more explicitly incorporated in studies on fisherfolk (Frocklin et al. 2014). There are many ways to do this, but first it requires a cognitive shift throughout SSFs research on the concept of fishers as incorporating both genders (Branch and Klieber, 2017).

8.5 Ibo Island and WIO management considerations

As Kittinger et al. (2013: 353) state, one of the strong points of SE research is its ability to "identify management practices that either enhance or jeopardise the sustainability of a SSF in the face of these pressures". The diversity of drivers, their characteristics and their interactions, indicate the need for what Kittinger et al. (2013) refer to as the 'diagnostic approach' to managing SSFs that better reflect the social-ecological context in which fishers operate. The SE approach helped in this

case to identify some of the emergent properties of the female intertidal fishery on Ibo with implications for fisheries' management. These implications are discussed here in relation to the four overall themes of this research: the social-political, social-environmental, social-economic, and social-institutional. While some of these implications, particularly the social-environmental, can be transformed into useful recommendations, others are broader implications that are useful to bear in mind, but might not be practically implementable by those fisheries managers working on a local-level.

Fisheries management is not a technical issue alone that can produce quick-fix solutions, but a social and political issue that requires a holistic perspective of fisheries (Degnbol et al. 2006). This thesis shows that using a social and ecological framework illustrates that fisher behaviour responds to a wide range of different drivers that are in themselves linked to processes such as wider social, political and economic changes, environmental factors, socioeconomic circumstances and institutional norms. This is important as there is a tendency in fisheries management and marine conservation to focus on the proximate drivers of change, as these are perceived as being within the practitioner's control (Kittinger et al. 2013). Ignoring ultimate drivers of change may lead to unintended outcomes. For example, this case study shows that the Mozambican government's economic, environmental and fisheries' policy shift towards promoting a tourism-conservation nexus, and having a less direct approach to fisheries management has severely restricted the number of fishing sites women can use. Despite this, the dominant approach to fisheries' management in the region is to introduce more spatial restrictions on fishing effort, such as marine sanctuaries and temporary octopus closures in Quirimbas National Park. These local-level measures aim to reduce or displace fisher effort in time and space, but do not address the underlying factors that drive people to fish.

The influence of external drivers and gender norms on fishing practices raise important questions as to how to implement spatial regulations in this context. Not only do periodic octopus reserves influence effort over time, they also influence access to particular fishing zones. Teh and Meitner (2012) caution against any spatial regulations that assume that fishers can redistribute their fishing effort elsewhere,

which is an important assumption of octopus temporary reserves (Benbow 2014). This study illustrates that fisherwomen on Ibo Island would likely exhibit low flexibility to adapt to spatial restrictions on effort, because travel time is a significant constraint and ultimate drivers have restricted access to fishing sites off the island. As octopus temporary reserves are often placed closer to villages to allow for surveillance (Oliver et al. 2015), this would have implications for women's travel times and should be carefully planned with fishers. The work also shows that seemingly small factors, such as the degree that each zone wears down your sandals, can influence women's use of a fishing site, and are important barriers to understand at the local level. Therefore, management measures to increase the number of areas accessible to fishers may appear to contradict widespread management approaches to create no-take zones but, within this context, could promote a more sustainable social-ecological system, as women can continue to benefit from fishing but spread their effort more evenly.

These research findings show that functional groupings often applied in fisheries management, such as 'octopus fisherwomen' in this case, can hide important social differences. This has two obvious implications. Firstly, this case study shows that fishers within the same functional group fish with different frequencies, and that in the case of octopus fishers this appears to be related to characteristics of vulnerability. Fisheries managers need to consider whether to deal with the structural issues related to vulnerability (as a fisheries' manager), or just to accept as the status quo, and only implement certain management measures that have the least damaging livelihood impact. This in part depends on the capacity and resources that exist within fisheries' management programmes that can be allocated to these social issues. This will rely on developing partnerships with organizations and government departments with skills that can be targeted towards these social issues that influence fisheries. On Ibo this could mean providing women with the necessary skills they need to expand their income generating activities but also addresses the institutional issues associated with women as active economic agents in a community with pervasive gender norms. Therefore, skill development could be accompanied by gender awareness, targeting both men and women. Gender norms are part of slow

moving and multifaceted institutions (Maricela de la Torre-Castro and Lindström 2010), and fisheries' managers should be cognizant of this when setting time frames.

A second implication of this variation within a functional group, is related to representation in fisheries management. In northern Mozambique fishers are represented in co-management through the local fisheries committee (CCP), which must include a minimum of 25% women. This case study illustrates that fisherwomen, let alone women more generally, have very different personal circumstances and frequency of fishing. This should be borne in mind when working with female fishers, to ensure that opportunistic fishers, who might be wealthier or less vulnerable than frequent fishers, are not representing fisherwomen on the whole.

From an institutional perspective, the application of Scott's (2014) typology of institutions, previously applied in a SSFs context by de la Torre-Castro and Lindström (2010), illustrates the importance of norms and beliefs in influencing fisher behaviour in relation to introduced rules and regulations. Therefore ecosystem-based approaches, which are scientific-technical in their nature – and based on the application of new rules and regulations – could benefit from taking into account the additional 'institutional pillars', rather than a narrow focus on stricter regulatory measures. This approach would aim to understand the existing institutional context – local norms which influence behaviour – and build those which are socially and environmentally favourable into new management measures. This approach is more likely to be locally legitimate, and could have greater success in influencing behaviour (Agrawal and Benson 2011).

This research identified some specific issues that might have a bearing on fisheries management on Ibo:

- As octopus fishing effort was highest between July and October, periodic octopus closures during this period would have a greater cost.
- There is more fishing effort in Cumwamba compared to Mwembe, and yet catch is higher in Mwembe than Cumwamba; selection of periodic closures should take into account the different roles of these fishing zones.
- Temporary or periodic closures are often situated adjacent to communities to

allow for easy monitoring. This may be acceptable if the reserve is not too large, but if the reserve alters travel distance too much (e.g. 20 minutes) then this could prevent women from accessing a fishing site.

- Any management activities designed to offset fisherwomen's costs due to spatial restrictions should include measures to address women's vulnerability status, such as Village Savings and Loans Associations (VSLAs), training in literacy and employment skills.
- Prevention of access to one intertidal resource targeted by women is likely to lead to increased fishing pressure on another, considering that women switch between intertidal resources. Management measures addressing the use of one resource are likely to have a knock-on impact on the use of others.
- Managers should not interpret lack of formal groupings as an absence of institutions; instead they should build-on existing informal ties women use to fish and conduct other activities, and understand and build on customary norms such as not fishing during the neap tide.
- Men's (husband's) consent is a prerequisite to any intervention that involves fisherwomen. Sensitising husbands to what their wives may be doing (e.g. participation in a savings group) is a way of achieving higher levels of participation from women in this context.

8.6 Directions for future research

Within the framework of a PhD working in the local conditions, it was not possible to study the full range of women's fishing activities on Ibo. Net fishing, including mosquito net fishing, is the other main fishing activity with a cash income available to women. Working in the region since 2006 and having had the opportunity to work with surrounding communities, and meeting with fisherwomen from other communities, confirmed that octopus fisherwomen carry out the activity in much the same way: under restrictive gender norms, under varying amounts of intertidal resource degradation and in the context of coastal developments. Hence, the research on octopus fisherwomen presented in this thesis might well be representative of the region's female octopus fishers. However, generalisations across different types of

fisheries are ill-advised. For example net fisherwomen's activities are embedded in a different dynamic. They are known to have a higher barrier to participation due to the cost of nets. Net fishing also has a history of conservation concern as it captures juvenile fish species that are often thought to be key to the functioning of adjacent coral reefs. Insight into the social-ecological dynamics of the behaviour of net fishers, and other fishing activities, can be achieved through more case studies using catch and effort statistics of fishers, and their behavioural dynamics.

This thesis illustrated the high degree of socioeconomic variation within a specific fisher group, illustrating the benefits of considering more than one socioeconomic factor – such as the binary (gendered) analysis that has previously been used in SSFs – in understanding the linkages between fisher's profiles and their fishing behaviour. Although this thesis made a first step towards understanding social diversity among fisherwomen, this type of analysis can be applied more broadly in SSFs to understand the variation in other gear types and fisher groupings commonly used. This could be approached through the lens of intersectionality, as it parallels SES theory in recognising the dynamic links between factors in creating the circumstances under which fishers operate, and uses ethnographic methods. Similar to this research in an intertidal fishery, this type of research could provide understanding on peoples' circumstances, and allows fisheries managers to tailor-make interventions.

In the context of decline in resources that female fishers use, and management measures that aim to prevent this decline, it is important to generate evidence on how fishers adapt to such changes. While chapter 4 aimed to explore long-term changes and drivers of women's intertidal fisheries with implications for their ability to maintain their catches, further analysis should consider the whole range of fisherwomen's livelihood options in such a context. Fishers' ability to adapt in the face of rapidly changing SSFs is critical to prevent livelihood decline. As some groups of octopus fisherwomen showed clear signs of vulnerability in their livelihoods, investigation into their adaptive capacity is a pertinent next step to preventing their situation from worsening.

8.7 Conclusions

Women's fishing has been poorly documented and studied. This research examined a women's intertidal fishery in northern Mozambique in order to provide empirical evidence to address this knowledge gap. The findings illustrate the complexities of this social-ecological system, with significant variation in the spatial and temporal dynamics of fishing behaviour. This case study highlights the range of drivers that can influence women's fishing behaviour, including the environmental conditions that characterise the intertidal zone, and several context-specific social, economic and political drivers. Octopus fisherwomen on Ibo Island are not a homogenous group, and some of the most frequent users appear to be caught in a social-ecological trap. The importance of gender norms in influencing fisherwomen's behaviour is evident in every aspect of this fishery, and needs to be taken into account in the understanding of small scale fisheries more generally. In contexts such as this, where coastal enclosure has already restricted fishing to particular fishing grounds, fisheries managers and conservationists who aim to enable a sustainable social-ecological system, should be extremely considerate of the local setting and sensitivities to new management measures. From a research perspective, the application of mixed-methods, and particularly ethnographic methods, is necessary to understand the complexities of fishing behaviour, and should be considered prior to fisheries interventions. From a practical perspective, engaging directly with the most frequent fishers to involve them in management is essential.

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APPENDICES

Appendix S2: Supporting Information for Chapter 2 (I- IV)

I - Table of livelihood activities on Ibo Island (source: Wosu and Riddell, 2006; page 13)

Livelihood activity	Activity type	Type of harvest	Market	Group
Fishing	Net fishing (cavogo, jariffa) by boat -boat owner -boat captain -fishermen	Fish, prawns, turtle	Ibo, mainland	Men
	Trap fishermen	Fish: medium-low quality	Ibo, mainland	Men. Often older men trap fish
	Line fishermen	Fish: high quality (groupa, barracuda, rock fish)	Ibo, mainland IIS	Men
	Spear fishermen	Fish: high quality. Lobster Sea slugs	Ibo, mainland	Men
	Fence/ gamboa fishermen	Rays	Ibo, mainland	Men and women
	Crab fishers	Crab	Ibo, mainland	Men
	Cowrie/ ornamental shells	Cowries, e.g. helmet shell	Transported to Tanzania	Women and children
	Bivalves/ molluscs	Bivalves/ molluscs	Ibo, mostly consumed	Women and children
	Octopus Fishing	Octopus	Ibo, mainland	Women predominantly. Some men
	Small net fishing by foot (mosquito nets)	Small fish and fry	Ibo, mainland	Women, children, some men
	Torch/ night fishing	Fish and crabs	Ibo, mainland	Men
	Shark finning	Sharks	Tanzania	Men: usually Tanzanians
	Oyster Fishing	Oysters	Ibo	Men

Agriculture	Farms (mainly on south of Island, some small plots within community)	Main crops: Cassava, maize, rice, sweet potatoes.	Ibo and consumed	Women
	Farms	Pumpkins, coconuts, papaya, beans (x2 species),	Ibo, Quirimba	Mainly women but also men (some full-time, some when not fishing)
	Vegetable plots (mostly within community)	Tomatoes, lettuces, onions, peppers, chilli	Ibo, Quirimba	Mainly women
	Coffee	Two major machambas, some in small gardens	Ibo and tourist lodges	
Domestic livestock	Livestock	Cows, goats, chickens, duck, guinea fowl,	Ibo and tourist lodges	Men and women
Non –timber forest products	Cashew		Tourist lodges	Men
	Honey	Honey from mangroves and from the Island forest	Tourist lodges	Men
Building and material use	Boat makers	Mangrove wood	Ibo, Quirimbas	Men
	Stone collection	Coral stone, small stone	Ibo, local projects	Women
	Lime production	Cutting mangrove wood, crushing limestone	Ibo, local projects	Women and men
	Wood sale	Mangrove and forest wood for firewood and construction (clakas for fences,		Women predominantly
	Brick building	Using earth to make bricks for houses	Ibo	Men

II - Fisherwomen's main target species (common name, scientific name, habitat type, use)

Common name	Scientific name (s)	Habitat type	Use	Targeted by:
Cowrie	*Cypreae annulus; cypraea moneta; cypraea caputserpentis*	Sandy substrate , sea-grass beds	sell	Women, Children
Prickly pen shell	*Pinna muricata*	Sandy substrate and sea-grass	eat, sell	Women, Children, Men
Black-lip pearl oyster	*Pinctada margaritifera*	Sandy substrate and near shore	eat, sell	Women, Children, Men
Bull mouthed helmet	*Cypraecassis rufa*	Sandy substrate	sell	Women, Children
Horned helmet shell	*Cassis cornuta*	Sandy substrate	sell	Women, Children
Humpbacked conch	*Strombus gibberulus*	Sandy substrate	sell	Women, Children
Tulip shell	*Pleuroploca trapezium*,	Sea grass beds	eat, sell	Women, Children
Rock shell	*Chicoreus ramosus*	Shallow sheltered reefs	sell	Women, Children
Rock shell	*Murex pecten*	sandy substrate	sell	Women, Children
Rock shell	*Murex brevispina*	Sandy substrate and seagrass beds	sell	Women, Children
Rock shell	*Morula granulata*	On or under rock in intertidal areas	sell	Women, Children
Crown conch	Volema pyrum and Volema paradisiaca	Sandy substrate and sea-grass beds	sell	Women, Children

Venus shell	*Protapes sinuosa*	Sandy substrate	eat	Women, Children
Cockles: red cockle and pacific cockle	*Trachycardium rubicundum; Trachycardium rugosum*	Sandy substrate	eat, sell	Women, Children
Tulip shell	*Pleuroploca trapezium*	Sandy substrate	sell	Women and Children
Mangrove Whelk	*Terebralia palustris*	Mangrove swamp	eat, sell, use as fish bait	Women, Children, Men
Tiger cowrie	*Cypraea tigris*	Sandy and sea-grass, coral rock	sell	Women and Children
Top shell	*Trochus maculatus; Tectus mauritianus; Trochhus virgatus*	Coral rock	eat	Women, Children
Rock shell	*Morula granulata*	Coral rock	eat, sell	Women and Men (sell to Nacala)
Mangrove crab	*Scylla serrata*	Mangrove	sell	Men
Swimming crab	*Portunus pelagicus*	Mangrove and sandy substrate	eat, sell	Women, Children
Coral crabs	*Platypodia granulosa*	Coral reef	eat	Women and Children
Brown mussel	*Perna picta*	Coral rock	eat, sell	Women and Children
Octopus	*Octopus cyanea*	Coral rock	eat, sell	Women, Men
Sea cucumber	*Bohadschia atra and subrubra; Actinopyga miliaris and mauritiana; Holothuria scabra, edulis, conusalba and nobilis; Thelonata ananas*	Sandy substrate and coral rock	sell	Men, women and children
Needle fish or Gar fish	*Tylosurus crocodilus crocodilus*	Lagoons, shallow waters	eat, sell	Women, Men

Spotted-half beak	*Hemiramphus far*	Lagoons, shallow waters	eat, sell	Women, Men

III - Supplementary information on women's key fishing practices.

Fishing practice	Supplementary information
Octopus fishing	• Fishing occurs over the reef and along the reef edge • The majority of the catch is usually sold within 40 mins of leaving the beach on route home. • Fishers need to invest in an iron rod and a pair of shoes • Requires a degree of technical knowledge to use the rod effectively • Predominately women
Cowrie fishing	• Local middle man present on the island and neighbouring Matemo Island. Predominately international trade to Tanzanian buyers. • Woman and children. Age range for children is approximately 6-15 yrs. • Children are knwon split the money from the sale of cowries between themselves and their household. • Money from cowries is a form of pocket money for children. They often buy food, drink, toys or other personal items with it. • During the pilot study it was sold for 3.5Mts a kilo, however it can go vary seasonally. During the dry season the price per kilo can double. • Periods of high price encourage people to use the no-take zone on Ibo. • Don't need any technical knowledge to participate.
Net fishing	• Mainly women living in Cumwamba district. Women from Ritutu tend to use Mwembe zone which does not have a sloping sea grass bed suitable for net fishing. • Women usually fished in groups of 5 -15 • One net owner per 4-5 women • Majority of it is sold on the beach to local male traders • Requires less technical knowledge than octopus fishing • Access to a net is harder than accessing a rod for octopus fishing. It requires relying on one's social network or having the capital to invest in a net. • Net owner receives minimum one pile of fish more than the others. This is approximately 1USD.
Shell fishing	• Shells collected for food and curio trade • Sold mainly to Tanzania but there is also a tourist market in southern Mozambique • Only women and children

IV - Key biological and social characteristics of each fishing zone on Ibo Island

Women's intertidal fishing sites	Biological Characteristics	Social Characteristics
Zone 1 Local name: Cumwamba Location: Stretches from north western area to north eastern area of Ibo Island, north of the lighthouse.	**Habitat**: Rocky beach near the coastline extends into sea grass beds *(*predominantly *Thalassia hemprichii)* **Topography:** Has gently sloping reefs, which allow for intertidal fishing by foot. **Species**: Pen shells and cowries were the two most abundant invertebrates (Frontier, 1995) Further east you encounter more snails (*Nerita textiles, Rhinoclavis sinensis, Littoraria glabrata)* and Cowries (*Cypraea annulus*)	Mainly women from Cumwamba and Cement Districts. Net fishing (in sea grass areas) octopus and cowry Fishing.
Zone 2 Local name: Mwembe Location: Covers south eastern intertidal area south of the lighthouse.	**Habitat**: Predominantly intertidal reef flat which stretches all the way to Quirimba island, surrounded by fringing reef. Mangrove stands along the south western corner bordering the coastline. **Topography:** Has gently sloping reefs, which allow for intertidal fishing by foot. **Species:** Gastropod, *(Strombus mutabilis),* Sea snail (*Thais sp*), Brown mussel (*Perna perna*), Star fish (*Fromia sp)*	Mainly women from Ritutu. May encounter some women from Quirimba island during lowest spring tides. Perhaps once a week a women will come from Cumwamba and Cement districts. Mainly octopus and cowry Fishing. No net fishing. Men fish the outer fringing reef area in small boats.
No-take zone	**Habitat**: Predominantly sea-grass beds. **Topography:** Shallow areas surrounding the mangrove stand and west coast of Ibo Island, with a deep central channel running from south to north out to sea. **Species**: Pen shells (*Pinna sp*) and cowries (*Cypraea annulus*) were the two most abundant invertebrates (Frontier, 1995).	Use prohibited. Area used mainly by tourists who walk along the beach.

Appendix S3 – Supporting Information for Chapter 3 (I – IV)

I - Catch data sheet

DATE……..LOCATION……WIND…….
TIDE……..

Name of fisher	District they live in	Name of resource	Quantity *(where weight does not apply e.g. shells)*	Kilo *(weight)*	Location of harvest	Sale (Yes/No)	Time spent harvesting (*hours)*	
							Start time	End time

II - Fisher questionnaire survey

Data (*date*):

Bairro (*district*):

Investigador (*researcher*):

1. **Características socioeconómicas** (*socioeconomic characteristics*)

1.1	**Nome do entrevistado** (*name of interviewee*)	
1.2	**Nome do chefe do agregado familiar** (*name of head of household*)	
1.3	**Relação entre o entrevistado e o chefe do agregado familiar** (*relation between the head of household and interviewee*)	
1.4	**Idade do entrevistado** (*age of interviewee*)	
1.5	**Género** (*gender*)	
1.6	**Estado civil** (*marital status*)	
1.7	**Proveniência de Ibo?** (*provenance from Ibo*)	
1.8	**Proveniência se não de Ibo** (*provenance if not from Ibo*)	
1.9	**Grau escolar** (*school grade*)	
1.10	**Grupo étnico e religião**? (*ethnic and religious group*)	
1.11	**Línguas faladas** (*languages spoken*)	
1.12	**Número imediato do agregado: género, idade e relação com o entrevistado** (*number of immediate household members, their*	

	gender, age and their relation to the interviewee)	
1.13	**Tem família no Ibo? Grau parentesco** (*do you have family on Ibo, and relation*)	
1.14	**Está enquadrada em alguma associacão? Qual?** (*is the interviewee involved in a formal group or association, if so, which?*).	

2. USO DE RECURSOS MARINHOS (*use of marine resources***)**

2.1 Desde quando iniciou? (*since when did you start using marine resources?***)**

2.2 Que tipo de recursos? (*what type of resources***)**

2.3 Na sua opinião, onde abunda muito mas: (*in your opinion, where is there the highest abundance of:*)

Espécie *(species)*	**Sitio** *(site)*
Polvo *(octopus)*	
Mingalare/Liono/Sala *(fish commonly caught in nets)*	
Makaza *(pen shells)*	
Ombe *(cockles)*	
Nhamata *(limpet)*	
Caurie *(cowries)*	

Otros como Sololandimo/Pwasi...*(other shells such sololandimo/tiger cowries)*	

2.4 Mencione seus <u>três principais</u> fontes de rendimento de recursos marinhos *(mention your three principle sources of income from marine resources)*

Hoje *(today)*

	TEMPO SECO *(dry season)*	**TEMPO CHUVOSO** *(rainy season)*
1		
2		
3		

2.5 Anteriormente *(previously)*

	TEMPO SECO *(dry season)*	**TEMPO CHUVOSO** *(rainy season)*
1		
2		
3		

2.6 Uma diferença existente entre hoje e antes[64], ou não. Porquê? *(a difference exists between now and before, or not. Why?)*

---

[64] **Faz a referencia ao ano antes de inicio de PNQ** *(make reference to the year before the start of QNP)*

1.7 Mencione seus <u>três principais</u> fontes de recursos marinhos para a subsistência de familia *(mention three principle sources of marine resources for family subsistence)*

Hoje *(today)*

	TEMPO SECO *(dry season)*	**TEMPO CHUVOSO** *(rainy season)*
1		
2		
3		

2.8 Anteriormente *(previously)*

	TEMPO SECO *(dry season)*	**TEMPO CHUVOSO** *(rainy season)*
1		
2		
3		

2.9 Uma diferença existente entre hoje e antes, ou não? Porquê? *(a difference exists between now and before, or not. Why?)*

2.10 **Onde pescava antes, e hoje?** *(where did you fish before, and today)*

Sitio *(site)*	**ANTERIORMENTE** **S/N** *(previously – yes or no?)*	**Tipo de rec. Marinho** *(type of marine resources)*	**Hoje** **S/N** *(today – yes/no)*	**Observações** *(observations)*
Zona fechada				

Cumwamba				
Mwembe				
Muajka				
Songossaui				
Sencar				
Quilalea				
Mejumbe				
Tembuzi				
Otros..				

Notas adicionais: *(additional notes)*

2.11 Frequências de pesca comparadas entre hoje e anteriormente *(frequencies of fishing compared between today and previously)*

2.12 Como você usa o dinheiro desses recursos hoje *(how did you use the money from these resources today)?*

1.

2.

3.

2.13 Como você usou o dinheiro desse recursos anteriormente *(how did you use the money from these resources previously)?*

1.

2.

3.

3. MODO DE VIDA *(livelihood)*

3.1. Principais fontes de rendimento HOJE *(principle sources of money today)*

	TEMPO SECO *(dry season)*	**TEMPO CHUVOSO** *(rainy season)*
1		
2		
3		

3.2 Principais fontes de rendimento Anteriormente

	TEMPO SECO *(dry season)*	**TEMPO CHUVOSO** *(rainy season)*
1		
2		
3		

3.3 Uma diferença existente entre hoje e antes, ou não? Porquê? *(a difference exists between now and before, or not. Why?)*

3.4 Os principais fontes de rendimento HOJE de chefe de agregado familiar *(the principle sources of income today of the head of the household today)*

	TEMPO SECO *(dry season)*	**TEMPO CHUVOSO** *(rainy season)*
1		

2		
3		

3.5 Os principais fontes de rendimento anteriormente de chefe de agregado familiar *(the principle sources of income previously of the head of the household today)*

	TEMPO SECO *(dry season)*	**TEMPO CHUVOSO***(rainy season)*
1		
2		
3		

3.6 Uma diferença existente entre hoje e antes, ou não? Porquê? *(a difference exists between now and before, or not. Why?)*

3.7 Quais são as atividades económicas de cada membro de agregado familial? *(what are the economic activities of each family member?)*

Nome *(name)*	**Atividade** *(activity)*	**Local de trabalho** *(site of work)*	**Grau parentesco** *(kinship relation)*

4. RIQUEZA *(wealth)*

4.1 É Dono de Casa? *(are you the house owner?)*

4.2 Que matérias foram usados para a construção de paredes? *(what materials were used for construction of walls?)*

4.3 Que matérias foram usados para a cobertura? (*what materials were used for the roof?*

4.4 Por favor indique se possui dentro de sua casa: *(please indicate if you own within the house)*

Enxada *(hoe)*		**Panela** *(pans)*	
Rádio *(radio)*		**Esteira** *(mats)*	
Arpão *(spear)*		**Colchão** *(mattress)*	
Barco *(boat)*		**Bicicleta** *(bicycle)*	
Rede de Pesca *(fishing net)*		**Motorizada** *(motorbike)*	
Gaiola *(fish trap)*		**Árvores de fruitas** *(fruit trees)*	
Telefone *(telefone)*		**Que tipo de combustível usa para a coisinha?** *(what type of fuel do you use for cooking)*	

4.5 Tem gado*?* *(do you have livestock)*

Tipo *(type)*	**Quantidade** *(qunatity)*

4.6 **Possui alguma ruina?** *(do you own a ruin)*
Onde? *(where?)*

Dimensão? *(dimensions)*

III - Summary of results from the Participatory Wealth Assessment (PWA)

Category of indicator	**Poor**	**Normal**	**Good**
i. Food availability	Daily purchase all year	Some stock of rice during year but mostly daily purchase	Always have a stock of rice in the household
ii. Livelihood activities: Household head occupation	Retired No formal employment Collecting and breaking stones Agriculture Fishermen	Occasional construction work Tailors Carpenters Fish trading	Formal salaried employment Trader of goods or shop owner
iii. Livelihood activities: Women's livelihood activities	Bread/cake baking and sale Mat weaving Fishing for: octopus; edible shells; juvenile reef fish Prostitution	Gill net fishing	Owner of a gill net Doesn't have to leave the household to work
Women's livelihood diversity	Diversity: Fishes only; other activities in neap tide are necessary	Diversity: Fishes and farms	Diversity: Multiple. Most common: fishing, farming and trade.
iv. House ownership, type and condition	Ownership: rental Material: earth walls and *makuti*(palm) roof Condition: damaged; leaks in roof	Ownership: rental Material: earth walls and zinc roof Condition: some limited repairs needed	Ownership: yes Material: cement walls and zinc roof Condition: no repairs
v. Marital status and number of people in the house	Unmarried	Married More than one	Married Married couple living in their own house with children
vi. Size of social events	Does not hold ceremonies	Holds ceremonies but with few guests (family)	Able to invite many guests
vii. Health	Sick/disabled	Able bodied most of the	Always able bodied

		time	
viii. Material assets	Machete	Telephone; Bike; Mattress; Chicken and ducks; Radio	Motor bike; Fishing net; Boat; Goats
ix. Remittances	No remittances	Receives remittances from family members	Receives remittances from family members

IV - Semi-structured interview guide for fisher-follows

1. Aim: To provide more in-depth information on fishing strategies which will complement the catch survey and calculations of CPUE.

Information to be collected on each follow:

1. A measure of effort

Aim: to establish a measure of effort for CPUE calculation,

- Average travel for each of the districts = return journey from house to beach
- Time from beach out to harvesting site
- Time spent doing other activities whilst on the harvesting trip
- Actual amount of time spent harvesting (active harvesting time).
- Handling time for each animal

2. Information for resource user distribution:

Aim: To provide qualitative data to contribute to questions on resource distribution and access to benefits from octopus harvesting. For each trip:

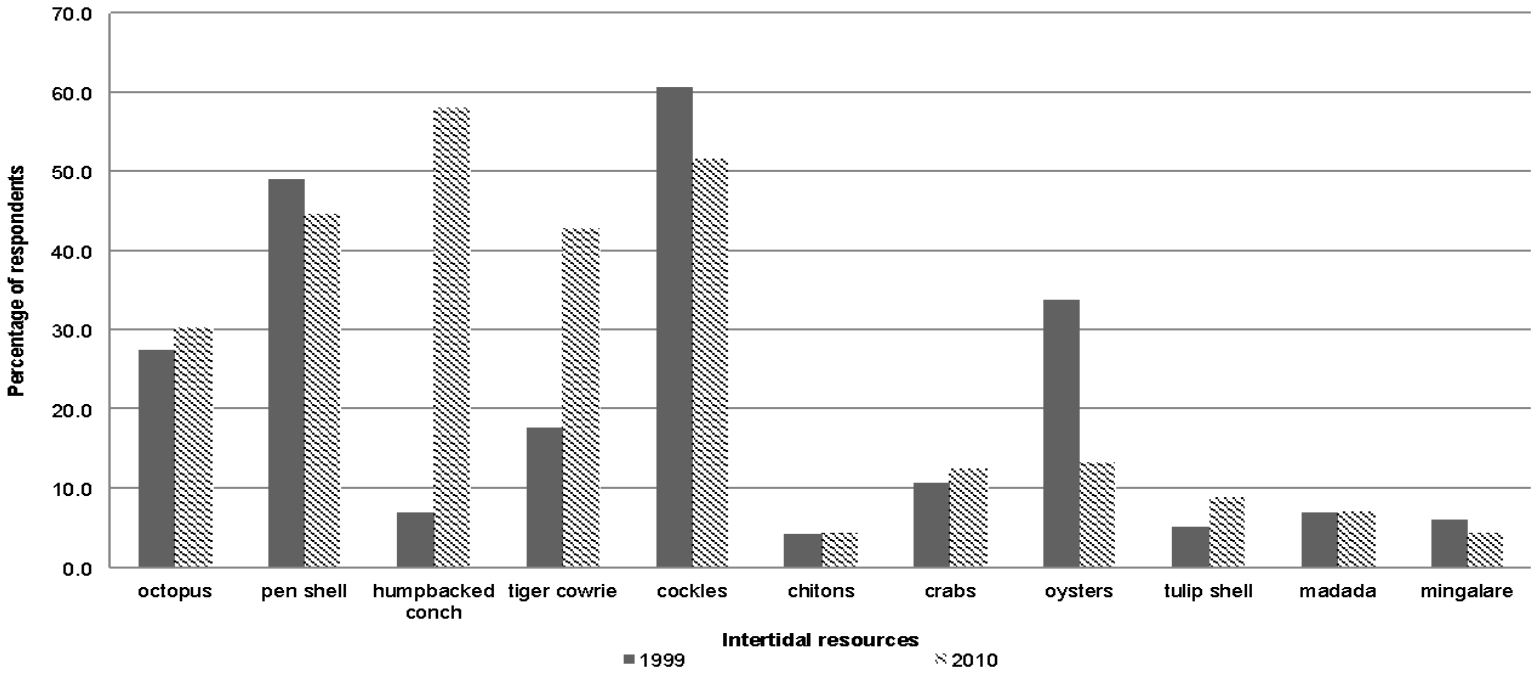
- Name, age, marital status and family composition.
- District resource user lives in.
- Climatic conditions on the day of trip.
- How many people go on the trip and relationship to person I am following.
- Take notes on harvesting strategies, e.g. choice of location within the harvest zone.
- Post harvest strategies, to whom does the individual sell to, what is the nature of their relationship to the trader (kinship, friendship, purely trade)

- Reason given for site selection.

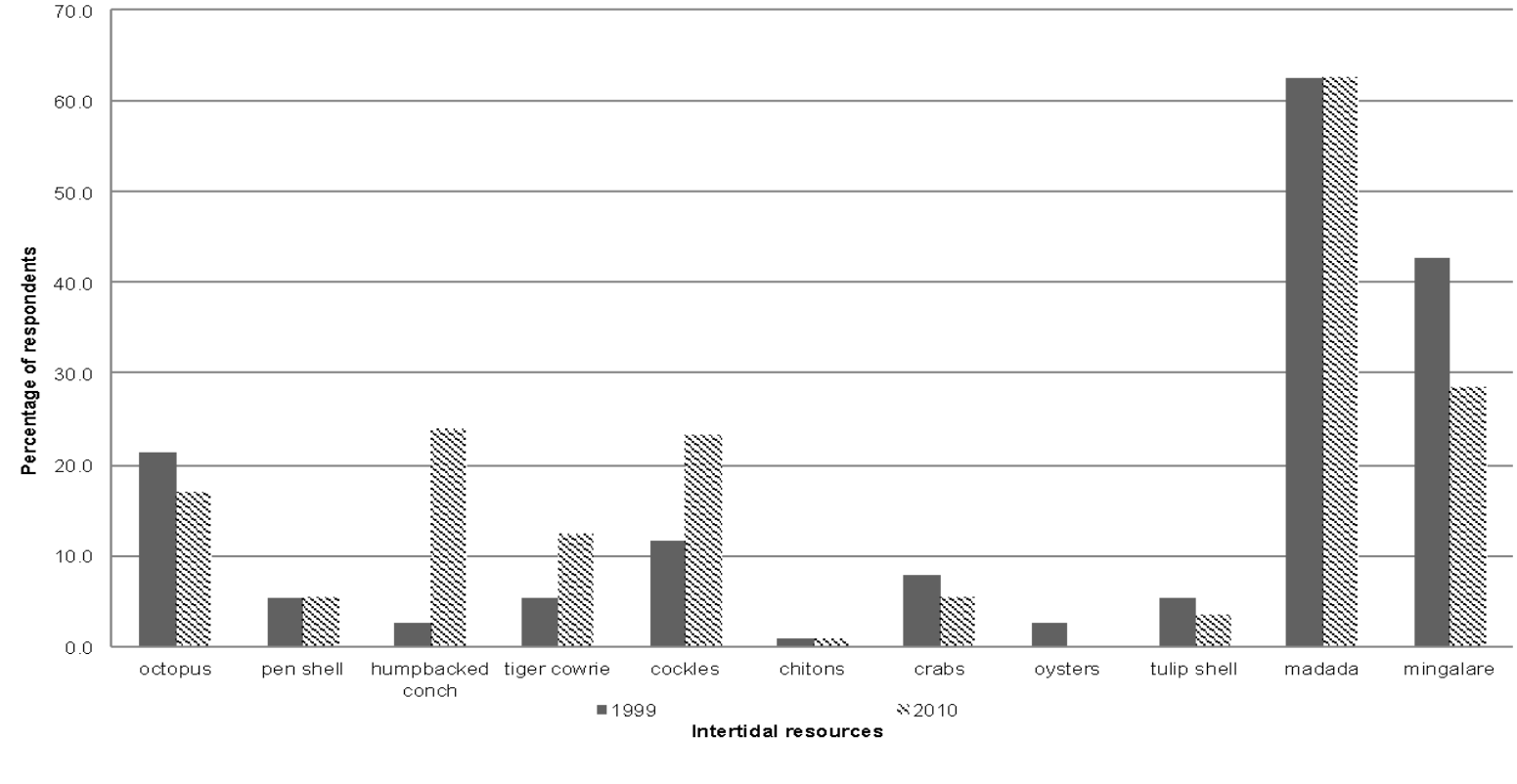
Appendix S4 Supporting information for chapter 4 (I – V)

I - Seasonal changes in resources targeted for consumption and sale.

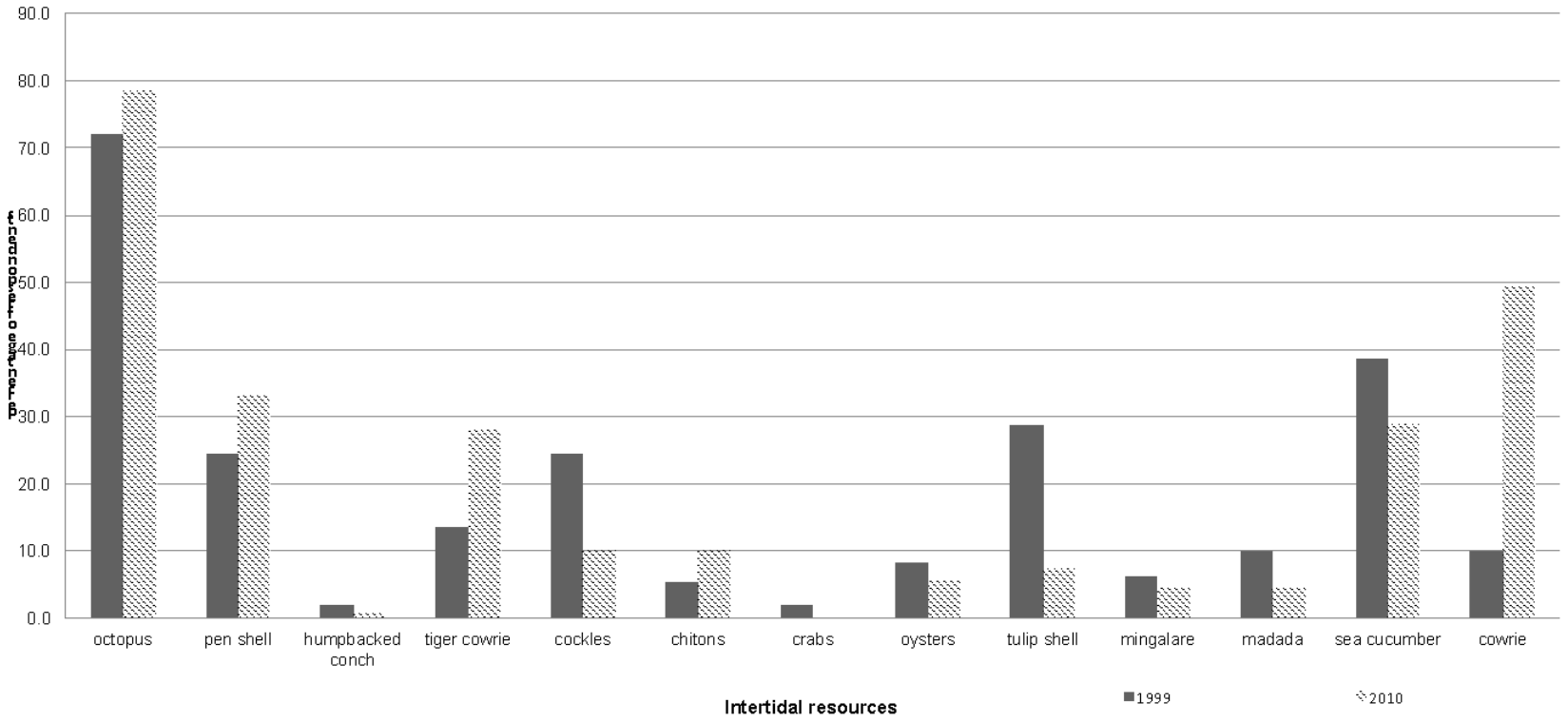
Reported target intertidal resources for consumption during the dry season between 1999 and 2010



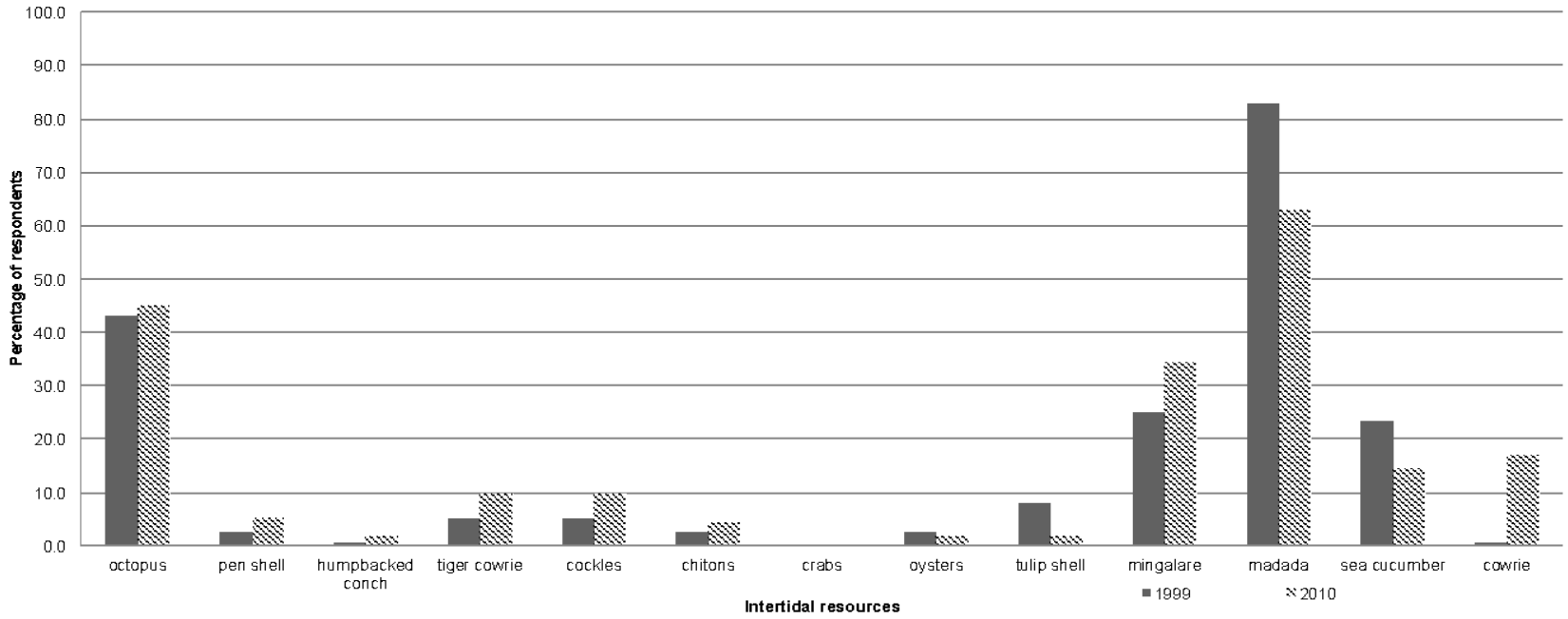
Reported target intertidal resources for consumption during the rainy season between 1999 and 2010



Reported target intertidal resources for sale during the dry season between 1999 and 2010



Reported target intertidal resources for sale during the rainy season between 1999 and 2010



Appendices
II - Fishers' estimates versus catch survey estimate

Summary fishers estimates alongside estimates generated from the catch survey.

Resources	**1998 (kg/trip)**	**2010 (kg/trip)**	**n**	**%**	**Catch survey (kg/trip)**
Octopus	20	4	53	44.2	3.9
Cowries	15	8	41	34.2	5
Edible shells (e.g. pen shells)	6	1.5	44	36.7	0.8
Ornamental shell (e.g. helmet shells)	9	-	12	10.0	n/a

Appendices

Appendix S5 Supporting Information for Chapter 5.(I – III)

I - Fishing characteristics of octopus fisherwomen

Fishing characteristics of octopus fisherwomen (n=67)

Fishing characteristics	**Household head status**			**Wealth category**				**Income generating activities**					**Education**		
SE variables	FHHHs (n=33)	HHs (n=34)	p value	Poor (n=16)	Normal (n=46)	Good (n=5)	p value	F (n=18)	FF (n=22)	FO (n=18)	FFO (n=9)	p value	Yes (n=24)	No (n=43)	p value
Mean number of octopus harvesting trips/per person	**20.38 (+/- 0.58)**	**12.89 (+/- 0.38)**	**0.038**	19.21 (+/- 1.42)	16.76 (+/- 0.32)	7.25 (+/- 2.00)	0.349	21.73 (+/- 1.31)	18.11 (+/- 0.72)	11.81 (+/- 0.68)	13.13 (+/- 1.14)	0.241	21.10 (+/-0.92)	14.32 (+/- 0.31)	0.091
Mean number of trips over the wet season trips	8.10 (+/- 0.29)	5.00 (+/- 0.19)	0.101	8.01 (+/0- 0.79)	6.59 (+/- 0.14)	1.5 (+/- 0.43)	0.279	10.27 (+/- 0.71)	6.52 (+/- 0.31)	4.02 (+/- 0.22)	4.63 (+/- 0.58)	0.082	9.45 (+/- 0.49)	4.71 (+/- 0.13)	**0.024**
Mean number of trips to Mwembe intertidal zone	10.3	3.1	0.055	9.1	6.6	1	0.602	10.1	6.8	4.1	4.9	0.724	6.8	6.8	0.997
Mean number of spring tide trips	15.2 (+/- 0.64)	8.8 (+/- 0.21)	**0.024**	13.8 (+/- 0.95)	12.3 (+/- 4.13)	4.3 (+/- 0.87)	0.298	15.7 (+/- 0.95)	13.4 (+/- 0.55)	10 (+/- 0.99)	7.9 (+/- 0.48)	0.221	15.8 (+/- 0.71)	10.1 (+/- 0.21)	0.055
Mean number of trips without wind	7.1	4.2	0.067	4.3	5.7	5.1	0.38	7.8	5.3	4.7	6.0	0.12	7.6	7.8	0.06

Fishing characteristics	**Residency**				**Age category**				**Household size**			
SE variables	Cumwamba (n= 42)	Ritutu (n=19)	Cimento (n=6)	P value [F value]	Young (n=12)	Mature (n=35)	Old (n=20)	P value [F value]	Small (n=6)	Medium (n=40)	Large (n=21)	P value [F value]
Mean number of octopus harvesting trips/per person	17.94 (+/-0.42)	15.50 (+/-0.90)	11.60 (+/-1.92)	0.614	**21.91 (+/-2.50)**	**16.27 (+/-0.36)**	**14.41 (+/-0.69)**	0.424	13.8 (+/- 1.92)	19.47 (+/-0.47)	12.28 (+/-0.66)	0.210
Mean number of trips over the wet season trips	7.36 (+/-0.22)	5.51 (+/- 0.37)	4.41 (+/- 0.87)	0.539	10.71 (+/-1.30)	5.72 (+/- 0.17)	5.71 (+/- 0.29)	0.131	2.84 (+/- 0.71)	7.76 (+/- 0.23)	5.39 (+/- 0.31)	0.244
Mean number of trips to Mwembe intertidal zone	3.17	15.38	5.4	0.13	16.5	4.9	4.4	**0.054**	6	9.3	2.2	0.237
Mean number of spring tide trips	12.4 (+/-0.30)	12.2 (+/- 0.73)	9 (+/- 1.72)	0.806	17.1 (+/- 1.91)	11.3 (+/- 0.26)	10.4(+/- 0.49)	0.263	10.4 (+/- 1.45)	14.2 (+/- 0.36)	8.6 (+/- 0.44)	0.193
Mean number of trips without wind	7.8	6.9	6.3	0.9	8.9	7.2	7.8	0.18	5.9	5.2	6.5	0.12

Appendices

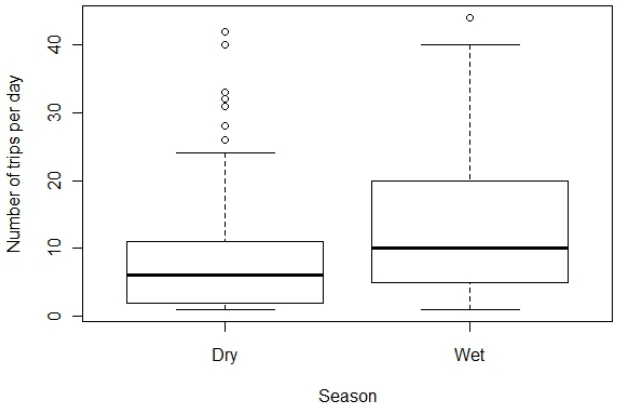
II - Supplementary model material

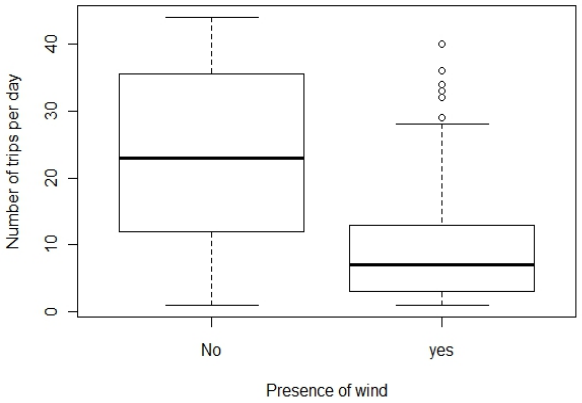
a. Model selection table. Criteria: Delta values <2 selected

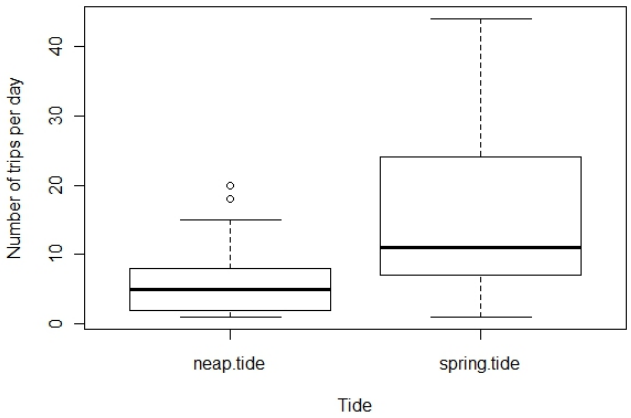
Model selection table										
	(Int)	H'head	Season	Tide	Wind	df	logLik	AICc	Delta	weight
16	-2.449	+	+	+	+	6	-2592.209	5196.4	0	0.817
15	-2.856		+	+	+	5	-2594.867	5199.7	3.31	0.156
8	-2.837	+	+	+		5	-2596.792	5203.6	7.16	0.023
7	-3.243		+	+		4	-2599.446	5206.9	10.47	0.004
14	-2.463	+		+	+	5	-2608.404	5226.8	30.39	0
13	-2.868			+	+	4	-2611.06	5230.1	33.7	0
6	-3.019	+		+		4	-2617.168	5242.3	45.91	0
5	-3.423			+		3	-2619.819	5245.6	49.21	0
12	-1.864	+	+		+	5	-2652.173	5314.4	117.93	0
11	-2.266		+		+	4	-2654.821	5317.6	121.22	0
4	-2.356	+	+			4	-2659.959	5327.9	131.49	0
3	-2.757		+			3	-2662.602	5331.2	134.78	0
10	-1.9	+			+	4	-2662.303	5332.6	136.18	0
9	-2.301					3	-2664.95	5335.9	139.48	0
2	-2.53	+				3	-2674.111	5354.2	157.8	0
1	-2.93					2	-2676.753	5357.5	161.08	0

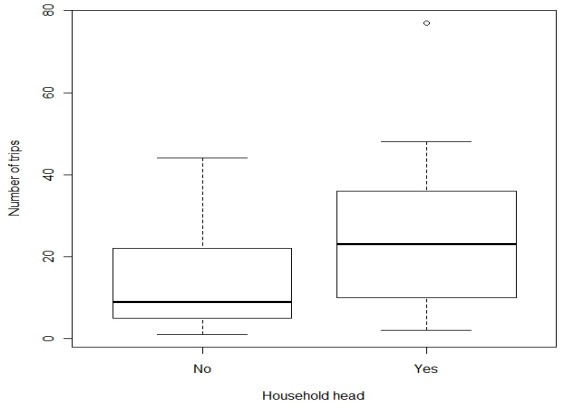
Appendices

b. Graphical output of model of daily effort. Number of trips a day against Season; Wind; Tide and Household head status (left to right).









III - Supplementary travel time information

The different travel times presented in the Table below refer to the three different districts, Cumwamba, Rituto and Cimento.

Appendices

Travel distances for the two intertidal zones				
	Cumwamba: closest point	**Cumwamba: most distant point**	**Mwembe: closest point**	**Mwembe: most distant point**
Cumwamba	1.7KM	3.4KM	4.3KM	5.7KM
Rituto	2.8KM	4.5KM	3.3KM	4.4KM
Cimento	2.9KM	4.6KM	4.4KM	5.5KM

Appendix S6: Supporting Information for Chapter 6

I - Full output from hierarchical cluster analysis

Cluster 1					
	Cla/Mod	Mod/Cla	Global	p.value	v.test
H.head=female head	69.565217	86.486486	44.660194	8.22E-11	6.496432
LH.Cat=FF	80	64.864865	29.126214	4.29E-09	5.872715
Age.Category= Old	78.26087	72.648649	22.330097	3.46E-06	4.641729
Education.Cat=none	49.253731	89.189189	65.048544	8.01E-05	3.944051
H.size=small	100	13.513514	4.854369	4.98E-03	2.808368
Res.Cat=Ritutu	52.777778	51.351351	34.951456	1.10E-02	2.542555
wealth.ranking=normal	42.647059	78.378378	66.019417	4.96E-02	1.963817
H.size=large	13.333333	5.405405	14.563107	4.87E-02	-1.971187
Age.Category= young	5.555556	2.702703	17.475728	1.94E-03	-3.098516

LH.Cat=F	8	5.405405	24.271845	4.97E-04	-3.482151
Education.Cat=some	11.111111	10.810811	34.951456	8.01E-05	-3.944051
Age.Category=mature	0	0	21.359223	1.20E-05	-4.377817
H.head=male.head	8.77193	13.513514	55.339806	8.22E-11	-6.496432
Cluster 3					
	Cla/Mod	Mod/Cla	Global	p.value	v.test
Age.Category=mature	95.45455	50	21.359223	2.23E-09	5.980245
H.head=male.head	61.40351	83.333333	55.339806	1.66E-06	4.791168
H.size=large	80	38.095239	14.563107	1.22E-03	3.234207
Res.Cat=Cumwamba	55.55556	71.428571	52.427184	1.50E-03	3.175111
wealth.ranking=rich	87.5	16.666667	7.76699	7.91E-03	2.655701
LH.Cat=FFO	65	30.952381	19.417476	1.78E-02	2.369605
H.size=large	100	9.52381	3.883495	2.53E-02	2.236543
Res.Cat=R	22.22222	19.047619	34.951456	5.11E-03	-2.800079
Age.Category=young	11.11111	4.761905	17.475728	4.05E-03	-2.874294
wealth.ranking=poor	14.81481	9.52381	26.213592	1.19E-03	-3.24183
LH.Cat=FF	13.33333	9.52381	29.126214	2.11E-04	-3.705686

H.head=female.head	15.21739	16.666667	44.660194	1.66E-06	-4.791168
Cluster 2					
	Cla/Mod	Mod/Cla	Global	p.value	v.test
Age.Category=young	83.333333	75	17.475728	1.97E-09	6.000534
wealth.ranking=poor	59.259259	66.666667	26.213592	1.60E-06	4.79874
Education.Cat=some	47.222222	70.833333	34.951456	5.31E-05	4.041735
LH.Cat=F	48	50	24.271845	1.79E-03	3.123108
H.size=small	100	16.666667	3.883495	2.40E-03	3.035248
H.size=medium	50	33.333333	15.533981	1.25E-02	2.498846
Age.Category= mature	9.09091	8.333334	42.718446	1.43E-02	-2.448422
LH.Cat=FF	6.666667	8.333333	29.126214	8.30E-03	-2.639773
wealth.ranking=normal	11.764706	33.333333	66.019417	2.24E-04	-3.690744
Education.Cat=none	10.447761	29.166667	65.048544	5.31E-05	-4.041735