Reconstructing Swahili Foodways:
The Archaeology of Fishing and Fish Consumption in Coastal East Africa, AD 500-1500

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Abstract

This study investigates fishing and fish consumption throughout the development of Swahili settlements (AD 500 to 1500) along the East African coastline. Zooarchaeology provides an effective methodology to investigate how fish, as a principal food item, interlink culture and environment and shape life in these past coastal communities. I hypothesise that fishing and fish consumption practices are integrated parts of Swahili culture; thus, forms of fishing and fish consumption—and the material traces associated with them—reflect the cultural and environmental conditions of Swahili life at different scales.

I consolidated published and unpublished reports of faunal remains from excavations on the Swahili coast and identified the faunal remains from two 14th to 16th century Swahili towns, Songo Mnara and Vumba Kuu, to explore subsistence practices at regional and local scales. These faunal data form the basis of analyses that explore trends such as changes in the relative proportions of the principal food items over time, the range of exploited marine habitats around settlements, and the distribution of differently-sized fish across a town. My interpretations of these patterns are aided by ethnoarchaeological observations and interdisciplinary perspectives from the fields of marine ecology, ethnography and paleo-climatic studies.

The results indicate that the development of offshore fishing and an increasing consumption of domesticated bovids occur at particular settlements during a key period of growing urbanism and overseas trade in the Swahili region. Faunal remains from Vumba Kuu and Songo Mnara show evidence of different fishing and fish consumption practices within and between settlements that are linked to the variety of available natural resources and social spaces. These results demonstrate how local environmental and cultural conditions influence fishing and fish consumption practices, contributing to our understanding of the complexity and diversity of life within Swahili communities and across the Swahili region.

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Author's Declaration

I declare that the work in this dissertation was carried out in accordance with the Regulations of the University of Bristol. The work is original, except where indicated by special reference in the text, and no part of the dissertation has been submitted for any other academic award. Any views expressed in the dissertation are those of the author.

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ACA:	Acanthuridae
ALB:	Albulidae
ARI:	Ariidae
BAL:	Balistidae
CAR:	Carangidae
CARCH:	Carcharhinidae
CHA:	Chanidae
CHI:	Chirocentridae
CONG:	Congridae
DASY:	Dasyatidae
DIO:	Diodontidae
EPH:	Ephippidae
GER:	Gerreidae
HAE:	Haemulidae
LAB:	Labridae
LAM:	Lamnidae
LET:	Lethrinidae
LOB:	Lobotidae
LUT:	Lutjanidae
MON:	Monacanthidae
MUG:	Mugilidae
MUR:	Muraenidae
NEM:	Nemipteridae
OST:	Ostraciidae
PLA:	Platycephalidae
PLO:	Plotosidae
POM:	Pomacanthidae
SCA:	Scaridae
SCO:	Scombridae
SCOR:	Scorpaenidae
SER:	Serranidae
SIG:	Siganidae
SPA:	Sparidae
SPH:	Sphyraenidae
STE:	Stegostomatidae
TER:	Terapontidae
TET:	Tetraodontidae

MNI:	Minimum Number of Individuals
NISP:	Number of Identified Specimens
W:	Weight (grams)
UFR:	Unidentified Fragments

NMK:	National Museums of Kenya
MNHN:	Muséum national d'Histoire Naturelle

Chapter 1: Food Consumption in the Swahili World

1.1 Introduction

Fish bones retrieved from archaeological sites are more than relics of past meals. They tell a story about the people who captured, cooked, ate, and eventually discarded those bones. They offer clues to the ways people interacted with each other and with their surrounding environment. The many ways food shapes human lives can be described as foodways. This work uses the remains of fish, an important food item in the Swahili region, to reconstruct the foodways of past inhabitants of the East African coast.

The word *Swahili* is used to describe a group of people, a language, and cultural phenomenon in East Africa. I use the term to refer to the culture that developed from the last centuries BC to the 16th century along the coastal fringe of the Western Indian Ocean. The East African coastline from Somalia to Mozambique is dotted with remains of "stone towns" known for the coral-based architecture that formed the homes, palaces, and mosques of the Swahili people (Kusimba 1999; Horton and Middleton 2000). The inhabitants of these settlements are known as intermediaries linking the Indian Ocean trade network with trading routes into the interior of Africa. Sailors and traders from the fringes of the Indian Ocean navigated the predictable monsoon winds that changed direction during different parts of the year. The archaeology and history of this area has revealed a variety of exchange goods including imports such as glass, cloth, glazed ceramics, and metalwork; and exports of ivory, turtle shells, gold, and slaves. The sea played an important role in the development of Swahili culture not only because of the cyclical monsoon currents that allowed traders to travel around the Indian Ocean, but also because the sea was the source of an important daily subsistence food: fish.

Evidence from historical, linguistic, anthropological, and archaeological sources indicate that coastal subsistence was based on a combination of hunting, fishing, agriculture, and rearing of domesticated animals. However, little is known about how diet and subsistence shaped the way coastal societies interacted with their surrounding environment and how this interaction, in turn, influenced life in these communities. I use fish bones, which make up the majority of faunal remains excavated from Swahili sites, to explore the intersecting roles of culture and environment in shaping Swahili society. In this chapter, I introduce the history of the Swahili region and the methodologies and theories underlining cultural-environmental studies, placing my research on Swahili food consumption in a wider context of archaeological debate.

1.2 A zooarchaeological approach to food consumption

I use zooarchaeology as an approach to study food consumption through the analysis of faunal remains. It is a field that investigates the relationship between humans and their social and natural environments through their interactions with animals. Reitz and Wing (2008) summarize the fundamental uses of animal remains identified in archaeological sites: nutritional needs, other products (manure for fertilizing, hair for clothing, etc.), labour (domestic animals), symbolic association, and pets.

My study focuses primarily on the use of animals, mainly fish, for food—although the different uses are often related. This research relies on an understanding of fish ecological patterns to interpret how fishers may have exploited these resources in the past. Yet my focus is not exclusively nutritional and environmental; I am also interested in the role of fish and fishing in the social web of past settlements on the Swahili coast. I recognize that culture and environment must be viewed as overlapping phenomena in the context of food consumption because food is derived mainly from natural resources and transformed in cultural contexts.

1.3 Subsistence at the intersection of environment and culture

The impact of culture and environment on human societies has been a key question in anthropology, and subsistence is at the heart of the matter. One assumption in the previous archaeologies of subsistence practices in Africa is that development progressed slowly, with great innovations influenced by foreigners:

> *It is remarkable how far the emphasis of archaeological enquiry has focused exclusively on the exotic derivations of such plants and animals, and ignored the equally interesting African role in their exploitation.* (Sinclair et al. 1993, 9)

This observation is relevant to the study of Swahili culture, since many of the early efforts in understanding this region focused on foreign objects and influences. Fish remains represent the exploitation of local resources and can be used to reconstruct the lifeways of the inhabitants of Swahili settlements.

The dichotomy of culture and environment is another problematic feature of discussions about subsistence. Hassan (2002) describes the impact of climate fluctuations in terms of food shortages which in turn affect social structure. In his view, climate is a force for great social changes such as the transition from hunting and gathering to pastoralism in northern Africa. Although he describes climate as an important pressure for social change, he acknowledges the importance of the "elements and structural organization of the particular culture involved" (2002, 4). For example, he uses elite status to demonstrate how ideologies used to support a stratified society may make a society more vulnerable to environmental stress.

Existing subsistence studies, particularly in Africa, are focused around large scale changes in subsistence related to cattle. Van Neer highlights how "the role of hunting and fishing in food provisioning is often neglected" in studies of African faunal remains (2002, 263). He investigates the degree of reliance on fishing and hunting and their relationship to climate change using detailed species lists from West and Central Africa. He demonstrates that "southward migrating populations were not exclusively searching for suitable pasture for their herds, but that they preferred regions that also allowed them to continue to hunt and fish" (Van Neer 2002, 269). His paper attests to the importance of analysing the relative importance of different subsistence strategies.

A case for the Swahili in this debate

The coastal settlements in East Africa provide an opportunity to study the changing role of fishing throughout the development of these complex societies. My study of food consumption on the Swahili coast addresses the discrepancy in time scales by exploring the role of fishing in regional trends and localized coastal environments. I use ethnoarchaeology as a tool for interpreting the social dynamics related to fishing strategies and consumption. Instead of viewing environment and culture as opposing forces that drive changes in subsistence and social organization, I see food consumption as the interface where these two phenomena interlink.

1.4 Brief overview of the Swahili Coast

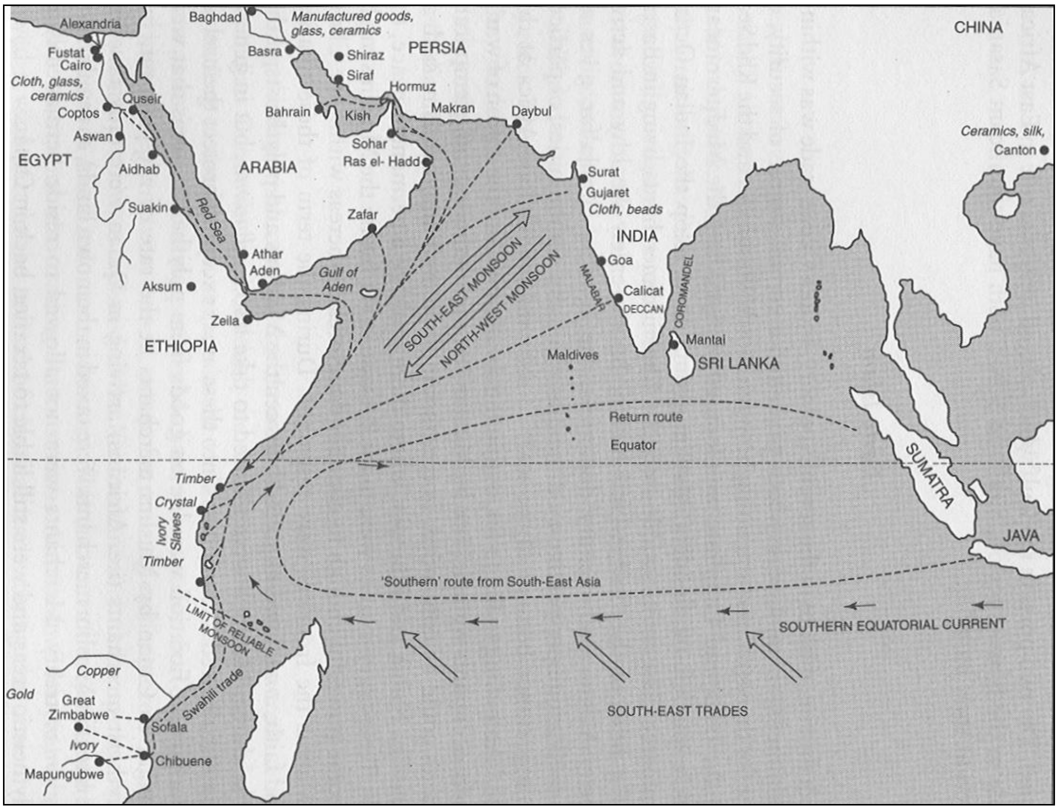


Figure 1.1: Map of the Indian Ocean trading routes
(Horton and Middleton 2000, 74)

The coastal environment

The Swahili culture extends along 3000 km of coastline, approximately 20 to 200 km wide and including adjacent islands, from Somalia to Mozambique (Kusimba 1999, 21, 67). The natural vegetation of this narrow strip of land is described as the Zanzibar-Inhambane regional mosaic, characterized by “the complex integration of moist and drier forests with coastal thicket, fire-climax savannah woodlands, seasonal and permanent swamps, and littoral habitats” (Schipper and Burgess 2012; White 1983). Kusimba (1999, 76) envisions the Swahili coast as an “interdependent ecological zone” where settlements exploited different resources and depended on each other for the exchange of derived products. The uneven distribution of resources and the variability in settlement locations around these different resources shaped the development of Swahili settlements (Fleisher 2003).

Along the mainland, soil is most fertile around the numerous river deltas. Marine resources such as fish, molluscs, and turtles, are available in the coastline environments containing fringing reefs, estuary bays, and mangrove swamps; the nearby woodlands offer a range of wild animals. The surrounding environment provided other important resources that enabled the development of coastal settlements. Construction materials were available in the mangrove swamps and mainland forests. Coral was another important construction material that can be found along the coast.

The monsoons are yearly phenomena that affected the social patterning of the Swahili people (Figure 1.1). *Kusi*, the southerly monsoon, brings heavy rains amounting to 70 percent of the yearly rainfall from April to June; *kaskazi*, the northeast monsoon, occurs December to March and is characteristically hot and dry (Horton 1984, 44). These monsoon currents determined the timeframes in which traders could travel across the Indian Ocean to the Swahili Coast; and their presence during certain times of the year would lead to the regular patterning of yearly activities (e.g., Prins 1961, 59). Seasonal rains would limit certain kinds of activities, such as the construction of buildings or travelling. On a shorter time-scale, ocean tides would influence the flow of daily activities. Most likely, boats were brought to shore during high tide and left exposed on the beach to be unloaded at low tide. Daily trade activities would be structured around the times that trade goods could be carried in and out of boats.

From organizing daily routines around tides to the formation of regional exchange networks to distribute resources, the environment has shaped the spatial and temporal organization of Swahili culture at different scales. The archaeological record of fishing and fish consumption activities provides evidence of the different scales of interactions between Swahili people and their environment.

History of research on the Swahili coast

Research on the pre-colonial history of the Swahili coast includes the study of written, oral, and material evidence. Written historical accounts go as far back as two thousand years ago. Chittick (1968) divides written sources into two categories: those that reflect the perspectives of foreign visitors and those from the viewpoint of local residents. The first group consists primarily of the recorded experiences of geographers and merchants who visited the East African coast in the period before and during the arrival of the Portuguese. Among the better known are *Periplus of the Erythraean Sea* (1^{st} c. AD), Ptolemy's *Geography* (2^{nd} c.), Al Masudi's geography (10^{th} c.), Ibn Battuta's narrative (14^{th} c.), and *The book of Duarte Barbosa* (16^{th} c.). The second category of historical evidence includes a set of chronicles of prominent coastal settlements that are rooted in the oral histories of those areas. These "oral traditions that have been committed to writing", as Chittick (1968, 99) describes them, relate the foundations of these settlements and their successions of leaders while emphasizing overseas connections. The chronicles played an important role in the interpretation of early archaeological work on the coast, which also focused on the external origin of these settlements (Kusimba 1999, 53–4). These oral/written histories are now believed to reflect the past through the lens of the interests of the moment in which they were recorded (Wynne-Jones 2010).

Linguistic studies of Kiswahili—the Swahili language—have also played an important role in understanding the origins and development of Swahili culture. For example, Nurse and Spear (1985) show that the language spoken along the coast is connected to the African Bantu language, providing evidence for the African roots of Swahili culture. Other linguistic research has contributed a reconstruction of the linguistic history of the region (Nurse, Hinnebusch, and Philipson 1993) and the relationships among dialects and communities (Nurse and Walsh 1992). Although historical linguists and archaeologists in the Swahili region have mostly failed to reconcile the parallel trajectories of their fields, Fleisher and Wynne-Jones (2012) highlight the potential for combining these disciplines in order to understand the meanings and uses of space in the Swahili coast.

Archaeological research from excavated sites along the coast has provided another lens through which we can reveal Swahili culture. The changing objectives of archaeological research on the coast largely reflect the conditions of their time. Archaeological research began in Kenya during British colonialism. Chauncy H. Stigand (1913) was the first to make extensive written observations of the archaeological record of the Swahili coast in the area around Lamu in 1913, and more than 400 sites have been identified since then (Kusimba 1999, 51).

James S. Kirkman (1954) was the first to do an archaeological excavation at a Swahili site (Gede) and was also appointed as the first curator of Gede ruins in 1948. His efforts to understand Swahili culture were followed by Neville Chittick (1961, 1962, 1974) in 1958 at Kilwa and Kisimani Mafia in Tanzania (Kusimba 1999, 53). Their work focused on the architecture of the stone town ruins and the influence of the Indian Ocean trade. The prevailing idea of Swahili culture during colonial rule was that it originated from the cultures that mixed on the coast during trading enterprises between Arabs, Persians, and Chinese.

A new perspective emerged after the 1960s in the midst of the newly gained independence of East African countries. The need to develop national identities in these emergent countries required a new agenda for understanding the history of the region that emphasized its African roots. For example, Mark Horton's (1996; 1984) archaeological research at Shanga put an emphasis on cultural process that challenged the idea of external origin; he demonstrated the African roots of many of the early features of Shanga's material culture and their continuation throughout Shanga's development (Kusimba 1999, 60–1). Other key works contradicted the external origins theory, such as the analysis of local pottery by Wilding (1989) and linguistic studies by Nurse and Spear (1985). These works showed that the language and material culture of the coast had close links to those of other African communities in the region.

Recent publications by archaeologists working along the East African coast highlight some of the current lines of research in Swahili archaeology, which increasingly focus on the reconstruction of daily life. In contrast to the static, descriptive view of Swahili culture that characterizes early work (e.g., Kirkman 1966a; Chittick 1974), current research on the Swahili coast discusses concepts of dynamic social behaviour through the use of material remains, such as in the production and use of local pottery (Wynne-Jones 2007), household activities (Flexner et al. 2008), identity (LaViolette 2008), and food consumption (Walshaw 2010). These works emphasize the role of agency in the use of material remains rather than simply describing trends of artefact types. My work adds to these social archaeologies by seeking to understand the social dynamics of fishing practices in the daily lives of people inhabiting the coast. This goal is the basis of the ethnoarchaeology component of my research and the interpretation of the fish remains data.

Overview of Swahili History

A general chronology of the development of Swahili settlements can be summarized in a series of phases tracing the region's early development, height and decline throughout the first and second millennia. At the turn of the first millennium—what Kusimba (1999) designates as Period I (100 BC-AD 300)—Bantu and Cushitic speaking farmers began to settle scattered villages in the coastal region, which was already inhabited by groups of pastoralist and foraging communities (Kusimba 1999, 33). Even at this time, the East African coast, then known as Azania, already had trade connections through the Red Sea to India and the Mediterranean world (Pouwels 2002, 392).

From around AD 300-600, referred to as the Azanian period by Kusimba, the inhabitants of the settled villages continued to engage in a variety of food producing activities and iron working—this period is also known as early iron working (see Chami 1998). During this period, the Persian Gulf dominated the Western Indian Ocean trade (Pouwels 2002, 391) and the coast between Mogadishu and Sofala was called Zenj by the Arabs traders who visited this region (Horton and Middleton 2000, 10).

In the period between AD 600-1000, which Kusimba calls Zanjian, a particular style of local pottery known variously as Triangular Incised Ware (Chami 1998), Wenje Ware (Phillipson 1979), Early Kitchen Ware (Chittick 1974; 1984), or Early Tana Tradition (Horton, Brown, and Mudida 1996; Fleisher and Wynne-Jones 2011) was prominent and villages developed into larger settlements (LaViolette 2008, 29). Trade continued to grow such that by the 9th and 10th centuries the coast received merchants primarily from Siraf and Oman in the Persian Gulf. In this climate of developing settlements and trading connections, a timber mosque was constructed in Shanga around the 8th c., on the northern coast of Kenya (Horton, Brown, and Mudida 1996)—this represents the earliest evidence of coastal residents practicing Islam.

Kusimba (1999) calls the entire period between AD 1000-1500 the Swahili classic age. Around the 10th century, there was a shift in trade relations from the

Persian Gulf back to the Mediterranean and India through the Red Sea, now dominated by the Fatimids in Egypt (Pouwels 2002, 396). The beginning of the new millennium, perhaps propelled by the opening of new exchange markets (Pouwels 2002, 371), was marked by important changes that defined the Swahili coast, such as the rise of well-known urban commercial centres (LaViolette 2008, 29; LaViolette and Fleisher 2005). The 11th to 13th centuries saw the development of a distinctive culture with coral-stone architecture, use of coins, and adherence to Islam; evidence of iron slag and spindle whorls during this time attest to the growing importance of locally produced goods in some towns (Kusimba 1999, 35–7; Pouwels 2002, 392). The coast reached a height of wealth and activity in the 14th to 15th centuries before the arrival of the Portuguese (LaViolette 2008, 31). After the 15th century, Swahili prosperity declined as control of the region shifted among a series of colonial rulers starting with the Portuguese, followed by the Omani Arabs, and later by the Germans and British.

A general timeline of Swahili history is useful in identifying important periods when we might expect changes in the way coastal people exploited the environment and consumed marine products. For example, the 11th-13th centuries were a period of growth in which many of the defining features of Swahili culture—coral-stone architecture, urban centres, and Islam—developed. I review the available zooarchaeological data in the region, which covers the 6th to 16th centuries, including the principal periods of development on the coast up until the arrival of the Portuguese. Additionally, I explore the fishing and subsistence and consumption practices at two contemporary Swahili towns from the 14th to 16th centuries, during the historical height of Swahili culture. A comparison of these two case studies reveals differences among coastal settlements and regions.

1.5 Food consumption in the Swahili world: an introduction

There is evidence for fishing and food consumption practices on the Swahili coast in the form of written descriptions, vocabulary, and material remains. The length of this thesis is dedicated to the study of the numerous excavated animal remains, particularly fish, to understand the role of fishing and fish consumption in the Swahili world. Here I summarize other forms of food consumption evidence in relation to the history of Swahili culture outlined above.

The lexicon of fishing and subsistence

Nurse and Hinnebusch (1993) reconstruct the development of Kiswahili through its shared traits within different language groups. A sample of words from the different stages in the development of Kiswahili reveals the early use of vocabulary associated with fishing, cultivating and hunting (Table 1.1).

Table 1.1: Subsistence vocabulary in the development of Kiswahili (Nurse, Hinnebusch, and Philipson 1993, 287–97)

Language group	Sample Words
Proto-Northeast Coast Bantu (c. AD 1-500)	**mutama** 'sorghum' **mupunga** 'rice' **kindoro** 'cassava, sweet potato' **ngonzj** 'sheep' (**n**)**swala** 'gazelle sp.'
Proto-Sabaki (c. AD 500)	**iziWa** 'milk' **ituWi** 'coconut juice' **[z[gu** 'banana' **nkamba** 'lobster, prawn, shrimp' **mfuno** 'sp. duiker' **mpampa** 'shark' **lwavu** 'fishing net', ?Pers/Indian languages **nkasa** 'sea turtle', Pers *kasa*, also Indian forms
Proto-Swahili (c. AD 500-800)	**mutumbwi** 'canoe' **muTepe** 'type of sailing vessel' **nkusi** 'south' (SD), 'rainy season' (ND) **mpweza** 'cuttlefish' **t^{h}afi,** t^{h}asi 'a common (small) fish' **ncaza** 'oyster', ?Pers **ncelewa** 'giant rock cod' **nguva** 'dugong' **lu(w)ando** 'fish weir' **lukonjo** 'sharpened stick', mukonjo 'fish spear' **yema - ema** 'fish trap', Pers (also Hi) *dam*

Nurse and Hinnebusch (1993) use linguistic evidence, along with archaeological and historical sources, to portray the history of Swahili culture, which closely follows the historical timeline described above; in short, a group of Proto-Sabaki speakers separated from the Proto-Northeast Coast Bantu who were living around northeastern Tanzania at the turn of the first millennium (Nurse, Hinnebusch, and Philipson 1993, 307). The inhabitants of this group participated in a variety of subsistence activities, including rearing domestic animals, cultivating, hunting and fishing (1993, 308). For example, the introduction of the word for fishing net (*lwavu*) falls within the Proto-Sabaki stage of development of the Swahili language, and several other words for fishing tools and marine animals are included in the next stage, Proto-Swahili. There is also evidence that some of these words were introduced from outside of Africa, such as the word for fishing trap (i-ema) that “seems to be a loan from Persian or an Indian language into Comorian, later into early Swahili” (1993, 320). These preliminary observations indicate that in the early stages of Swahili culture and language (c. AD 500), coastal people were fishing and continued to widen their vocabulary associated with this activity into the next stage.

Written sources on food consumption

As mentioned above, the East African coast was already part of the historical record by the first century. Descriptions of East African peoples, cultures and environments were written down in the journals and reflections of travellers since the first century work *The Periplus of the Erythraean Sea*. Travellers from as far as China had compiled information about this region by the 9th century. In these works lie glimpses of the day-to-day experiences of the inhabitants of the Swahili coastal settlements, albeit from somewhat limited perspectives.

These records vary in content depending on the author’s motives for travelling to the region. Some accounts, especially by early authors, include vivid descriptions of places and peoples. Many include extensive accounts of trade items, trading customs and distances between sites so as to provide a guide for future trading voyages. For example, the most cited marine product is ambergris, a popular trade item (Table 1.2). Ambergris is a substance formed in the whale digestive system that was used as a fixative for perfumes. It could be found washed up on the shores.

It is important to consider the context in which many of these accounts were recorded. Several were written by people who had not travelled themselves but rather used known descriptions and other notes. Even those dictated or written by the travellers themselves were written down several years after the fact. Regardless of these setbacks in the precision of their accounts, these historical documents provide a valuable sense of life in the times and places they have captured.

Table 1.2: Early reports of marine resource exploitation along the coast of eastern Africa Data from (A: Freeman-Grenville 1962; B: Casson 1989; C: Mackintosh-Smith 2002)

Author/work	Date AD	Location	Marine products/tools	Uses	Pg
Periplus Maris Erythraei	First century	Menuthias Island on Azania coast	Sewn boats, dugout canoes, baskets	Fishing	B:59 A:1
		Rhapta Island	Tortoise shell, nautilus shell	Export	B:61 A:2
Tuan Ch'eng-Shih	9th century	Land of Po-pa-li	Ambergris	Export	A:8
Al-Mas'Udi	c. 915	The Zanj	Amber[gris]	Export	A:14
Al-Idrisi	1100-1166	Malindi	Fish	Fish, cure and sell	A:20
Chao Ju-Kua	1226	Ts'ong-pa (Zanguebar)	Ambergris	Export	A:21
Marco Polo	c. 1295	Zanzibar	Ambergris	Export	A:26
Ibn Battuta	1325-1354	Maqdashaw	Fish	Subsistence	C:90 A:29
		Mambasa	Fish	Subsistence	C:90 A:31

Among these histories are descriptions of the food resources consumed at settlements along the coast. Little is mentioned about the fishing practices of the encountered people. The earliest description of fishing appears in *Periplus Maris Erythraei*, and mentions the use of fishing gear:

> *The [Menuthias] island has sewn boats and dugout canoes that are used for fishing and catching turtles. The inhabitants of this island also have their own way of going after these with baskets which they lower instead of nets around the mouths of [? rocky inlets].* (Casson 1989, 59–60)

An account by Al-Idrisi highlights the importance of hunting and fishing as important forms of subsistence in the 12th century:

> *[Malindi] is a large town, whose people engage in hunting and fishing. On land they hunt the tiger and other wild beasts. They obtain various kinds of fish from the sea, which they cure and sell.* (Freeman-Grenville 1962, 20)

Although meat and grains are mentioned in some of the earlier texts, later texts seem to place an increasing emphasis on domesticated animal meat and rice. For example, a 14th century account of Mombasa by Ibn Battuta mentions mainly fish and bananas:

> *The inhabitants of this island [Mambasa] grow no grain, and it has to be transported to them from the Sawahil [Coastlands]. Their food consists mostly of bananas and fish.* (Mackintosh-Smith 2002, 90)

Two hundred years later, Mombasa is described as plentiful and varied:

> *This Momaça is a land very full of food. Here are found many fine sheep with round tails, cows and other cattle in great plenty, and many fowls, all of which are exceeding fat. There is much millet and rice, sweet and bitter oranges,*

> *lemons, pomegranates, Indian figs, vegetables of diverse kinds, and much sweet water.* (Freeman-Grenville 1962, 132: *The Book of Duarte Barbosa*, 1517-18)

Of particular interest, is that domesticated animals seem to take on a special role in Swahili social practices, as in the offering of sheep as gifts to welcome visitors:

> *On Monday, the 7th (of January) we again cast anchor off Milindy, when the king at once sent off to us a longboat holding many people, with a present of sheep, and a message to the captain-major, bidding him welcome.* (Freeman-Grenville 1962, 57: *Journal of the First Voyage of Vasco de Gama*, 1497–1499)

The descriptions of food items and their social milieu that are recorded in the travellers' accounts are invaluable insights into the past. However, they represent just one perspective, and are limited by the cultural outlooks of the observers. Archaeology provides another lens for understanding the connections between people and their environment through the remains of food items.

Material evidence of eating: burned seeds, bowls, and bones

In addition to the remains of animal bones found in excavated towns along the coast, the archaeological record of food consumption consists mainly of charred seeds and bowls. Other items used in the procurement and processing of natural resources, such as fishing tools, are rarely found in the archaeological record. Research on archaeobotanical remains on Pemba island shows that pearl millet was an important food item in the early economy of the region; although rice is present in small amounts in the early record, it becomes a major subsistence source after the 11^{th} century (Walshaw 2010, 141–2). Cotton and coconut are also found in significantly larger numbers after the 11^{th} century (2010, 142). The number of pearl millet remains increases again between the 13^{th} and 15^{th} centuries, which "may indicate that a widening of the subsistence base, and a return to the more drought-tolerant crops, was desired at this time" (Walshaw 2010, 142; Walshaw 2005). The increasing importance of rice after the 11^{th} century occurs as important cultural changes, such as the establishment of large urban centres and widespread Islamic practice, are taking place along the coastline, as described above.

Ceramic vessels are typically durable and numerous, representing a large component of the archaeological record at Swahili sites. They reflect not only technological and artistic skills used during their creation but also the nature of consumption activities for which they were used. Analysis of locally made ceramic types across the region reveals a shift in the form of ceramic vessels. Jars dominate coastal pottery assemblages from the 8th to 11th centuries but are replaced with large open bowls and wide-mouthed jars after the 12th century (Fleisher 2003, 264–5; Fleisher 2010). This shift in ceramic form is reflected in the assemblages of imported wares (Fleisher 2010, 205–6). Locally-made large bowls in this period also had two other distinctive characteristics: bases and elaborate decorations around their interior rims.

Evidence of shellfish consumption is also found in the excavation of Swahili settlements, and there are several available data sets of shell assemblages (e.g., Msemwa 1994; Chami 1994; Kleppe 1995; Mudida and Horton 1996; Wilson and Omar 1997; Radimilahy 1998; see Fleisher 2003 for a summary). However, the role of shellfish consumption in past coastal East African communities is not well understood and requires a regional synthesis that was not within the scope of this thesis. Msemwa's (1994) ethnoarchaeological research on shellfish exploitation in Tanzania showed that shellfish collecting is a difficult task undertaken by people without access to other means of sustaining themselves or when alternative types of food or work are not available; for example, in Dar es Salaam, shellfish was more commonly eaten when fishing was less productive. These observations suggest that shellfish consumption is mostly associated with times of stress or poverty, but further work is needed to understand the meaning of past shellfish consumption.

A series of significant changes in the patterns of consumption are evident in the archaeological record of the Swahili coast. The increased consumption of rice and the increased use of large, open, decorated bowls occurred together after the 11th century and could be related. Large bowls are more suitable for serving rice dishes than the typical millet foods that tend to be more liquid (Walshaw 2010, 148). Furthermore, the use of rice and open bowls could be associated with the practice of feasting along the coast. Fleisher (2010) describes large open decorated bowls as important tools used by elite members of Swahili towns to establish and maintain power and authority during ritual feasting, which occurred in a competitive atmosphere among towns. These consumption changes occur within the context of increasing trade and urbanization on the Swahili coast between the 11th and 14th centuries. Larger urban populations were also needed to sustain a labour base for the cultivation of rice at a larger scale (Walshaw 2010, 149).

Taken together, the various forms of evidence informing our understanding of Swahili culture point to interesting patterns in the uses and processes associated with the procurement and consumption of food items. The linguistic and historical evidence indicate that fishing and fish consumption was a major component of Swahili subsistence practices throughout the history of the region. However, an important piece of the puzzle is missing: the information obtained from the analysis of faunal remains has been described in relation to a few excavated coastal settlements—I summarize these in a regional analysis and compare local consumption practices at two 14th to 16th century towns. The role of fishing and fish consumption on the Swahili coast is revealed at various scales, from the distribution of consumption activities around a household to the variable exploitation of marine habitats across the region.

1.6 Summary

This chapter introduces the Swahili coast as the area of study and zooarchaeology as the principal approach to study the intersection of food, environment, and culture that forms the basis of this thesis. I described how the question of subsistence in African archaeology is largely dominated by studies of large scale changes related to the use of domesticated plants and animals. I proposed the study of fishing strategies in Swahili settlements as way of understanding the interrelated roles of culture and environment in subsistence strategies. With both a regional and localized approach, this study is also an opportunity to understand differences within the Swahili region. Historical sources on subsistence in the Swahili coast portray animal products as trade items, food and symbolic objects, with an increasing reliance on domesticated bovids; I explore these trends in the following chapters through faunal analysis and ethnoarchaeology.

1.7 Thesis aims

The tropical coastlines of East Africa contain the ruins of once vibrant commercial towns, where archaeologists now find long continuous records of fish consumption. This study investigates fish exploitation throughout the development of Swahili settlements during a period of 1000 years from AD 500 to 1500. One goal is to identify the extent to which fishing is a key part of Swahili culture through an overview of the varying patterns of fish consumption across the region. The second aim is to reveal aspects of the daily life of different members of a Swahili community by showing how age, status, and gender play a role in fishing activities. Finally, this thesis seeks to identify and explain changes in subsistence strategies in this region against a backdrop of cultural and climatic changes in order to understand how human-environmental interactions shape history and culture.

Previous work on subsistence strategies in Africa has viewed climate as a critical pressure for subsistence change, which in turn has led to other social changes such as the development of complex societies (Hassan 2002). This view focuses on the dichotomy of culture and environment. Climate is viewed as the driving force in the spread of domesticated plants and animals in Africa. The role of additional subsistence strategies, namely hunting and fishing, is often ignored. Thus, subsistence change in Africa is largely understood through studies of agriculture and pastoralism in large regional and temporal timescales in the distant past.

My study of food consumption on the East African coast investigates the role of subsistence in society through a focus on fish exploitation on both a regional and localized scale. I used a multidisciplinary approach to study the interrelated roles of environment and culture in consumption practices. The following questions form the basis of my thesis:

1. How does fishing and fish consumption differ in space and time across the Swahili region?
2. How are environment and culture related in fishing and fish consumption?

3. How does fishing and fish consumption form a part of the social organization of a site?

The principal source of data was the identification of animal remains through zooarchaeological methods to determine which animal species were eaten throughout this region. I consolidated published and unpublished sources of faunal remains from excavations on the Swahili coast to review Swahili subsistence strategies from a regional perspective. In addition, I analysed 4,452 fish remains and 1,978 other animal remains excavated from two Swahili towns as comparative case studies to provide insight into local subsistence practices. I summarize and explore these data, collected between 2010 and 2011.

An ethnoarchaeological study complements the zooarchaeological analysis of local and regional subsistence patterns. I recorded 89 semi-structured and structured interviews and undertook participant observation during two field seasons in 2009 and 2010. These were conducted at three coastal fishing communities in southern Kenya to record the social dynamics and taphonomic processes of fishing and fish consumption in an East African coastal environment.

I explore the relationship between culture and environment in changing subsistence practices through a multidisciplinary approach that combines methods and perspectives from the fields of marine ecology, ethnography and paleo-climatic studies in addition to archaeology. I applied ecological models to the archaeological fish data to identify exploited marine habitats through time. Published paleo-climatic data from four East African lakes provided a history of wet and dry periods in the region.

A comparison of fishing practices at two 14th to 16th century Swahili towns—Songo Mnara and Vumba Kuu— along with the regional overview of Swahili fishing and diet, allowed me to demonstrate the variability of Swahili communities and identify shared regional patterns of food consumption and subsistence strategies. This approach acknowledges the interrelationship between people, their history and environment.

Organization of thesis

The thesis is organized to reflect the trajectory of fish from its natural environment into the cultural realm in which it is transformed and discarded, where fish remains are eventually excavated and analysed. The first three chapters serve as a background to the conceptual framework of the thesis (Chapter 1), the methodological approach (Chapter 2), and the natural contexts in which fish are exploited (Chapter 3). Chapter 4 explores the cultural processes that transform fish from the moment of capture to deposition, using ethnoarchaeological research I conducted in Kenya. The next three chapters contain analyses of zooarchaeological data at a regional level (Chapter 5) and at a town level (Chapters 6 and 7), followed by the conclusions (Chapter 8).

This first chapter is an introduction to the history of the Swahili region, with an emphasis on evidence of subsistence strategies, and the methodologies and theories underlining previous cultural-environmental studies. I summarize the zooarchaeological approach and address how my research on Swahili fish exploitation contributes to the study of food consumption in African archaeology.

The aim of Chapter 2 is to present the value of fish remains in the pursuit of archaeological questions related to diet, society and the connection between societies and their environments. I outline the zooarchaeological methodology I apply to the analysis of faunal remains from two Swahili settlements noting the challenges of taphonomy, such as the biases resulting from preservation, excavation, sampling and analysis. Examples of convincing interpretations of archaeological fish remains show the potential of zooarchaeological data to address questions that range from environmental reconstructions to social inequality.

The purpose of Chapter 3 is to create a link between various fish species and particular East African coastal environments and fishing methods that will help me interpret trends in the archaeological data. I explore variability in the environmental setting across space and time in order to determine the environmental factors that influence the composition of fish catch. The association of particular fish species to specific coastal habitats is useful to determine the range of exploited habitats in the past. I discuss how these marine environments may be affected by changing climatic conditions and anthropogenic pressures. Lake cores provide a regional picture of shifting dry and wet periods over a century to decadal time scale throughout Swahili history; a significant climatic shift is recorded at the end of the 12th century that may have affected coastal habitats. I consider the types of archaeological evidence of environmental change on the Swahili coast that may serve to identify how local coastal communities mitigated these environmental changes.

In Chapter 4, I discuss the application of ethnoarchaeology to archaeological interpretation, comparing two different forms of analogy—relational and historical—in relation to Swahili zooarchaeological data. I summarize the contributions of published fishing ethnoarchaeologies and four main ethnographies of Swahili fishing. My ethnoarchaeological study in Vanga and the surrounding area is an example of the use of analogy to aid interpretation of faunal remains. I discuss how I apply ethnoarchaeology to my interpretation of the final data analysis; for example, an emphasis on the material traces that result from the capture, use, transformation, and disposal of fish allows me to understand the social behaviours behind the patterns that result from these processes.

In Chapter 5, I combine all available zooarchaeological data from the Swahili coast to identify spatial and temporal trends at the regional level. This regional comparison highlights methodological discrepancies in the history of Swahili zooarchaeology. I consider these differences when selecting a comparative data sample for regional analysis. My interpretation and discussion is aided by insights from the chapters on ethnoarchaeology and fish ecology. I analyse spatial differences in the exploitation of marine habitats and subsistence strategies along the Swahili coast. Comparing settlements with long term faunal data, I consider changes in subsistence and fishing strategies throughout the span of Swahili history. The regional analysis allows me to identify general trends across the region and throughout the span of Swahili history as well as differences among the varied settlements, showing that although inhabitants of the Swahili coast engaged in a combination of fishing, rearing of domesticated animals, and hunting, these activities varied across the region.

Chapters 6 and 7 include the core of original data from two recently excavated towns on the East African coast: Chapter 6 is dedicated to Songo Mnara in southern Tanzania, and Chapter 7 to Vumba Kuu in southern Kenya.

Each chapter includes a description of the area's historical and environmental background, in addition to a discussion of the methodology used for analysis and a descriptive summary of the fauna identified at each site. These contemporaneous sites represent different coastal environments and different levels of urbanity that allow me to compare and contrast diet and fish consumption trends in two contrasting sets of conditions. The island settlement of Songo Mnara contains a series of well-preserved architectural features that make this Swahili town a good case study to explore the use of space during its relatively short period of occupation. Vumba Kuu, on the other hand, lies along a creek on the mainland coast and is characterized by an extensive oral/written record but limited remains of architectural features. The results of zooarchaeological analysis portray the differences and similarities of life at these two contemporaneous Swahili towns.

The final chapter (8) is dedicated to the concluding remarks, summarizing how my study contributes to our understanding of subsistence in both a regional and localized setting, recognizing the interrelatedness of culture and environment. I review the role of fishing and fish consumption at different scales, from the distribution of food debris around a household, to differences in consumption practices across a town, to the varying exploitation of marine habitats across the region. I discuss the limits of my study and future research directions.

Chapter 2: Diet and Society Revealed through Fish Remains

"It is only in the last few decades that archaeologists have begun to appreciate how abundant and informative fish remains can be."

-A. Wheeler and A.K. Jones, 1989 (p. 7)

2.1 Introduction

I used three principal forms of data to connect the evidence of changes in marine resource exploitation to the social and environmental contexts of Swahili settlements. Ecological data (Chapter 3) describe the environmental setting in which fish are captured. Ethnography (Chapter 4) provides the background for understanding social and material aspects of fishing and fish consumption. The focus of this chapter is on fish remains and what they contribute to our understanding of diet, society and the connection between societies and their environments. I begin with an overview of methods and applications of fish bone analyses. In the second part of this chapter, I describe how zooarchaeologists use these analyses to form interpretations of past societies. I summarize their application to our understanding of Swahili marine exploitation and subsistence patterns.

2.2 Why fish?

A widely misused term, "*fish* refers to fin fishes (i.e., cold-blooded animals possessing backbones, fins, and gills)" (Colley 1990, 208). Fish have formed a regular part of the human diet since the earliest modern humans. Isotopic analysis of a 40,000 year old mandible from one of the earliest modern humans in Asia shows evidence for regular consumption of freshwater fish (Hu et al. 2009). At Jerimalai shelter in East Timor, near Australia, fish contributed 56% of the total weight of faunal remains accumulated by early modern humans occupying the shelter as early as 42,000 years ago (O'Connor, Ono, and Clarkson 2011, 1118). Moreover, pelagic fish—mostly tuna (Scombridae)—made up half of the fish identified from the earliest levels of occupation, leading researchers to believe that early modern humans had the "high level of maritime skills and technology" necessary to carry out pelagic fishing (2011, 1120). Fishing can thus be regarded as one of the major forms of subsistence in the history of the human species.

The field of ichthyoarchaeology (*ichthy-* Greek origin, meaning fish) is a branch of zooarchaeology that analyses excavated fish bones to investigate how fishing relates to human diet, technology, social structure and environment. This budding field has confronted a series of challenges during previous decades: lack of good reference collections and practical guides, easy fragmentation of the bones and ignorance of their value (Wheeler and Jones 1989). The formation and development of the Fish Remains working group, a subgroup of the International Council of Archaeozoology (ICAZ), attests to the growing interest in the field of ichthyoarchaeology over the last 30 years. From the first 1981 meeting in Copenhagen, with seven presentations, the group has grown to include over fifty presentations at the latest meeting in Jerusalem, October 2011 (Morales Muniz 1996; Irit Zohar et al. 2011).

Despite widespread evidence of fishing on the Swahili coast, East African ichthyoarchaeology has only just recently entered the international arena of ichthyoarchaeological research. A large part of the reported assemblages of fish remains form part of site-focused monographs (summarized in Chapter 5). The disjointed nature of these findings has stunted the development of a consistent regional methodology and restricted our understanding of fishing in the history of this region. In the following sections, I review relevant ichthyoarchaeological methodologies and discuss how I apply them to analyse fish remains from Swahili contexts.

2.3 Reference collection

A reference (or comparative) collection is an assortment of skeletons of the representative animals found in an area for the purpose of identifying excavated animal bones. Essentially, one can identify a bone (what part of the body and which animal it belongs to) because of the morphological (form and structure) differences that vary among animals and different sections of the body. For example, a femur serves certain functions within the body that give it a particular structure—a rounded head that allows it to pivot and a long body for the attachment of large muscles. Furthermore, a human femur differs from a cow femur because of variations in function—bipedal vs. quadrupedal movement

(Figure 2.1). Zooarchaeologists use morphological differences to identify the taxa of a given bone.

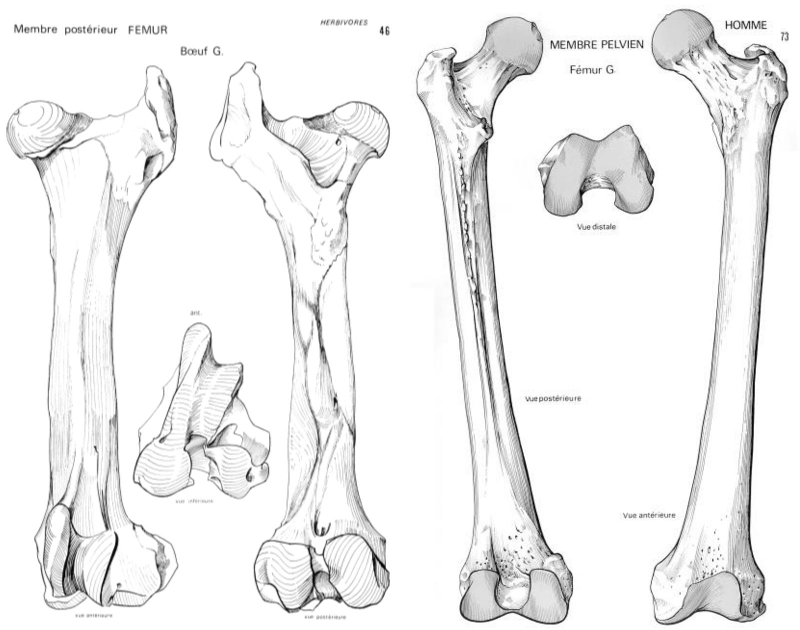


Figure 2.1: Comparison of cow (left) and human (right) femurs (Pales, Lambert, and Garcia 1971, Vol. 1: 46, Vol. 2: 73)

"Identification and subsequent analysis is only as good as the reference collection" (Reitz and Wing 2008, 362). This phrase, echoed in the work of many zooarchaeologists, emphasizes the importance of a good reference collection as a basis for zooarchaeological research. While a trained eye and experience certainly help, a reference collection is essential to correctly identifying bones to the most specific taxonomic category possible with certain degree of confidence. And if an archaeologically recovered bone is compared to a reference bone for identification, one can see the importance of correctly identifying reference specimens. A reference collection is central to the study of fish remains because of the great assortment of fish species that are exploited by humans, particularly from tropical marine waters as rich as the Western Indian Ocean. The sheer quantity and complexity of bones found within a single fish paired with the large array of fish types make ichthyoarchaeology a challenge and a joy.

Three established collections were essential to my identification of animal remains from Vumba Kuu and Songo Mnara: the collection of East African animals at the Osteology Department, National Museums of Kenya, in Nairobi; the Béarez collection of Indian Ocean fish at the Muséum national d'Histoire naturelle, Paris; and the mammal and bird osteological reference collections at the Environmental Archaeology Unit, University of York. The Nairobi collection contains over 300 fish specimens representing approximately 160 species from the coastal region of Kenya, mostly marine but some found in the rivers that flow into the coastline. The Kenyan collection also holds a large range of other animals present in East Africa. The Paris collection includes over 300 specimens of approximately 250 species of marine fish mostly from Oman but also representing other regions from around the Indian Ocean. At the University of York, I used the collections of domesticated animals and wild birds.

Figure 2.2: An ichthyoarchaeologist at work in the lab (Fish osteological collection behind her, Paris 2011)

Additionally, I collected 21 fish skeletons (list in Appendix A) during my fieldwork around Vanga to prepare and donate to the comparative collection at the Osteology Department, Nairobi. These fish specimens were useful in identifying the archaeological material presented in this thesis, and are now available to other researchers accessing the collections. I undertook the collection and preparation of these specimens with the help of Philippe Béarez, ichthyologist at the Muséum national d'histoire naturelle. The collection of fish skeletons involved buying fresh fish from local fishers. We photographed and measured each specimen with a standard metric measuring tape and recorded TL (total length), SL (standard length), HL (head length), and FL (fork length, only in the case of Carangoides spp.) (refer to Figure 2.3). We then weighed each fish using a 5 kg scale (Soehnle B001IT1M9K). We relied on the identification keys published by the Food and Agriculture Organization, primarily the *FAO Field Guide for the Western Indian Ocean* (Fischer and Bianchi 1984), to accurately identify the specimens. Once identified, we filleted the fish and boiled the skeleton for 5 to 10 min. We separated the bones from the flesh with tweezers following a standard order to ensure we retrieved all elements. The paired cranial and appendicular elements were separated from each side (similar order to Lepiksaar 1994), followed by the removal of the neurocranium and postcranial bones. The bones remained in containers full of water for 3 to 4 days to remove all the soft tissue from the bone until final cleaning and drying. More detailed information about methods for preparing, storing and curating a comparative osteological collection are available in a variety of published works (Casteel 1974; Wheeler and Jones 1989; Reitz and Wing 2008).

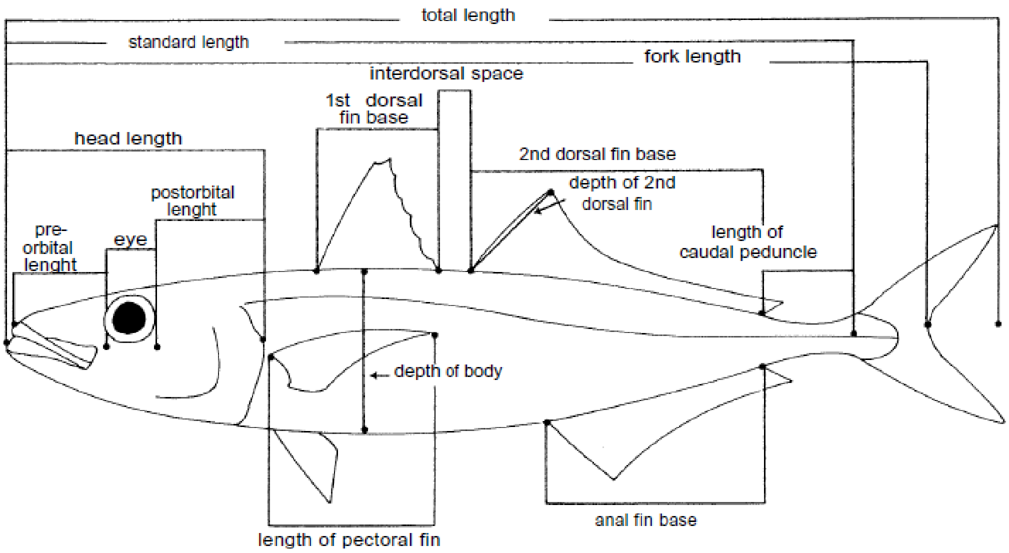


Figure 2.3: Standard fish measurements (Fischer and Bianchi 1984)

2.4 Taphonomy: from the sea to the lab

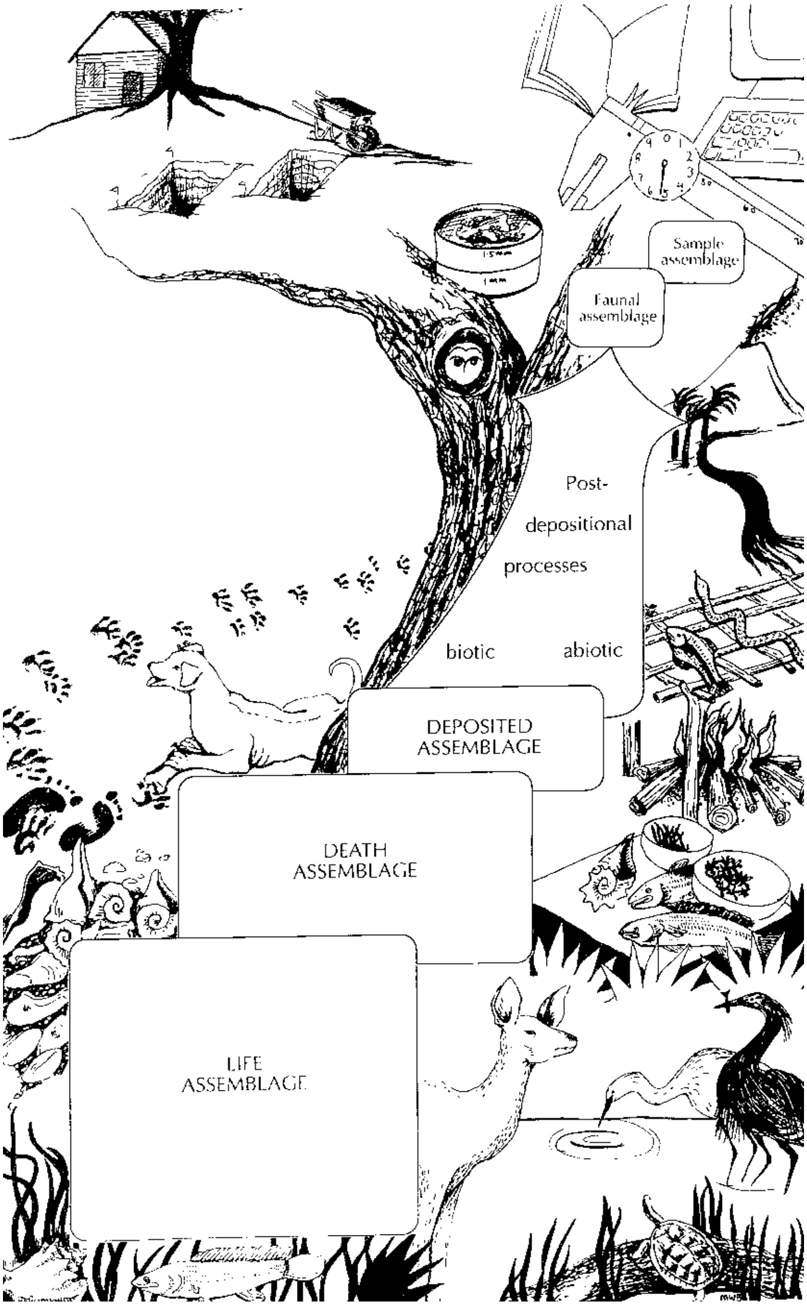


Figure 2.4: Illustrated model of faunal remains taphonomy (drawing by Molly Wing-Berman in Reitz and Wing 2008, 111; fig. 5.1)

Taphonomy is essentially the path that takes living things into the hands of a zooarchaeologist. Several authors (Klein and Cruz-Uribe 1984, 3; Reitz and Wing 2008, 111) recognize a series of five stages that summarize this process (Figure 2.4). In effect, a reference collection ideally represents the **life assemblage**, the living creatures that occur in a given area—e.g., populations of fish in the Western Indian Ocean. However, only some of those animals that come into contact with humans become part of the **death assemblage**—e.g., the fish caught in a line. The use and transformation of these animals in human hands determine the nature of the **deposited assemblage**—e.g., the burned remains of a fish skeleton in a rubbish pit. A series of post-depositional processes over time create the **faunal assemblage** which the archaeologists encounter—e.g., the robust fish elements that are better preserved. Finally, excavation design and methods determine the actual **sample assemblage** of faunal remains that a zooarchaeologist analyses.

It is important to consider the taphonomy of the material under study and recognize the possible biases at each stage in order to comprehend the limits of analysis before making an interpretation. The transformation of fish material in human hands may include processes from catch to excavation: selection; breakage during catch; scale/spine removal and discard at sea or land; method of processing, including smoking, drying, pickling, decapitating, gutting, filleting; eating; discarding; bone recovery; sampling, and human error in handling remains (Wheeler and Jones 1989). Abiotic factors (i.e., non-living chemical and physical factors in the environment) also play a role in the transformation of animal remains. For example, the bones of certain species (particularly of larger fish) preserve better than others, and fish bones are in general less resistant than mammal bone (Wheeler and Jones 1989). Soil conditions, such as the pH and presence of mineral particles that can increase abrasion, are important in understanding the composition of an assemblage during its interpretation. Neutral and alkaline soils favour the preservation of fish remains over acidic soils while abrasion increases weathering of the bone.

Many taphonomic factors, although potentially recognized by archaeologists, are out of their control—these are what Reitz and Wing (2008, 112) call ‘first-order’ processes. However, archaeologists are responsible for ‘second order’ changes that lead to the sample assemblage. In order to collect a useful sample for analysis, sieving is “paramount” during the retrieval of fish remains to ensure fish of different sizes are represented (Colley 1990). Optimal mesh size is contested by archaeologists, but it generally falls within the range of

0.5-3 mm (Wheeler and Jones 1989; Colley 1990). Hand collecting is not recommended because of human bias and the danger of overlooking small bones. However, it may be impractical to sieve the whole deposit; thus, developing a sampling strategy suitable for the questions, site, and resources of research may become necessary. Sampling is also part of the analysis phase; for example, an ichthyoarchaeologist may choose the most informative bones from her assemblage for measurements.

This discussion of taphonomic processes underlines the importance of a consistent methodology in order to compare different assemblages. Unfortunately, the methodologies of published fish remains data from the Swahili coast vary widely, from the examination of every identified fragment to simply noting the absence or presence of fish. This makes it difficult to make direct regional comparisons. Within an excavation project, such as at Songo Mnara and Vumba Kuu, the same excavation techniques—sieving, soil descriptions, storage of materials, and so on—are used around the site in order to control for second order taphonomic differences. Differences in first order taphonomic changes—such as the conditions for preservation—are evaluated for the various contexts around the site. When the contexts of several faunal assemblages are believed to be comparable, then differences in the representation of bone elements and species composition can be attributed to social factors. The goal of the zooarchaeologist is to disentangle the web of taphonomic processes that form the sample assemblage that reaches her lab.

2.5 Data analysis

During laboratory analysis, I identified the faunal remains from Vumba Kuu and Songo Mnara to the most specific taxonomic level possible and recorded any signs of modification and processing, such as cut marks and burning. The data I collected fall within two categories: primary and secondary data (Table 2.1). These categories distinguish between primary data “based on observational units or empirical manifestations” and the “analytical products” that are derived from the first (Lyman 1994).

Table 2.1: Primary and secondary data collected

	Primary Data	Secondary Data
Fish	• Provenience (trench, context) • Taxonomic identification (Class, Family, Genus, Species) • Body part (element, side) • Number of fragments • Weight (grams) • Reference specimen used in identification • Evidence of burning (colour scale) • Other modifications (cutmarks and distortions) • Measurements of width and diameter (shark and ray vertebrae only)	• MNI (cranial elements only) • Estimated weight (from direct comparison with reference specimens)
Tetrapod	• Provenience (trench, context) • Taxonomic identification • Body part (element, side, section) • Number of fragments • Reference specimen used in identification • Modifications (cutmarks, burning, gnawing) • Weight (grams) by taxonomic group • Fragment size categories (<3cm or >3cm, of maximum dimension)	• Age (unfused elements, tooth wear)

The following sections describe in detail the categories of data that I used to analyse the fish remains, which represent the majority of the faunal remains and are the focus of this research. However, many of the discussed aspects are relevant to the study of other animal remains.

Primary data: elements

Of the fish represented in archaeological assemblages, cartilaginous and bony fishes are easily distinguished from each other. The skeletons of chimaeras, sharks, rays and skates are made of protein and fibre with only some parts reinforced with layers of calcium phosphates and carbonates. Thus, jaws, teeth, scales and vertebral centra represent cartilaginous fish in the archaeological record (e.g., Figure 2.5). Their teeth are different sizes within the jaw; they are not attached to the jaw and shed. Teeth also reflect diet and feeding habits as well as sexual dimorphism, in some cases. Dermal denticles (also called placoid scales) are scales mostly found on cartilaginous fish but also on a few bony fish such as

Acanthuridae; they do not shed or grow and are useful for identification but too variable for detailed studies (Wheeler and Jones 1989).

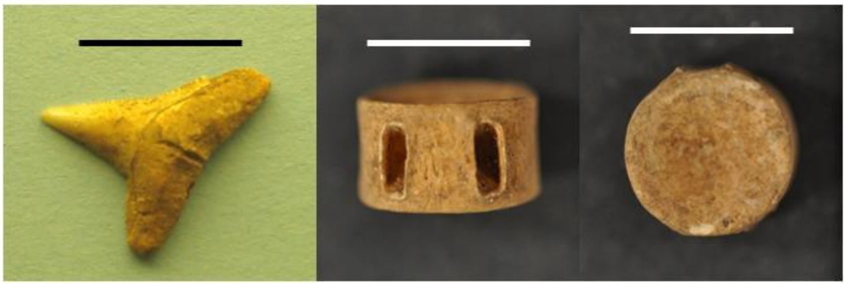


Figure 2.5: Shark tooth and vertebra
(tooth from SM006006 and vertebra from SM010020; line=1cm)

Bone is an organic and inorganic fibrous compound of collagen and hydroxyapatite (Reitz and Wing 2008). Fish bones can be easily recognized by their light fibrous (almost wood-like) consistency. Fish continue to grow throughout their lives, and bone growth is linked to seasons (see section on seasonality). The structure of bony fishes can be divided into three parts: (1) the head consists of a neurocranium (braincase), food securing bones (jaws and gills), and throat (hyal and branchial systems); (2) the axial skeleton contains the vertebral column, caudal fin, dorsal fin, anal fin, and ribs; (3) The appendicular skeleton has pectoral and pelvic fins. Many of the bones that are most easily identified are found in the head and throat. The neurocranium consists of many fused components that are difficult to identify as fragments except for the vomer, basioccipital, parasphenoid, frontal, and supraoccipital (Figure 2.5).

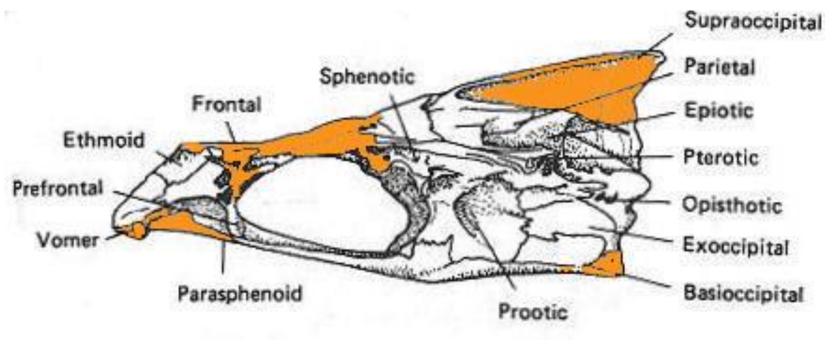


Figure 2.6: Cranium of a fish
Highlighted bones indicate those most easily identified: vomer, parasphenoid, frontal, basioccipital, and supraoccipital (adapted from Reitz and Wing 2008: 371).

The lower jaw is composed of the dentary, articular and angular bones. The upper jaw has a pair of premaxilla, maxilla, and sometimes a supramaxilla. This series of jaw bones are very useful as they reflect the fish's feeding habits and vary according to species (Figure 2.7). Some fishes, such as the parrotfish, have developed bone structures for processing food in their throats. In these cases, the throat bones (pharyngeal) will also reflect feeding behaviour. The gill cover (operculum) consists of four bones (opercular, preopercular, interopercular and subopercular), most of which are generally useful for identification except for the interopercular. Other useful bones for identification include: cleithrum, supracleithrum, posttemporal, hyomandibular and quadrate. Indeed, the most abundant elements in the analysed material—excluding vertebrae and spines—from Songo Mnara were (in order): premaxilla, dentary, quadrate, articular, maxilla, and hyomandibular (Figure 2.8). Higher preservation rates and easily distinguishable features combine to make these bones the most commonly identified.

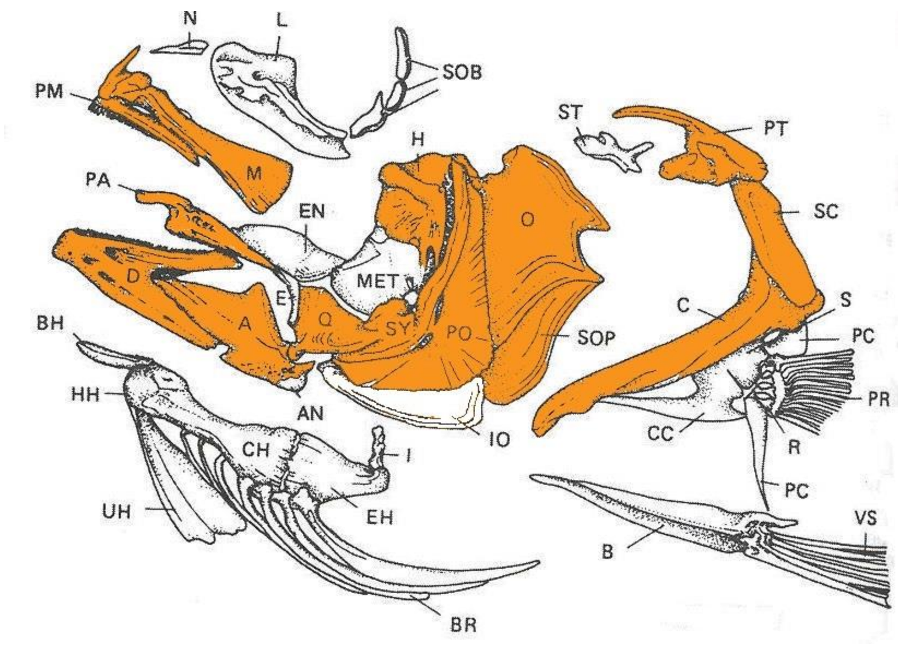


Figure 2.7: Jaw and appendicular bones of a fish
Bones most easily identified are highlighted and include: premaxilla (PM), maxilla (M), dentary (D), articular (A), quadrate (Q), hyomandibular (H), palatine (PA), opercular (O), preopercular (PO), subopercular (SOP), cleithrum (C), supracleithrum (SC), and posttemporal (PT) (adapted from Reitz and Wing 2008: 372).

Figure 2.8: Lethrinidae bones from across Songo Mnara
Left across: maxilla, dentary, quadrate; articular, premaxilla, hyomandibular; palatine (line=1cm)

However, I did not limit my identification to the most common 6 elements; my analysis includes 39 different elements. Other elements have diagnostic characteristics that are unique to certain families, such as the Lethrinidae palatine (Figure 2.8), the first dorsal spine of the Balistidae fish, and the Scaridae pharyngeal bones. I identified all elements in the material, where possible, in order to account for as many possible taxa. All elements where described as either left, right, or axial. I did not describe what sections of an element where represented (unlike nonfish elements that I described as complete, fragment, distal, proximal or shaft) because identifiable elements were mostly complete. Those that were not were usually unidentifiable fragments.

Vertebrae were the most common element in my material, which is usually the case in fish assemblages. They are common because there are many within one fish, they usually have a robust structure, and they preserve well in soil. In cartilaginous fish, the vertebral column continues in decreasing size while in bony fishes it ends in a series of modified vertebrae called urostyle that attaches to the caudal fin. Vertebrae can be divided into precaudal and caudal, the latter differentiated by having a haemal spine on the ventral side (Figure 2.9). The caudal vertebrae can be highly distorted and similar among species. Furthermore, vertebrae are difficult to identify because they vary depending on their position within the vertebral column and their key diagnostic parts are the most fragile.

The number of vertebrae varies by species. However, some fish may only be represented by vertebrae, therefore it is important to identify these elements.

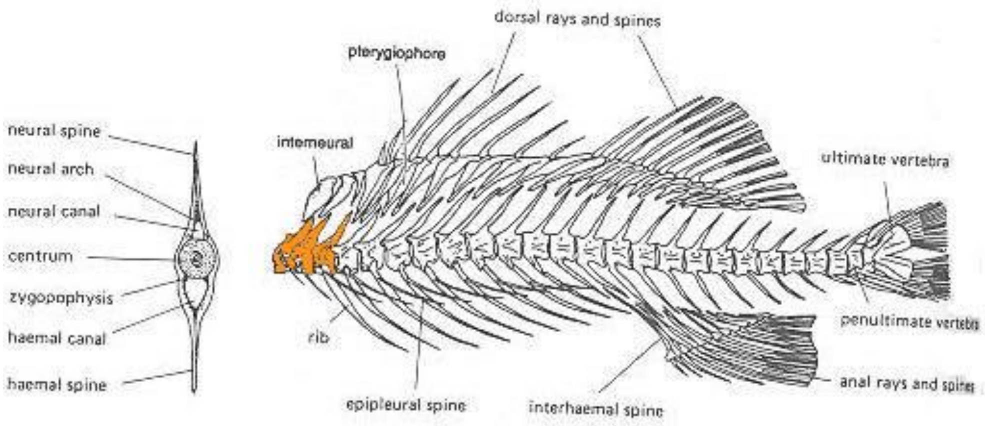


Figure 2.9: Axial skeleton of a fish
Highlighting the first three vertebrae that have more identifiable features
(adapted from Reitz and Wing 2008: 372).

Ichthyoarchaeologists have proposed several methods for dealing with vertebrae. Wheeler and Jones (1989) emphasize the importance of a good reference collection. They suggest first identifying the jaw bones in the assemblage to have an idea of expected species. Colley (1990) outlines some characteristics to aid the classification of vertebrae by shape (round, squashed, oval); sculpturing of lateral and ventral aspects; position, shape and angle of processes; and shape and size of neural arch. This classification system may aid during the use of a reference collection but does not solve the problem of vertebrae complexity. Radiography was proposed by Georges Desse (1984) but identification through radiographic images is just as meticulous as using a reference collection and more expensive; radiology is perhaps most useful with particular cases such as sharks and rays that have vertebrae with few external diagnostic features.

I identified vertebrae with a reference collection after the identification of cranial and appendicular elements, as suggested above. For the Vumba Kuu and Songo Mnara material, I chose to sample certain contexts to identify vertebrae (more details in Chapters 6 and 7). This allowed me to maximize the limited time I had to work with the reference collections, which were spread across different continents. Although this limited my ability to compare vertebrae across the entire site, it provided a picture of the types of fish that are better represented in analysed samples of vertebrae and nonvertebrae, allowing me to identify biases associated with my material. I described vertebra as either caudal or precaudal, and indicated the position of precaudal vertebrae when possible.

Otoliths and scales are two other important elements useful in ichthyoarchaeology, although virtually absent from my material. Otoliths, also known as ear stones, are aragonite (calcium carbonate) parts in the ear used for hearing and balance (Figure 2.10). Finfish have three: sagittal, asteriscus, and lapillus. These elements show seasonal growth and their shape is species specific, making them useful tools for interpreting past fisheries (e.g., Van Neer at al. 1999; Higham and Horn 2002; Van Neer et al. 2002). However, they are usually found in alkaline and neutral pH soils such as base-rich deposits in shell sands. Limited preservation may explain in part why otoliths are virtually never reported for Swahili sites, although other cranial elements occur. Another explanation could be that excavators are not trained to identify them in the archaeological deposits—their small rounded shape could easily be confused with rocks. I have participated in the excavations myself and failed to find any. There seems to be some debate as to the potential contributions of otoliths in archaeology. Wheeler and Jones (1989) see them as having limited use because the growth varies with sex and environment. However, it is perhaps exactly this aspect that makes them most useful, in that they reflect the conditions of the environment and are thus useful for studying seasonality.

Figure 2.10: Lethrinidae otolith (line=1cm) (Lass 2011)

Scales come in two general types in bony fishes: ganoid (often rhomboid in shape) and elasmoid (charactericistly round and present in the majority of bony fishes) (Helfman et al. 2009). Cycloid and ctenoid scales are the principal types of elasmoid scales. They can be identified to species level but are rarely recovered in Swahili archaeological assemblages. Elasmoid scales could be another avenue for estimating fish size since their length and diameter have linear relationships to fish length. However, they are not found consistently enough to form a good sample for analysis. Some placoid and ganoid scales survive well and are used for identification of certain species, but the grand majority of elasmoid scales are fragile and more difficult to recover.

Primary data: taxonomic identification

I identified all the analysed material to the most specific taxonomic level possible: class, family, genus, species. In some cases, I was not able to identify the exact species but the element in question was very similar to a reference specimen. These cases are denoted by a 'cf.' (*confer*) before the taxonomic identification. In all cases, I noted the reference specimen used for identification. A species is a population of organisms that produce fertile offspring under natural conditions. There are over 32,400 species of fish in the world (Froese and Pauly 2012), of which more than half live in salt water habitats. Fish are very diverse and adaptive. This plethora of diversity, which is reflected in the behaviour and physiology of fishes, is what leads Wheeler and Jones to conclude that "perhaps the most fruitful study [in ichthyoarchaeology] is in species distribution" (1989, 76). Identifying fish remains to species level permits numerous types of analyses. Wheeler and Jones (1989) divide taxonomical studies in archaeology into two categories. One is based on the presence or absence of fish species that may indicate whether the fishes are local or transported. Another way is to study species diversity through their relative importance. This can be calculated through numbers and weights of fragments, frequency, minimum number of individuals (MNI), or estimated weights (described as secondary data).

Primary data: modification

Ichthyoarchaeologists make note of any types of modification in their material, which could have occurred before or after the bones were deposited. I recorded a variety of modifications in my material, including burning, cutting, gnawing, and hyperostosis (Figure 2.11). Particular types of processing may be identified through cut marks and charring. Burned bones are good indicators of certain types of cooking that exposes bones to high temperatures, such as roasting.

However, bones may be burned after consumption by either intentional or unintentional burning of food waste. I recorded traces of burning on a colour scale: brown, black, grey, blue, and white. This gradient of coulors can be loosely associated with different degrees of burning or temperature scales (Nicholson 1993; Cain 2005). I recorded traces of cutting as presence/absence. Cut marks can be used to trace certain forms of processing, such as filleting (see Belcher 1998, 205; see also Shipman 1981). Other forms of processing that leave no marks (e.g., smoking, drying, salting) are difficult to trace. For example, beheading the fish by hand would leave no cut marks. Ethnoarchaeological studies can greatly contribute to this area of research, noting how fish are modified and the visible traces they incur in the process (Chapter 4).

Relatively few bones will survive digestion, which crushes and dissolves bone tissue. An experiment by A.K. Jones (1984) compared the bone survival rate through four fish consumers: humans, rats, dogs, and pigs. The results showed that 11% of bones passed through the human digestive system. No fragments were found in rat faeces. Pigs had the highest survival rate (13%), and dogs the highest percentage of vertebra survival (7%).

Figure 2.11: Examples of bone modifications in analysed material
From left: burned Lethrinidae palatine, cutmark on unfused sheep/goat metapodial, rodent gnaw marks on chicken humerus, hyperostosis in fish bone (line=1cm)

In the Swahili region most recovered bones are from middens of undigested bones, which are exposed to midden scavengers. Commonly identified modifications after deposition include gnawing by rats and carnivores, each with its signature marks (e.g., Lyman 1994b; Haynes 1983; Klippel and Synstelien 2007). Zooarchaeologists also record signs of weathering (e.g., Behrensmeyer 1978; Lyman and Fox 1989) and breakage patterns (Outram 2001; Pickering and Egeland 2006; Karr and Outram 2011) to interpret forms of food processing. Finally, hyperostosis is an excessive growth of the bony tissue found in certain fish species. This characteristic has been described in archaeological and reference fish specimens in other parts of the world (e.g., Béarez 1997; Guzman and Polaco 2002), and is also found in the Swahili fish remains (Chittick 1984; Mudida and Horton 1996). Several examples occur in the material from Vumba Kuu and Songo Mnara. I classified hyperostosis under modifications, although it is found naturally in living populations of fish.

Secondary data: taxonomic representation

One of the major debates in zooarchaeology is how to best quantify the relative distribution of taxa in an assemblage (e.g. Marshall and Pilgram 1993; Lyman 1994a; Dominguez-Rodrigo 2012). A comparison of the different measures of taxonomic distribution shows the strengths and weaknesses of each method. Number of Identified/Individual Specimens (**NISP**) is the number of identified elements per taxon. Its best asset is that it is straightforward. In fact, it is a form of primary data, but I include it here in order to compare it with a secondary form of frequency count. Frequency is measured by counting the number of times a species occurs in the contexts, which can then be used to calculate the relative frequency or percentage of the total number of species recorded. This measure favours taxa with robust bones that are better preserved and counts elements that come from a single fish individually. Thus, the frequency of a taxon can be overestimated.

Minimum Number of Individuals (**MNI**) accounts for exactly this problem by counting together bones that could be from a single individual. It is based on the comparison between the observed frequency of occurrence of an element and the expected frequency of occurrence. For example, bones that occur once in an individual (e.g. premover, basioccipital) each represent a single individual. When using paired bones (e.g. premaxilla, dentary), one must consider size differences and sides (right or left) to account for different individuals. Wheeler and Jones find MNI to have limited use because of mixing horizons: "surviving remains represent N individuals at least, but N is likely to bear no relationship to the number of individual fish which were brought to the site and which formed that horizon" (1989, 150). Often, the lines that separate archaeological contexts are not clear cut, making it difficult to attribute a set of faunal remains to a single deposit event. One of the main problems with this form of secondary data is the tendency to underestimate the number of individuals represented.

Another method is to sum the weight (**W**) of bones per taxon. Because size and weight varies among species, this method favours species with large solid bones and requires that the remains be equally clean. Elizabeth Wing (in Desse-Berset 1984) makes a distinction between NISP and MNI, and weight counts, stating that the first two methods "provide an approximate measure of the relative abundance of different taxa, while the weight of the remains reflects, at least within classes, the relative contribution different taxa may have made to the diet" (Wing in 1984; a similar argument is given in Van Neer 2002).

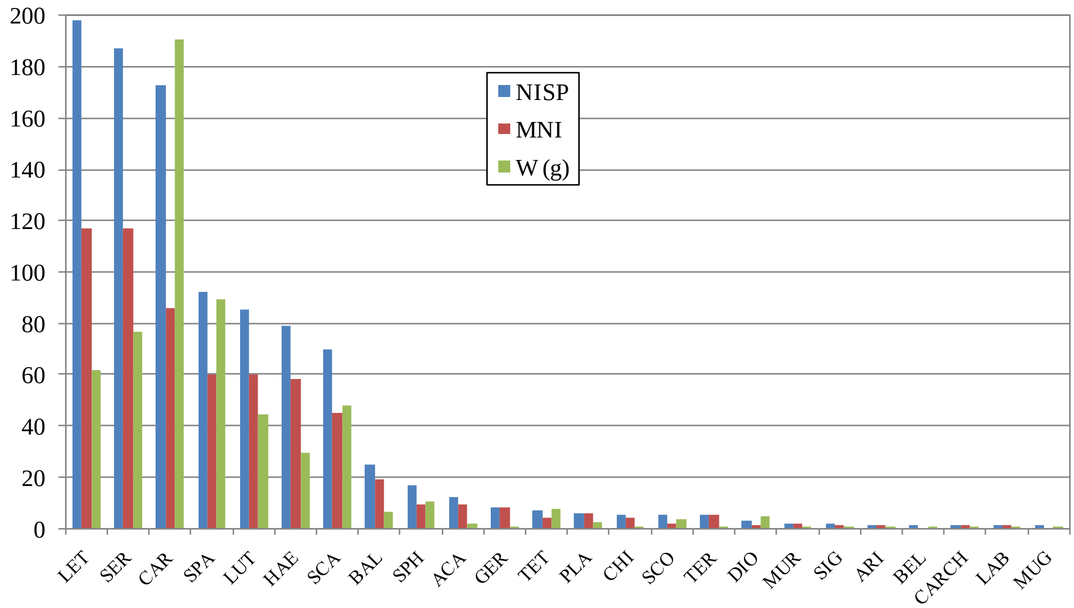


Figure 2.12: Measures of taxonomic distribution of fish families at Songo Mnara

I collected NISP and Weight (in grams) data of all the identified fish remains, and calculated MNI from the nonvertebral elements of identified taxa. Although methods for calculating MNI from vertebrae exist (e.g., Desse et al. 1989), I chose to focus on the nonvertebral elements because these were analysed in all contexts. On the other hand, I identified a sample of the vertebrae from each case study site. A comparison of the three measures for the distribution of fish families (nonvertebrae elements) at Songo Mnara exemplifies the characteristics of each approach (Figure 2.12). Although NISP is usually higher than MNI for each family, the pattern of distribution is similar between these methods. The distribution of weight is very different from these two, showing a dominance of Carangidae fish (jacks). One possible explanation for this pattern is that it reflects differences in the average sizes of each fish family. In this case, Carangidae fish elements in the assemblage would be significantly larger than the others families. This hypothesis can be tested by comparing estimated sizes for each family (results in Chapter 6).

Secondary data: size and age estimation

Size estimations are useful in calculating the relative meat contributions of specimens. Fish size is also an important criterion that determines how a fish is caught—depending on the mesh size of the net or the width of the trap entrance. Age is also important to distinguish since juvenile fish often inhabit different areas than the adults of the same species. Because fish grow continuously throughout their lives, smaller specimens are younger than larger ones of the same species. The bones useful for estimating fish size must be chosen to suit the research aims and the conditions of the collected material. Ichthyologists use regression analysis to estimate size and weight based on particular sets of bones with clear features for accurate and reproducible measurements (e.g., Reitz et al. 1987; Leach et al. 1997). These elements are measured using standardized methods (Morales and Rosenlund 1979) and compared to the same elements of fish of known size and weight. This method is widely accepted, although the number of specimens required in the comparative sample is debated. Wheeler and Jones (1989) recommend using 2-3 specimens of different sizes, while Casteel

(1976) encourages the use of simple regression with at least 30 comparative specimens. This method provides very accurate size estimations but requires a lot of work in measuring the bones. It is well suited for sample assemblages with high rates of species identification and low diversity or with specific research questions related to size.

I calculated the size (weight in kg) of identified nonvertebral elements from direct comparison with the reference specimens used in identification. In other words, when the archaeological element was of the same size as the reference element, I estimated that both of the fish represented were of similar sizes. The reference specimens were of a known length and weight and often included specimens of different sizes from the same species. Fish weight was estimated to calculate the total mass of fish that was consumed and to compare the range of fish sizes across contexts within Songo Mnara and Vumba Kuu and between these two towns. Weight estimations are limited by the fact that fish weight can vary seasonally due to the growth of reproductive organs during spawning seasons (e.g., Ntiba and Jaccarini 1990). However, an approximation of the range of fish sizes is possible by categorizing the estimated fish weights into size classes: starting with <1 kg and followed by intervals of 3 kg. Future work on fish size reconstructions of Swahili material should include fish length estimations, which are more easily compared to other studies.

Age estimation is radically different in the study of animals with determinate growth, such as mammals. Instead of a continuous process, growth is defined in stages marked by tooth eruption, tooth wear and epiphyseal fusion. The variation in these characteristics is especially well documented for the principal domesticated mammals (Dawson 1934; Noddle 1974; Reitz and Wing 2008, 161–167). For example, the ends (epiphyses) of different types of long bones become fused to the shaft (diaphysis) at different ages. Thus, when describing unfused bone, it is important to note whether it is distal or proximal in addition to the element and taxonomic identification. Epiphyseal fusion, tooth eruption and tooth wear are, in effect, forms of primary data. However, I include them in the discussion of secondary data because they are so closely tied to age estimation.

2.6 What do fish bones tell us?

Primary and secondary data provide a description of the sample assemblages from Vumba Kuu and Songo Mnara. Further analysis and interpretation are based on an evaluation of possible taphonomic factors that create the sample assemblages and an understanding of the cultural and environmental settings of each settlement. It is important to consider both the role of resource availability and human action as factors that determine the composition of a sample assemblage. I summarize several interpretive models of faunal analyses relevant to my research in order to illustrate how zooarchaeologists investigate past human societies.

Interpretation: seasonality

It is possible to deduce the time of year fish were caught through growth rings. Certain fish elements show visible records of growth patterns similar to the way trees exhibit growth rings: scales, otoliths, vertebrae, cleithrum and opercular. Variations in the rate of growth are visible in the spaces between rings, called "annuli" (Reitz and Wing 2008, 80). The basic premise states that growth rings that are close together indicate slow growth rate during winter while those that are farther apart indicate fast periods of growth when food is abundant. Seasonality is best observed in the growth patterns of temperate fish because they experience marked seasonal variation. In tropical fish regular growth cycles are more difficult to describe because they do not experience such strong seasonal changes. The study of seasonality through growth rings is complicated by the fact that fish growth can be stunted by reproductive activities, overpopulation and disease. Thus, these studies require a large set of comparative data and a large sample size to make any meaningful speculations about seasonality. Van Neer shows the potential for fish seasonality studies in Africa (1984, 157–8) in an example from Wadi Kubbanya, a late Paleolithic site in Upper Egypt. To test whether an assemblage of mostly catfish (*Clarias*)—which can be caught during the low waters of the dry season—represents occupation at a dry season camp, he proposes to determine the season of capture from the analysis of growth rings.

No growth ring study has been attempted for the Swahili fish assemblages, but there is potential for identifying seasonal fishing strategies linked to monsoon rains. Seasonality could play a role in the types and amounts of fish that are caught throughout the year. During my ethnoarchaeology research on contemporary fishers in southern Kenya, I observed that fishers used more basket traps close to shore during the rainy *kusi* season to avoid confronting the turbulent weather offshore. Different fishing strategies associated with the changing climatic conditions could be reflected in the taxonomic representation of the fish bone assemblages. Large amounts of fish remains from Songo Mnara and Vumba Kuu indicate that fish was a major source of protein year-round. Most likely, fishing also took place year-round, as it does in contemporary fishing communities in the area. However, currently it is not clear if the assemblages from Songo Mnara and Vumba Kuu represent any evidence of seasonal variation. A growth ring study could reveal seasonal variation in fishing and fish consumption. My research sets a background from which to conduct further analyses such as these. The resources needed to create a strong comparative data set and to identify a large sample of bones to conduct growth ring analysis were not within the scope of the research presented here.

Interpretation: technology

There are few examples of traditional fishing tools that are made of durable material; i.e., fish hooks, net and line sinkers, and pots for fish traps. These artefacts are direct evidence of fishing methods but are rarely found in archaeological sites. Instead, ichthyoarchaeologists rely on analysis of taxonomic representation and size of fish remains to investigate past fishing strategies (e.g., Greenspan 1998). The characteristics of fishing technologies—e.g., the width of the trap opening, size of the net mesh and the types of bait used—influence the sizes and types of fish they catch.

One way of deducing fishing technology is by identifying the habitats of the captured fish. Fishers combine their knowledge of fish habitats and behaviour with their ability and technology to target particular types of fish. Thus, fish habitats determine, in part, the technology necessary to exploit certain types of fish. Fish generally inhabit three aquatic habitats: lakes, rivers and seas—with more biomass and more complexity present in tropical regions. Wheeler and Jones (1989) divide marine fish into three habitats that require different levels of fishing technology: 1) Littoral: fish found between the high and low tide, captured with minimal technology; 2) Inshore: more varied fish ranging from small coral fish to large predators that come to the edge of the coral reef and are moderately easy to catch; 3) Offshore: larger pelagic fish caught over the continental shelf require a high level of technology such as boats, nets, and more organized effort.

On the Swahili coast, there is a long tradition of largely inshore fishing documented in ethnographic and historical sources as well as archaeological evidence. Remains of large pelagic fish indicate that offshore fishing developed later in the history of Swahili towns such as Shanga (Mudida and Horton 1996). Archaeologists have relied on taxonomic lists to identify which inshore habitats were exploited. For example, Van Neer (2001) divides the identified fish remains from Kizimkazi, Tanzania, into three habitats: deep water, sandy muddy bottom, and near or in coral reef. He deduces the types of technologies that past fishers used to exploit those habitats. I use a similar approach to compare the variety of exploited marine habitats around Vumba Kuu and Songo Mnara, categorizing identified fish species into habitats. Furthermore, I conduct a systematic regional comparison of habitat use with available fish taxonomic lists from Swahili towns distributed along the coastline (Chapter 5).

In addition to their ties to the environment, fishing strategies have a social dimension because fishers adopt these strategies in relation to social aspects such as age, gender, and socioeconomic status. For example, a shrimp cast net is suitable for a single fisher with no boat while offshore net fishing requires a team of fishers and expensive gear that may only be accessible to certain social groups. Colley (1984) encourages the use of a variety of sources to aid the interpretation of fishing technology and its social implications: historical documents, pictures, written records, zoological field guides, fisheries records and ethnographic studies. I use fisheries reports and ecological data to determine the types of habitats present along the East African coastline and how they relate to particular types of fish and fishing strategies (Chapter 3). I combine historical and anthropological sources with an ethnoarchaeology of Swahili fishing in order to understand the social dynamics of fishing along the East African coast (Chapter 4). During this part of my research I conducted a series of interviews and participant observation while living in a contemporary fishing village in southern Kenya during a three month period. I interpret the patterns evident in the analysis of the faunal assemblages through a combination of these approaches.

Interpretation: social organization

As outlined in the review on taphonomy, the social dimension of fish remains extends beyond the moment a fish is captured. Fish undergo a series of transformations and distributions that are linked to social processes, such as "the ways meat and other animal products are produced, distributed and consumed" (Crabtree 1990, 158). Zooarchaeologists can identify differences between producer and consumer activities from certain characteristics of the faunal assemblage. Crabtree (1990) outlines the principal models associated with domesticated animals. For example, zooarchaeologists use bone fusion and dental wear to determine age and kill patterns of sheep. Consumer sites are represented by more market age specimens and few reproductive specimens. In a producer site, more infants and old-aged specimens occur. In a "self-contained" site that plays both roles, all age classes are present. Zooarchaeologists can also speculate about the types of animal products from the kill pattern composition. For example, in sheep, a majority of females may indicate the use of milk while a majority of males may imply wool production. Another form of analysis to distinguish between a processing and a consumption site is body part distribution. Butchery waste in a producer site may include the parts of the animal with less meat: skull, mandible, and feet. Bones with more meat content would be found at a consumer site.

Models for differentiating between producer and consumer activities exist for fish remains (e.g., Stewart and Gifford-Gonzalez 1994; Desse and Besenval 1995; Belcher 1998); these can vary across cultural contexts and exploited species. In some cases, processing sites are associated with a dominance of fish cranial elements as opposed to body elements in consumer areas (Stewart and Gifford-Gonzalez 1994). Belcher (1998) identified differences in cutmark distributions among fish remains from discard, fillet and market samples in his ethnoarchaeological work in Pakistan. The Swahili assemblages contain a wide range of elements that indicate that fish were eaten whole. However, a comparison of body part distribution in different size groups could show a differential processing of small versus large fish. For example, small fish that are eaten whole would be represented by a wide range of skeletal elements, while large fish broken up into parts might be represented by only a section of the skeleton. Ethnoarchaeology plays an important role in connecting consumption and processing activities to patterns in faunal remains that can be useful in the interpretation of faunal assemblages. This is accomplished by identifying signature patterns in the composition of the assemblage or marks in the bones themselves that result from specific types of processing or consumption activities.

The relationship between food and social status is based on the assumption that differences in socioeconomic status imply differential access to food (Crabtree 1990, 171). In animal remains, status may be evident in the distribution of quality meat (visible in body part frequency figures) or in differences in the range of species (determined by NISP and MNI). Yet the determination of quality meat is subjective and thus, one should use historical documents or other sorts of evidence to determine what is valuable in that cultural context. Crabtree (1990) supports a "conjunctive approach" that uses other markers of status differences to support the claim. Therefore, the status should be determined by the artefacts and architecture associated with an assemblage rather than the characteristics of the assemblage itself. I explore differences in the composition of fish species and sizes in different areas around Vumba Kuu and Songo Mnara that could be related to differences in social status.

Interpretation: fishing intensity

Overfishing has become a worldwide concern in recent decades, prompting studies on the negative effects of intense fishing practices on fish populations. A study of contemporary fisheries shows a significant drop in the mean trophic level of catches around the world in the last 45 years (Pauly et al. 1998). Trophic levels represent the position of living objects in the food chain on a scale of 1 to 5, from producers (plants) at the lowest level to the highest predators. The mean trophic level of a region decreases when the top predators in the ecosystem decline, potentially as a result of intense fishing.

Ichthyoarchaeologists use mean trophic levels (MTL) to compare past fish populations represented by sample assemblages (e.g., Reitz 2004; Wing 2001). Used in archaeology, MTL is a descriptive measure derived from the proportion of fish taxa from different trophic levels present in an assemblage. Combined with other forms of analysis—MNI, biomass, diversity, fish size, etc.—MTL can help explain the variability in fish composition as a result of a combination of factors, such as cultural change, climatic change, and overfishing (Reitz 2004). Wing (2001) uses size estimates and trophic level to determine the degree of fishing intensity in four Caribbean sites. The area inhabited by the "ceramic age people" in her study is similar to some Swahili environments consisting of "islands with shallow inshore waters, mangrove lagoons, coral reefs, and relatively sparse land faunas compared with the continental mainland" (2001, 112). She compares early and late deposits of faunal remains from four sites. Fish bone data show a decline in reef fish sizes and an increasing proportion of herbivorous to carnivorous fish. Wing's analysis demonstrates that while the composition of fish species stays relatively stable through time in her study area, decreasing sizes and trophic levels of fish catch, along with other changes in the faunal record, suggest intensive fishing that may be related to an increasing population density in the area.

Wing estimates fish size using allometric formulas for the width of the centrum of anterior vertebrae (2001, 116). She calculates trophic level per species by estimating the average weight of individuals in each taxon, multiplying this number by MNI to estimate the biomass, and then multiplying the biomass by the mean trophic level index, using the formula (based on Pauly et al. 1998; the same formula is used in Reitz 2004):

$$\boldsymbol{TL_i = \sum_{ij} TL_{ij}Y_{ij} / \sum Y_{ij}} \qquad \textbf{(1)}$$

where TL_i is the mean trophic level for year *i* and Y_i is the landings by the trophic levels of the individual species groups *j*. (Wing 2001, 119–120)

I applied a similar method to the Swahili region using available fish remains data from Swahili settlements with long-term occupation (see Chapter 5; Quintana Morales n.d.). Although size estimates are not available for these data sets, other measures, such as taxonomic representation and habitat use, are combined with MTL analysis to explore regional and chronological changes in Swahili fishing practices.

2.7 Summary

This chapter began with an overview of the methods and contributions of ichthyoarchaeology. I identified some of the challenges of working with fish bones, such as the biases resulting from preservation, excavation, sampling and analysis. I outlined my methodological approach for analysing the Songo Mnara and Vumba Kuu zooarchaeological samples: I specify which skeletal elements are analysed, describe the categories of data I record, and review relevant models of interpretation. There are many examples of convincing interpretations of archaeological fish remains. Faunal analysis is used to address questions that range from environmental reconstructions to social inequality. It is evident that culture and environment are deeply interrelated in the study of fish remains. The following chapters address the roles of cultural and environmental factors in fishing and subsistence. My analysis of other Swahili faunal assemblages explores regional and localized trends in fishing and fish consumption.

Chapter 3: The Socio-natural Landscape of Fishing

"The socio-natural landscape: This should seek to assess both natural influence upon the changing patterns of settlement and land use, and at the same time, explore how human activity has modified the landscape over time. In this way, the history of vegetation, climate and the agricultural potentiality of past soils will help in understanding the observed changing pattern of past subsistence economies. Only then will research be able to move beyond the restricted study of settlement areas and begin to understand their context within the socio-natural landscape as a whole."

-R. Helm, 2000 (p. 299)

3.1 Introduction

The goal of this chapter is to determine the environmental factors that influence the composition of fish catch. Variability in the environmental setting exists across space and time. I explore the habitats associated with particular fish species found along the East African coastline. The link between excavated fish species and their habitats reveals which sections of the coastal environment were exploited by past fishers. I use fisheries records from East Africa to determine the characteristic fish catch of common fishing methods along the Swahili coastline, and explore aspects such as species, size, and habitat of fish. In addition to the spatial variability of the coastal environment, I consider environmental change through time in the interrelated effects of climate and human activity.

3.2 East African coastal environments

Climate along the East African coastal fringe is largely influenced by seasonal patterns associated with the monsoons. The Northeast Monsoon, locally known as the *kaskazi*, is generally a dry, calm period occurring between November and March. During this time, coastal sea surface temperatures tend to be high (up to 29º C) and salinity low (Tychsen 2006, 18). This calm period is followed by an onset of rainy and windy weather called the *kusi*, which marks the beginning of the Southeast Monsoon from April to August. Sea surface temperature is lower (reaching 24º C) and salinity higher (Tychsen 2006, 18). However, abundant rainfall causes river discharge to create more variable salinity conditions along the shoreline.

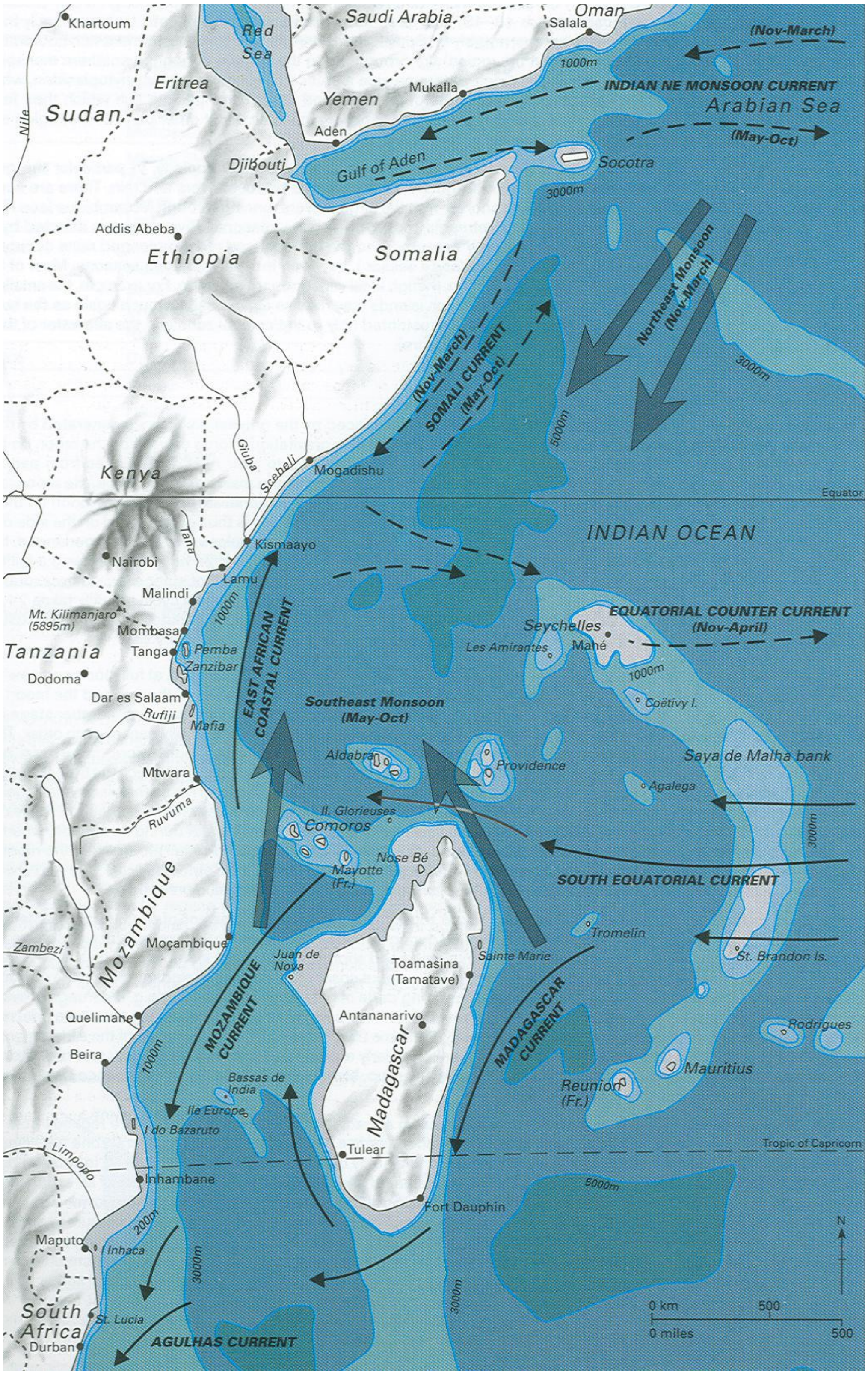


Figure 3.1: Western Indian Ocean currents, monsoon winds and water depths (Richmond 2011, 13: fig. 2)

Coastal currents are also affected by the seasonal monsoons (Figure 3.1). The South Equatorial current coming from the Eastern Pacific reaches the African coast at Cape Delgado and splits into two; the East African Coastal Current flows northwards along Tanzania and beyond while the Mozambique Current flows southward. During the Southeast Monsoon (April to August), the East African Coastal Current joins the Somali Current around Malindi and continues northward. However, during the Northeast Monsoon (November to March), the Somali Current is reversed towards the south and meets the northwardly East African Current between Malindi and Lamu, then flowing eastwardly as the Equatorial Counter Current (Tychsen 2006, 17).

The environment along the coastline is subject to the changing seasonal conditions, particularly around river mouths, where the seasonal rains increase discharge of freshwater and sediments into the Indian Ocean basin. The Tana River, for example, is the longest river in Kenya and has an average annual discharge of 4000 million m^3 of freshwater and 3 million tonnes of sediment into Ungwana Bay (Tychsen 2006, 13). A number of perennial and seasonal rivers drain into the East African coast, creating varied and rich coastal ecosystems. The fringing reef growing parallel to the coastline is interrupted in the areas around river drainage, where mangrove forests inhabit estuarine environments. Fishing strategies tend to be specialized according to habitat, and the Swahili coastline is comprised of diverse and dynamic environments. I argue that these natural contexts, the sources of exploited marine products, are critical to incorporate in analyses of past fishing patterns.

Classifying the East African coastline

The role of environment in the development of Swahili settlements is recognized by scholars working in this region. Fleisher (2003, 7) writes, “the ecological context is crucial to understanding how the diversity of the coastal environments provided a context for a variety of economic strategies—herding, farming, fishing, and gathering—and the basis for regional and long-distance exchange systems.” The environmental context of Swahili settlements is often described and acknowledged in the studies of investigated Swahili towns, such as Shanga (Horton 1996), Unguja Kuu (Juma 2004), and Chwaka (LaViolette and

Fleisher 2009; Fleisher 2003). These studies consider the effects of land vegetation, rainfall, and monsoon currents on the lives of the inhabitants of these settlements. However, the richness and diversity of surrounding marine environments could be studied more closely in conjunction with evidence of the variety of exploited fish species. Fish species lists in themselves provide a great source of information about where fish are likely to be found and how they behave, giving clues as to the nature of their exploitation. However, a fuller understanding of Swahili fishing emerges from a more systematic analysis of how exploited habitats are distributed around settlements.

The Swahili coastline and its settlements have been subdivided and categorized by other authors (e.g., Wilson 1982; Kusimba 1996a). James de Vere Allen (1981) categorized 173 Swahili stone-towns based on region, period of efflorescence, population size, settlement type, and harbour. Half of all the sites from his 1100-year survey (800-1900) were considered Period II sites (1300-1700). According to his survey, the majority of Swahili stone-towns occurred north of the Kenya-Tanzania border until after 1700, when the majority of Swahili towns were found in the Tanzania mainland (1981, 324). Of particular relevance is his classification of harbour types and settlement locations, which shows the variable coastline conditions associated with Swahili settlements. Of the 173 settlements, 107 occur on the mainland and the remaining 66 on islands (1981, 326: Table 4). His descriptions of harbour types hint at the surrounding environment: inland (6), open coast (46), peninsula (9), inlet or estuary (48), tidal/small island (44), and unascertainable (20). His work is admittedly restricted by its focus on stone-towns and his choice of temporal and spatial categories, but it begins to portray the variety of environmental settings for Swahili towns.

Early Swahili inhabitants and visiting Arab seafarers classified the coast into sections (Figure 3.2). Each region represents a different set of cultural traits, forming a ‘social and commercial landscape’ along the East African coastline (Horton and Middleton 2000, 10). These stretches of coast can also be characterized by different patterns of rainfall, vegetation, and coastline traits (Fleisher 2003, 11–13), demonstrating that while the physical landscape along the stretch of the East African coast does not vary greatly, there are important environmental differences along it just as there are cultural ones (Table 3.1).

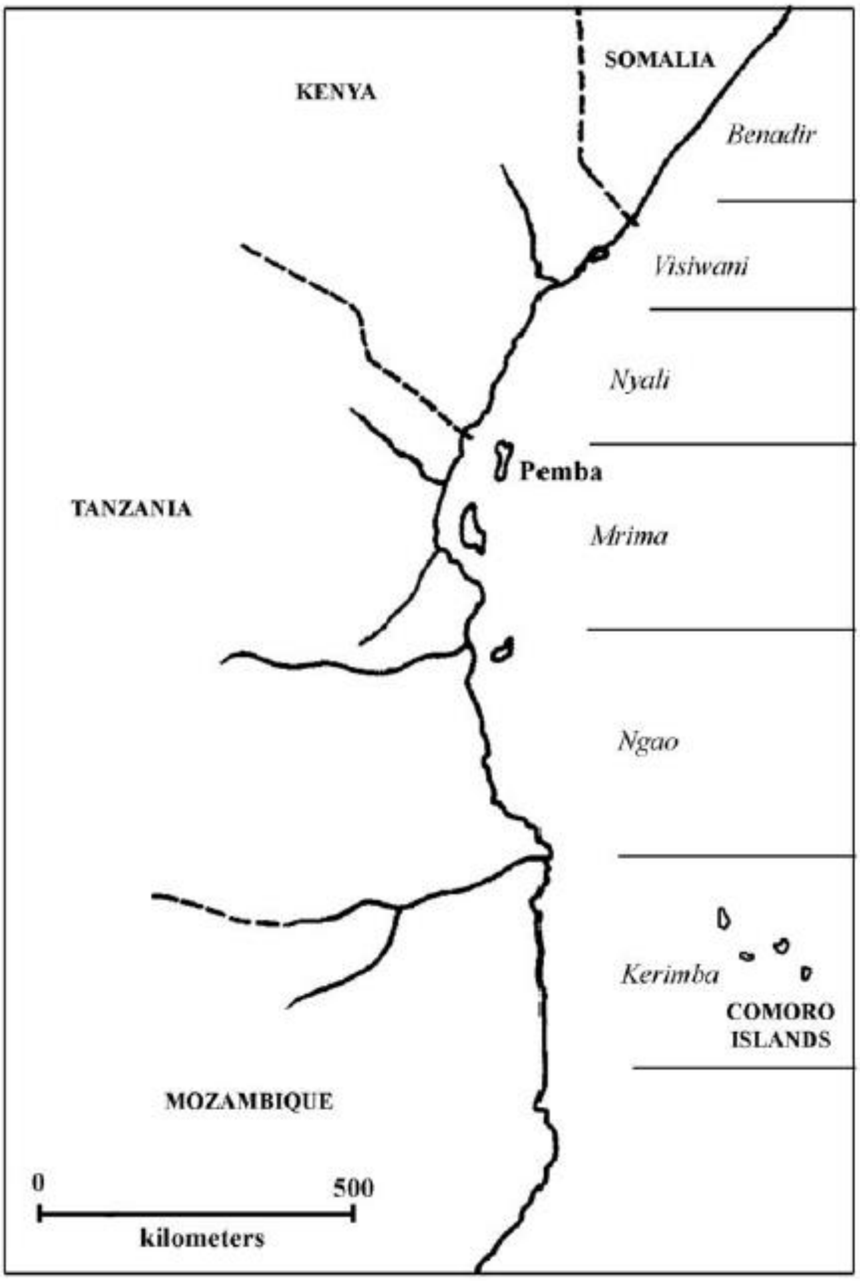


Figure 3.2: Swahili divisions of the East African coastline
(Fleisher 2003, 33: fig. 1.6; based on Horton and Middleton 2000, 6–7: Map 1.1)

Table 3.1: Environmental characteristics of the coastal Swahili regions (Fleisher 2003, 11: Table 1.1)

Coastal Regions	Area	Major Towns	Characteristics
Benadir	Somali coast to Kenya border	Mogadishu, Barawa, Kisimayu	arid
Visiwani	Kenya border to Tana River	Shanga, Manda, Pate, Ungwana, Lamu, Siyu	coral islands and offshore reefs, mangrove swamps, dry woodland hinterlands
Nyali	Tana River to Tanzania Coast	Mombasa, Malindi, Mtwapa, Jumba la Mtwana	coral cliffs and flats, wide shoreline beaches, hilly and fertile hinterland
Mrima	Tanzania Coast to Rufiji Delta	Tongoni, Mtangata, Pangani, Vumba, towns of Pemba and Zanzibar	highest rainfall, mangroves, offshore reefs, hinterland coastal forests
Ngao	Rufiji Delta to Mozambican border	Kilwa, Songo Mnara, towns of Mafia	southern extent of reef system
Kerimba	Mozambican border to Chibuene	Sofala, Chibuene	southern extent of Zanzibar Inhambane Mosaic

In line with the ‘socio-natural’ research aims defined in the introduction to this chapter, Nakamura (2011) proposes a ‘geo-historical classification’ of contemporary Swahili communities. He categorizes Swahili settlements by cultural traits and geographical types: continental coast, off-shore islands, and islands distant from mainland (2011, 65). Furthermore, he divides the areas around Kilwa Island into ‘ecological zones’ that he associates with distinct sets of resources and fishing strategies: mangrove forest, fringing reef, inland sea, intermediate sea, and open sea. This classification system is an effective tool for understanding the mechanisms of fishing practices connected to both social and ecological factors and can be extended to the entire coastline and into the past. In the following section I classify the typical fish habitats along the East African coastline in order to create a systematic point of reference from which to base my analysis of past fishing practices.

3.3 Fish habitats

The sea supports rich animal biodiversity—marine fish make up about 58% of the more than 28,000 known fish species (Helfman et al. 2009, 329).

These marine fish are divided into four principal ecological categories according to the depth and temperature of the water they inhabit (Figure 3.3; Table 3.2). The concentration of fish in the coastal area could be related to the occurrence of corals reefs in these zones. Reef-building corals support a rich array of fish species and grow in depths less than 100m and waters warmer than 18ºC (Helfman et al. 2009, 331). The interaction between marine and freshwater systems at the coastal fringe creates other types of productive areas such as mangrove stands and mudflats.

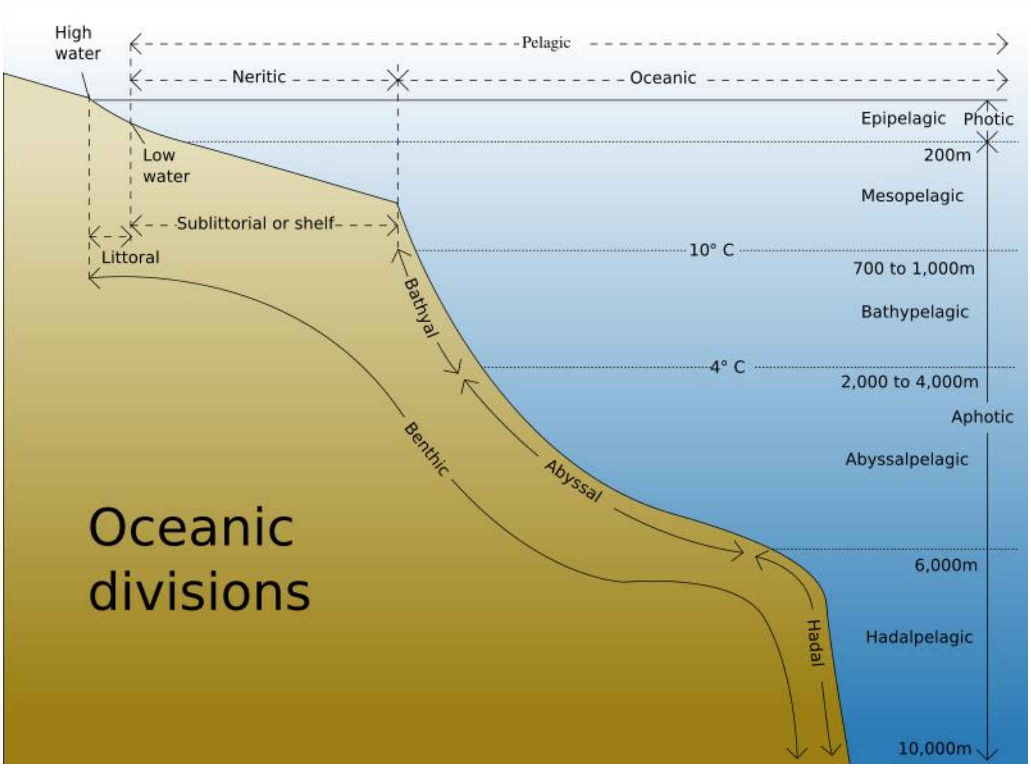


Figure 3.3: Oceanic zones
(http://commons.wikimedia.org/wiki/File:Oceanic_divisions.svg)

Table 3.2: Characteristics of oceanic zones
(Helfman et al. 2009, 329)

Category	Depth	Number of species (% of all known fish species)
Littoral/continental shelf	Surface to 200 m along shoreline	12,600 (45%)
Epipelagic	Surface to 200 m	360 (1.3%)
Mesopelagic Bathypelagic	200 to 1000 m 1000 to 4000 m	1400 (5%)
Deep benthic	Ocean bottom	1800 (6.4%)

The expanse of ocean around the globe can be divided into zoogeographic regions: Indo-West Pacific, western Atlantic, eastern Pacific, and eastern Atlantic. The Indo-West Pacific region—from South Africa and the Red Sea to Easter Island—is the most diverse, with over half the number of shallow marine fish, 3000 species (Helfman et al. 2009, 331). This region can be further divided into the Western Pacific and Indian Ocean subregions. The coastal fringe of the Indian Ocean along the East African continental shelf is a rich area of biodiversity. Coral reefs exist as far south as Durban, South Africa, and up to the coastal waters of Somalia (Lieske and Myers 2002, 7). Although coral reefs are the best known examples of underwater biodiversity, they exist within more complex coastal environments.

Continental coastlines contain a wide range of habitats that occur in the interface between marine and freshwater systems. Fringing reef systems interact with mangrove forests and seagrass beds by protecting them from erosion by the wave currents. Mangroves and seagrass, in turn, shield the corals from sedimentation by freshwater influx. Additionally, organisms living in these mixed ecosystems benefit from diverse habitats, breeding, feeding and hiding in different areas. As Sheppard describes, "A continuum exists not only between reef 'types' themselves but, as importantly, between reef habitats of all forms and non-reefal habitats," (Sheppard 2000, 9). Although coastal habitats are effectively interlinked, they have distinct characteristics that differentiate them.

Just like there is a continuum in the spectrum of marine habitats, there is also overlap in the range of environments inhabited by fish species, which can also vary according to fish age. However, I have classified fish taxa that are commonly identified in the archaeological material into six principal habitats in order to distinguish fish that are especially linked to particular environments. I chose five coastal habitats to best represent the types of environments generally occupied by different types of fish along the East African coast: Coral, Estuary, Sandy-Muddy, Mangrove, and Open Sea (a similar classification was used by Van Neer 2001; and Nakamura 2011). A sixth category, Various, includes fish species that inhabit several marine zones. I chose these categories based on the following criteria: 1) to represent typical coastal habitats along most of the East African

Coast; 2) to be easily identified around coastal settlements through surveys and maps; 3) to be relevant to local traditional fishing activities; and 4) to be easily associated with populations of fish species according to the current fish ecology literature.

There is enough behavioural variability within each fish family that I have chosen to classify fish into habitats using the most specific taxonomic category possible. I have combined information about fish behaviour and habitat preference from two principal internationally recognized sources that offer widely used fish ecological data: *The Food and Agricultural Organization (FAO) Species Identification Sheets for Fisheries purposes: Western Indian Ocean* (Fischer and Bianchi 1984) and the online database *Fishbase* (Froese and Pauly 2012). The following paragraphs characterize five typical marine habitats found along the East African coast (Appendix B contains a full list of identified fish species and their habitat category).

Coral

Figure 3.4: Coral reef of the Red Sea
(photo by author, 2011)

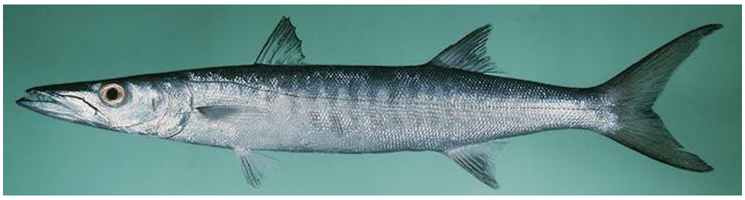
Known as the ‘rainforests of the sea’, coral reefs contain a plethora of marine life and biodiversity. Common reef-building corals are from the order Scleractinia, with limestone skeletons. Reef-building requires certain conditions that determine the geographical occurrence of coral reefs: sunlight, warm temperatures, a range of salinity, clarity (sediment-free water) and a stable hard bottom for attachment (Lieske and Myers 2002, 8). Coral reefs are typically found in shallow tropical waters up to around 100 m depth. Corals typically stop growing when temperatures fall below 20ºC, and they die at 16ºC (Lieske and Myers 2002). Water clarity is affected by the surrounding environment; for example, sediments carried into a bay by nearby rivers reduce visibility, especially during flooding. The best visibility occurs on seaward facing slopes where there is higher circulation with the open sea and the reef is protected from the influx of river sediments. The influx of freshwater from rivers also affects the levels of salinity. Coral reefs are divided into a variety of types that are linked to stages of development: fringing reefs, barrier reefs, and atolls (Richmond 2011, 20–21: Figure 9). In East Africa, the most typical reef is the fringing reef which occurs "discontinuously" along the coastline over the continental shelf (McClanahan, Sheppard, and Obura 2000, 9).

The reef flat itself can be divided into zones. The inner reef might contain seagrass meadows and massive porites corals (Lieske and Myers 2002, 11). The outer reef flat is often eroded from exposure to higher wave activity, especially during storms. However, this area can be covered in a film of algae that attracts schools of herbivorous fishes (Lieske and Myers 2002, 11). The reef landscape can contain a diverse set of features, like terraces, drop-offs, and cliffs, and each habitat attracts different sets of living creatures. This diversity in niches sustains the richness in coral reefs.

In his analysis of archaeological fish remains from Kizimkazi, Van Neer (2001) divides fish families into two categories of the coral reef habitat: 1) those inhabiting reefs—Acanthuridae (surgeonfish), Scaridae (parrotfish), Labridae (wrasses), Muraenidea (moray eels), and Serranidae (groupers); and 2) those over or in proximity to reefs—Haemulidae (grunts), Lethrinidae (emperors), Siganidae (rabbitfish), Lutjanidae (snappers), Sphyraenidae (barracuda) and Carangidae (jacks). These categories allow him to deduce that at least two fishing strategies were employed in this area: one that allowed fishers to catch fish sheltered among the coral, such as hook and line, and another that could catch fish inhabiting waters above the coral reefs, such as nets. Below I provide a sample of fish species found mainly in coral/rocky habitats.

Lutjanus sanguineus (58.9 cm TL)
Reef associated, depth range 9-100 m. Inhabits coral and rocky reefs. Active at night when it feeds over sandy or rubble bottoms.

Carangoides fulvoguttatus (55.3 cm TL)
Prefers rocky and coral reefs, but is occasionally found over offshore banks to depths of 100 m.



Sphyraena jello (41.7 TL)
Found predominantly at or near the surface. Diurnal and solitary (but the young are often in small schools), usually at the edges of reefs and over shallow banks.

Scarus psittacus (37.1 cm TL)
A shallow water species often found in intertidal areas, associated with coral reefs. Inhabit reef flats and lagoon and seaward reefs to at least 25 m depth. Found over corals.

Lethrinus mahsena (25.4 cm TL)
Inhabits coral reef and inshore waters to 50 m depth.

Acanthurus lineatus (23.1 cm TL)
An inshore species of coral reefs or rocky substrata exposed to wave action.

Siganus luridus (15.7 cm TL)
Lives in small schools around coral and rock reefs. Found in very shallow water close to the bottom.

Figure 3.5: A sample of fish found in coral habitats
The general habitat and behaviour of each species is described, along with the total length (TL) of the pictured specimen. (Fishbase; FAO)

Estuary

Figure 3.6: Estuary creek by Jasini, Kenya
(photo by author, 2009)

The terms lagoon, bay, and estuary oftentimes overlap in their definitions. Bays "often have sheltered, somewhat turbid waters and silty bottoms, sometimes with a river emptying at the head" (Lieske and Myers 2002, 9). Lagoons are another form of enclosed water often associated with barrier and atoll reefs and may contain patch reefs. Lagoons may be connected to the outer reef by deep channels, where larger predator fish are abundant with less severe currents. Estuaries are characterized by fluctuating salinity found at the mouths of rivers where salty ocean water and freshwater river discharge meet (Tychsen 2006, 24). In this sense, bays and inland seas with emptying rivers can be considered estuarine environments. Lagoons, on the other hand, are more closely associated with corals. For the purpose of distinguishing fish habitats, I use estuary to refer to the open areas of brackish water near river outlets that are distinct from mangroves and mudflats—these are considered separately. Since estuarine habitats are found close to the shoreline, they can be easily exploited with minimal gear. For example, fishing lines and cast nets can be used by foot or with a small boat. The fish found in this habitat are well-adapted to fluctuating salinity. Some fish can overlap with species found in mangroves, incuding juvenile fish that may live in other habitats as adults. Thus, the species in this category are more generally associated with estuarine conditions, including the following examples:

Netuma bilineata (62.0 cm TL—max length)
Found in estuaries, brackish water. Inhabits coastal waters, from estuaries onto the continental shelf.

Pomadasys multimaculatus (50.7 cm TL)
Inhabits coastal waters. Plentiful in tidal estuaries. (Photo by author)

Rhabdosargus sarba (25.2 cm TL)
A bottom living coastal fish, to 60 m depth, sometimes entering estuaries. Spawning takes place near river mouths; after a short planktonic period, the young fish move into the estuaries, which act as nurseries, and move out into the deeper waters with growth. Coastal, inshore waters and estuaries.

Figure 3.7: A sample of fish found in estuary habitats
The general habitat and behaviour of each species is described, along with the total length (TL) of the pictured specimen. (Fishbase; FAO)

Mangrove

Figure 3.8: Mangrove stand at low tide near Vanga, Kenya (photo by Philippe Béarez, 2010)

The mangrove habitat exists in the intertidal zone, the band of land between the high and low tide marks. There are up to nine species of mangrove trees in the East African coast (Pollard 2008b, 58: Table 2.3). Mangroves are closely related to estuaries, as they too thrive at the mouths of rivers where discharged sediments provide it with nutrients (Tychsen 2006, 25). In fact, they play an important role in moderating coastal erosion as a protective barrier from currents and by actively enhancing sedimentation. They also provide areas for fish spawning and nursery grounds. Thus a variety of juvenile fish are associated with this habitat, many of which populate other nearby habitats as adults. Mangroves provide specific conditions, such as sheltered areas, preferred by certain fish, such that here they are considered a separate fish habitat although they form part of the estuarine zone. Additionally, the protected cover of the mangroves makes this habitat suitable for certain fishing methods over others; for example, nets and lines can get caught in the branches, but traps can be placed among the trees or along the edges of mangrove stands.

Mangrove species often migrate to other habitats at different life stages. Thus, I have tried to limit the fish considered in this category to those that are mostly found in mangroves over other habitats. It would be useful to explore the size range of mangrove species in the analysed assemblages to distinguish between juvenile and adult fish because many species inhabit mangroves as juveniles. Some examples include:

Lutjanus gibbus (29.9 cm TL)
Inhabits shallow waters in rocky and coral reef areas; also on rock bottoms to depths of 60 m; juveniles occur in mangrove areas.

Lutjanus sebae (24.3 cm TL)
Juveniles inhabit shallow mangrove and seagrass areas; adults are found down to depths of 100 m.

Lethrinus nebulosus (17.9 cm TL)
Inhabits coral reefs and inshore waters to 50 m depth; also found in mangrove creeks and around jetties and wharves.

Lutjanus russellii (17.6 cm TL)
Inhabits shallow waters in rocky and coral reef areas; juveniles are found in mangrove areas.

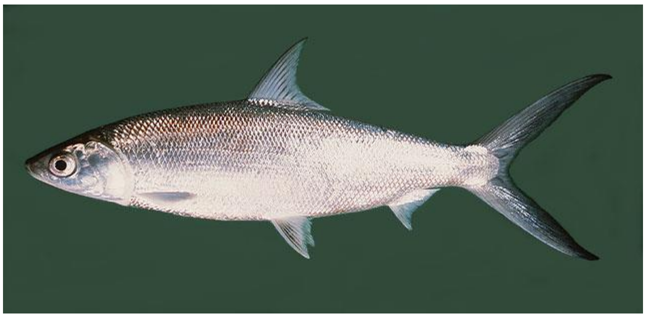
Figure 3.9: A sample of fish found in mangrove habitats
The general habitat and behaviour of each species is described, along with the total length (TL) of the pictured specimen. (Fishbase; FAO)

Sandy-Muddy

Figure 3.10: Sunrise at the mudflat to the NE of Songo Mnara (photo by author, 2011)

An accretion of sediments often extends past mangrove forests at the coastal edge, forming intertidal mudflats. Although this habitat has low biodiversity, it is a highly productive area for invertebrates, aquatic birds, and fish. Around the Indian Ocean, these habitats occupy a significant portion of the coastline but are disproportionately understudied (McClanahan, Sheppard, and Obura 2000, 26). They are associated with the sedimentation processes of estuarine areas but are also related to reefs that provide a protective barrier behind which they can develop. Like the mangroves, this habitat can be considered part of the estuarine environment. However, here it is considered separately because mudflats occupy distinct areas of the coastline that provide particular conditions, such as shallow sandy-muddy bottoms, favoured by certain fish species. Shallow open waters characterize mudflats, making them suitable for small nets and hand lines.

Of the fish identified at Kizimkazi, Van Neer (2001) classified the following fish as those found in sandy muddy environments: the family Mugilidae (mullets), the genera *Arius* (sea catfish) and *Gerres* (in the mojarra family), and the species *Albula vulpes* (bonefish) and *Chanos chanos* (milkfish). Other species that prefer sandy-muddy bottoms include: *Gerres longirostris* (strongspine silver-biddy), *Mugil cephalus* (flathead grey mullet), and *Platycephalus indicus* (bartail flathead).



Chanos chanos (37.5 cm TL)
Found in offshore marine waters and shallow coastal embayments, but also frequently enter estuaries and occasionally penetrate freshwater streams. A marine species which enters estuaries and rivers.

Mugil cephalus (31.2 cm TL)
Coastal species that often enter estuaries and rivers. Usually in schools over sand or mud bottom.

Albula vulpes (19 cm FL)
An inshore, shallow-water species associated with sand and mud bottoms. Feeds by grubbing in the substratum with the snout. Inhabits shallow coastal waters, estuaries and bays, over sand and mud bottoms.

Gerres longirostris (13.8 cm TL)
Prefers shallow waters over sandy bottoms, from coral reefs to brackish waters. Adults often in clear coastal waters up to about 50 m depth; juveniles in estuaries or lagoons influenced by fresh water.

Platycephalus indicus (12.5 cm TL)
A benthic fish found on sand or mud bottoms taken in very shallow areas in estuaries and near shore to depths of about 25 m.

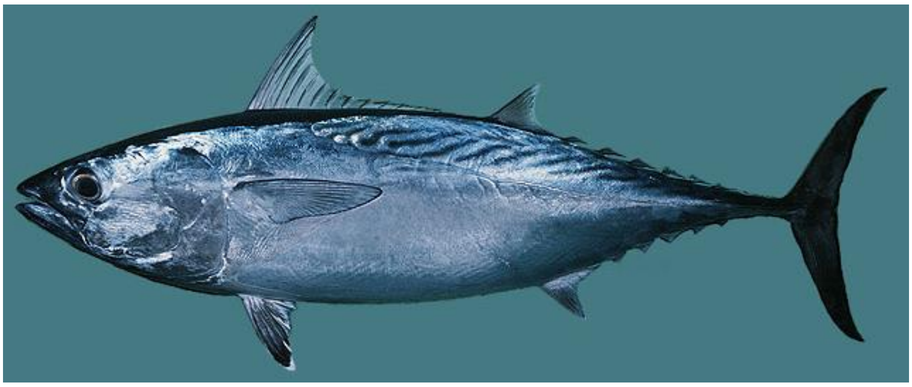
Figure 3.11: A sample of fish found in sandy-muddy habitats
The general habitat and behaviour of each species is described, along with the total length (TL) or fork length (FL) of the pictured specimen. (Fishbase; FAO)

<u>Open sea</u>

Figure 3.12: Net fishing in the open waters near Vanga (photo by author, 2009)

The pelagic zone refers more generally to "the surface or middle depths of a body of water" (Froese and Pauly 2012: Glossary). It is sometimes defined as far into the shoreline as the low water mark. Thus, it is also divided into two zones: neritic, the relatively shallow pelagic zone over the continental shelf; and oceanic, the open ocean beyond the continental shelf. The classification used here refers to offshore fish living and feeding mostly in open waters. Fishers target open sea fish with specialized gears, such as wide mesh *jarife* nets and larger boats. These fish, however, sometimes wander into inshore habitats to feed and can occasionally be caught closer to shore. The open water fish identified at Kizimkazi include *Euthynus affinis* (mackerel tuna) and Carcharhinidae (requiem sharks) (Van Neer 2001). Other pelagic fish found in the Western Indian Ocean include *Thunnus spp*. (tuna) and *Xiphias gladius* (swordfish), but these have not yet been identified in the archaeological record. A sample of pelagic fish found at Swahili coastal settlements includes:

Carcharhinus limbatus (70.9 cm TL)
An inshore and offshore shark found on or adjacent to continental and insular shelves. Often off river mouths and estuaries, muddy bays, mangrove swamps, lagoons, and coral reef drop-offs. Bottom associated or pelagic.



Euthynnus affinis (52.7 cm TL)
Found in coastal waters and around offshore islands. Occurs in open waters but always remains close to the shoreline. The young may enter bays and harbors.

Katsuwonus pelamis (51.7 cm TL)
Occurs in large schools in oceanic waters, generally above the thermocline. Deep coastal and oceanic waters. Found in offshore waters; larvae restricted to waters with surface temperatures of 15°C to 30°C.

Figure 3.13: A sample of fish found in the open sea
The general habitat and behaviour of each species is described, along with the total length (TL) of the pictured specimen. (Fishbase; FAO)

Various

A significant segment of Western Indian Ocean fish includes species that are difficult to pin down to a specific habitat, and these have been grouped into a single, broad category. Some fish species in this category lack relevant ecological information, although the majority simply inhabit a variety of habitats. There are also specific fish habitats that are found in association with a variety of others; for example, sea grass beds are found on sandy-muddy sediments, in shallow mangrove creeks, and the outer slopes of reefs (Tychsen 2006, 30). These subsurface meadows are also a challenge to trace without extensive surveying. Some examples of fish that are found in multiple habitats follow:

Epinephelus malabaricus (39.5 cm TL)
Common species found in a variety of habitats: coral and rocky reefs, tide pools, estuaries, mangrove swamps and sandy or mud bottom from shore to depths of 150 m. Juveniles found near shore and in estuaries.

Lethrinus harak (29.7 cm TL)
Found solitary or in small schools over shallow sandy, coral rubble, mangroves, lagoons, channel and seagrass areas inshore and adjacent to coral reefs.

Lutjanus fulviflamma (25.4 cm TL)
Inhabits shallow waters around mangroves, muddy and rocky foreshores and coral reefs.

Figure 3.14: A sample of fish found in various habitats
The general habitat and behaviour of each species is described, along with the total length (TL) of the pictured specimen. (Fishbase; FAO)

Habitats are a useful way to classify fish species in an archaeological assemblage because they reveal the past fishing strategies connected to the varied environmental configurations surrounding past coastal communities. However, there are other aspects of fish that are important to consider, such as fish size/age, depth of habitat, and schooling and migratory behaviours. I consider these characteristics in the interpretation of past fishing strategies. Although the focus of this study is fish, this systematic approach connecting animal behaviour and subsistence strategy applies to other animals. For example, there is a wide range of other aquatic animals found on the Western Indian Ocean fringe, including the marine mammal Dugong, four types of sea turtles (family Cheloniidae) and a variety of molluscs and crustaceans (Richmond 2011), many of which are also found in the archaeological record. These animals also have distinct habitats and behaviours that play a role in the ways in which humans interact with them.

3.4 Fishing gear selectivity

Various factors help to determine the catch composition of fish species and sizes, including the exploited habitat, season, fishing method and even fisher's experience. The relationship between fishing strategies and fish catch is an important research topic in the areas of fisheries management and marine biology. Government appointed fisheries officers study fishing strategies in order to manage coastal resources. These records form part of the fisheries management effort "aimed at ensuring that the optimal benefits are obtained for the local users, State or region from the sustainable utilization of the living aquatic resources to which they have access" (FAO 1997, 7). Marine biologists also undertake research on the exploitation of marine resources in the interest of conservation of coastal environments. These published fisheries data, from management and conservation perspectives, reveal how fishing strategies affect fish catch. Understanding the relationship between fish catch and fishing method allows ichthyoarchaeologists to infer past fishing strategies from the composition of sample assemblages.

In a study of 11,402 fish landed at 9 sites around Mombasa, McClanahan and Mangi (2004) compare catch composition among 6 common fishing gears:

small basket traps, large basket traps, gill nets, hand lines, spears and beach seines. These fishing gears were located across various reef lagoon habitats in this area, i.e., sea grass, coral and sand. The authors used Detrended Correspondance Analysis (DCA) to show how gears compared in terms of species selectivity among the top 43 fish species. In the discussion of their results, the authors divide the gears into groups based on their similarity:

> *Big traps and gill nets had a high dominance of* Scarus ghobban, Siganus sutor, Parupeneus barberinus, Scarus psittacus *and* Lethrinus harak. *Spears and small traps were similar because of the high dominance of* Leptoscarus vaigiensis, *while hand lines had a high abundance of* Lethrinus xanthochilus *and* Lethrinus sanguineus. *Beach seines showed a close correlation to all gears, occupying the centre of the DCA plot*. (McClanahan and Mangi 2004, 57)

Additional differences among the gears emerged from the comparison of species richness, size and trophic level of fish catch (McClanahan and Mangi 2004). Beach seines had the highest species richness (averaging ~14 species per day). Beach seines and small traps caught the highest number of fish per fisher (~34-36). These two gears and hand lines caught the smallest fish specimens (~14 cm). Large traps, gill nets and spears caught the largest specimens (17-18 cm). Hand line differed from the rest of the gears with a high mean trophic level (3.6) compared to the rest of the gears (2.6-2.9). Aside from beach seines that had high species diversity, four to five species dominated the daily catch from the other gears. However, sampling had a cumulative effect creating a long list of species per gear. The authors recognize that their study cannot distinguish differences in habitat variability although these could have important effects on the composition of fish catch. They note that most gears are not habitat specific (2004, 59). This observation is important because other patterns of gear selectivity could emerge from the exploitation of a coastal region with different sets of marine habitats. For example, in an area with extensive mangrove forests, fishers might use their traps more readily in this habitat than the coral reef if it is easier to access. Therefore, habitat can play an important role in the spatial distribution of gears and thus the species represented by different gears.

Comparative data on the species selectivity of fishing gears are available from the Songo Songo archipelago off the coast of Tanzania. This area, located approximately 140 km south of Dar es Salaam, consists of a group of 4 islands and 30 patch reefs protected by a fringing reef (Darwall 1996, 1). Catch surveys were carried out to reveal the fish selectivity of common fishing gears: shark nets, seine nets, hand lines, basket traps, and weir traps. The author presents the distribution of fish families as percentages of the total weight of fish caught with each gear. The shark net fishery was the most extensively surveyed (sample size=76); the distribution of fish families caught was dominated by two ray families: Dasyatidae (65%) and Myliobatidae (21%). The seine net fishery (sample size=13) was more evenly distributed among the top families: Scaridae (20%), Mullidae (19%), Lethrinidae (19%), Siganidae (17%), and Nemipteridae (16%). Basket traps (sample size=11) caught a range of families: Scaridae (25%), Acanthuridae (17%), Lethrinidae (16%), Lutjanidae (9%), Siganidae (9%), Balistidae (8%), and others. The author does not record the hand line fishery quantitatively, and instead provides a list of common fish families based on his observations at landing sites. He divides hand line fishing into small gauge and large gauge. Small gauge hand line caught mainly Lethrinidae, Lutjanidae, Serranidae, and Labridae, while large gauge catch consisted of Carangidae, Scombridae, and large species of Lutjanidae and Serranidae. Unfortunately, there are not even qualitative data on the species selectivity of weir traps (locally known as *wando* or *uzio*), which is understudied although it is widely used along the East African coast.

Several interesting observations arise from the comparison of these two studies on fishing gear selectivity. The comparison is limited by the varied methods employed, although the environment, from what we know, is comparable. Hand line fishing has the most distinct catch, consisting mainly of predatory species that take the bite (which leads to high trophic level). Hand lines can target different fish size ranges depending on gauge. Seine nets and beach seines have high species richness and diversity (evident in Songo Songo as a wide range of evenly distributed fish families). In both studies, Scaridae is the most abundant fish family represented in basket traps; this gear can also be divided into two size ranges. Size differences arise between large and small size categories in traps and hand lines. Larger fish are also associated with spears, which allow fishers to target specific individuals. In both studies, authors note that the catch in most gears generally consists of few taxa, but the range of taxa increases as the sample size increases. These observations provide a set of characteristics describing the relationship between fish catch and fishing strategies that can be useful in interpreting archaeological fish assemblages (Table 3.3). More comparative data would help develop these preliminary observations. In particular, the study of fishing gear selectivity would benefit from including the total range of fishing gears and considering the variable use of habitats and seasonal differences.

Table 3.3: Outline of fishing gear selectivity
data from 1: (McClanahan and Mangi 2004) and 2: (Darwall 1996)

Gear	species diversity	fish size	trophic level	quantity (fish/fisher)	examples[1]	examples[2]
Small basket trap		small		high	*Leptoscarus vaigiensis*	Scaridae, Acanthuridae, Lethrinidae, Lutjanidae, Siganidae, Balistidae
Large basket trap		large			*Scarus ghobban, Siganus sutor, Parupeneus barberinus, Scarus psittacus, Lethrinus harak*	
Gill net/ shark net		large				Dasyatidae, Myliobatidae
Spear		large			*Leptoscarus vaigiensis*	
Small handline		small	high		*Lethrinus xanthochilus, Lethrinus sanguineus*	Lethrinidae, Lutjanidae, Serranidae, Labridae
Large handline		large	high			Carangidae, Scombridae, large Lutjanidae and Serranidae
Beach seine/ seine net	high	small		high		Scaridae, Mullidae, Lethrindae, Siganidae, Nemipteridae

3.5 The role of environmental change

Just as there are distinct yet interconnected environmental segments across space, environmental variability also exists across time, and there have been efforts to classify these variations into phases or periods. This section considers the impact of environmental change in relation to climatic and anthropogenic influences.

Large scale climate trends in Africa

Climate studies in Africa have focused on long term changes visible through analysis of the composition of ancient lake sediments. According to Grove (1993), rainfall is the most important element of climate, particularly in tropical Africa where proximity to the equator increases the rate of evaporation. Scholars (Hassan 2002; Grove 1993; Maley 1993) generally agree on the chronology of climate change in African prehistory: a cooler and drier period at the end of the Pleistocene, followed by wetter period in the beginning of the Holocene. Shell remains mark the old shore lines of this wet period (9500-8500 BP) when Lake Nakuru and Lake Naivasha rose up to 200 m and overflowed (Grove in Shaw et al. 1993, 35). Throughout the Holocene, lake levels fluctuated but never reached the extremes of the earlier wet episode. Around 4500-3500 BP aridity increased significantly and lake levels lowered to the current stage. There were also fluctuations in rainfall throughout these larger scale trends. Lake Naivasha dried up completely during a dry spell and later formed again into the lake we see today (Richardson and Richardson 1972 cited in Grove 1993, 41). It is during this dry period, what Hassan (2002, 21) calls “2100-1300 cal BC climatic crisis” that climate change is seen as a key force for cultural changes such as the spread of domesticated animals and plants in sub-Saharan Africa.

Research linking environmental and cultural change has focused mostly on the large scale subsistence shifts during the Holocene. Changing subsistence strategies on a shorter time scale (century to decade) and with a regional focus are less well understood. Long records of subsistence practices on the Swahili coast from excavated faunal assemblage provide an opportunity to investigate regional subsistence changes on a shorter time scale. Faunal assemblages from along the coastline represent around 2000 years of occupation from early coastal inhabitants, through the development of Swahili culture, its height and subsequent fall into the colonial period. The composition of oxygen isotopes in cored corals along the coast provides records of climate variability in this area over the last 200 years (Cole 2000; Grumet, Dunbar, and Cole 2000). Unfortunately, this record does not extend farther into the past. However, the East African great lakes provide paleoclimatic data of regional climatic change throughout Swahili history.

Lake cores: regional climate proxies

Shifts in lake levels have been recorded by palaeoclimate studies of East African lake sediments (Stager et al. 2009; Stager et al. 2005; Russell and Johnson 2007; Johnson et al. 2002; Verschuren, Laird, and Cumming 2000).[1] The aim of these paleolimnology studies is to reconstruct past climatic conditions by analysing ancient sediments of inland freshwater bodies. The composition of pollen, diatoms (a type of phytoplankton), and other chemical and biological traces are used as proxies for water temperature and levels. The authors identified a series of drought episodes in their data (Table 3.4).

Table 3.4: Summary of East African lake core data

Source	Resolution	Time range	Droughts (dates AD)	Reference
Victoria	1-6 yr	AD 1000-1970	1130-1190, 1270-1290, 1310-1330, 1580-1610, 1730-1800	Stager et al. 2005
Tanganyika	15-36 yr	3.8 ka-present	250-550, 800-1050, 1250-1400, 1600-1750	Stager et al. 2009
Naivasha	~10 yr	AD 880-1993	1000-1270, 1380-1420, 1560-1590, 1810-1850	Verschuren et al. 2000
Malawi	21 yr, 14 yr	25 ka-present	around 1000	Johnson et al. 2002

Overall, the East African lakes appear to be affected by a decrease in lake levels before the end of the 12th century followed by an increase in the middle to

[1] Paleolimnology data is available for public use in the National Oceanic and Atmospheric Administration (NOAA) website: ftp://ftp.ncdc.noaa.gov/pub/data/paleo/paleolimnology/eastafrica/

late 13th century (Figure 3.15). Verschuren et al. (2000, 411) estimate that the depth of Lake Naivasha changed from around 20 m to <5 m during a saline lowstand between AD 1000-1270, with a wet interval that increased the lake levels to around 15 m and back to <5 m between AD 1200-1250. Lake Naivasha has a surface area of approximately 140 km^2—more than 200 times smaller than Lake Victoria and Lake Tanganyika. Thus, while all three lakes show evidence of drier conditions around the 12th century, the Lake Naivasha record shows higher sensitivity to changing regional rainfall patterns.

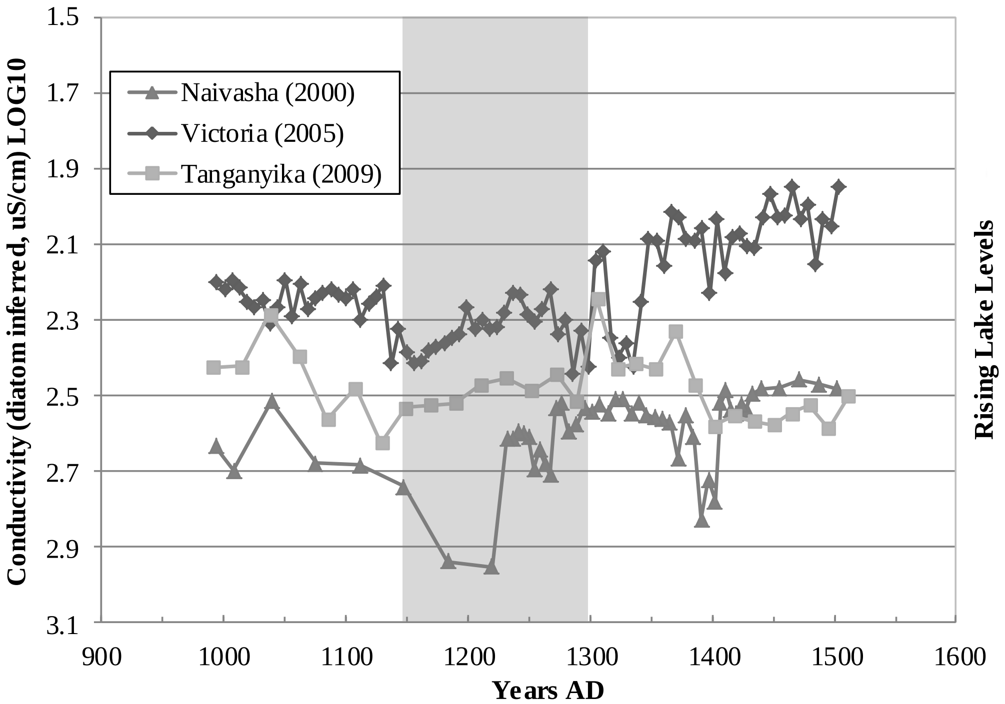


Figure 3.15: Comparison of East African lake level proxies (AD 1000-1500)
Conductivity levels through time, inferred from the diatom record. Lake levels are lower when conductivity is higher (as shown by the arrow on the right). The period of interest is marked in grey. (Data sets from Stager et al. 2005; 2009; Verschuren et al. 2000)

It is assumed that the climatic trends recorded in these proxies affected the entire East African region, although further studies are needed to understand these climatic effects on the coastal environments. Particularly around river mouths, this sudden shift between dry and wet conditions may have had an effect on coastal habitats by increasing the amount of sedimentation in the water and decreasing the amounts of light needed for a viable coral reef.

Climate and anthropogenic effects on coastal environments

Studies of climate and anthropogenic effects on coastal habitats focus on particular habitats, such as coral reefs, mangroves, and seagrass beds. Coral reefs, for example, are highly valued for their richness and beauty as well as the fragile nature of their existence. Coral reef habitats are determined by water temperature and sunlight, limiting their existence to a latitude of 25° North and South of the Equator—except where warm currents flow outside of these boundaries (Wilkinson 1999). Even within this restricted geographical range, corals require specific conditions: a depth of 0 to 100 meters below the surface, water temperature from 18 to 36°C, and salinity from 32 to 40.

The types and extent of reef threats vary according to different time and spatial scales as well as the rate of impact. From a biological time perspective relevant to human experience (seconds to decades), coral reefs are affected by both natural and anthropogenic factors that can be either localized or global. The corals' ability to recover or mitigate these forces also depends on their type and location. Wilkinson (1999, 870) divides coral reef threats into three categories: natural, localized/direct, and indirect stresses. Natural threats include volcanoes, earthquakes and cyclonic storms. Heavy rainfall may decrease salinity and increase sedimentation. Other threats are low tides and outbreaks of predators and disease. Direct anthropogenic stresses are caused by human activities (e.g. logging, agriculture) intensified by population and economic growth that result in increased sedimentation and pollution. Overexploitation and fishing pressures contribute to the destruction of coral reefs. Indirectly, humans contribute increasing amounts of carbon dioxide linked to rising sea levels and temperatures, extreme weather events, and other factors closely related to decreased survival of coral reefs. Although he categorizes natural and anthropogenic threats to coral reefs separately, Wilkinson acknowledges that they cannot be completely separated:

> *Severe rainfall events will result in increased sediment flows… Similarly, drought may also result in increased sedimentation if grazing lands and forests are laid bare of vegetation, permitting small rainfall events to remove topsoil*. (Wilkinson 1999, 874)

In the example above, the combination of severe rainfall and erosion create higher levels of sedimentation that rivers dump into the coastline where they threaten coral reefs. The amount of sedimentation accumulated during a strong episode of rainstorm is greater in areas that have suffered deforestation. A coral reef is less likely to recover from a drought if it is also experiencing stress through overexploitation. Moreover, the sustainability of the coral reefs is strongly tied to the viability of fishing cultures subsisting on their resources. Wilkinson's plea for the protection of coral reefs is made on behalf of the "many human societies [that] have developed a strong dependence on coral reefs and their productivity" (1999, 876).

Fringing reefs that run along most of the East African coast played an important role in the lives of the inhabitants of past Swahili settlements. Many of the fish excavated from Swahili towns are found in or near coral reefs, and other habitats linked to coral reefs. However, the configuration of environments surrounding Swahili towns is variable—near rivers, on nearshore islands, and on offshore islands. Most likely, the effects of environmental change vary according to the different conditions in each case. For example, environments located near rivers could be especially susceptible to river run-off. Thus, the connection between environmental change and the spatial layout of environments requires further consideration. Long chronologies of fish remains data from across the Swahili regions provide an opportunity to explore the long term effects of marine exploitation in a variety of environmental configurations.

Archaeological traces

The effects of environmental change on the coastal communities that occupied the Swahili region are visible in the archaeological record in the form of settlement occupation patterns, shifting diet, evidence of intensified fishing, and changing subsistence strategies. Although this chapter explores primarily the role of environment in fishing, environment and culture are interlinked in fishing because it is a human activity that occurs within a social setting. Humans simultaneously affect and are affected by the surrounding environment, making it difficult to disentangle culture and environment. The following examples of archaeological traces of environmental change underline the complex links between environment and culture.

Chami (2003) uses archaeological evidence to outline periods of climatic change on the East African coast. He associates occupation sequences and locations to changing climate. For example, in an archaeological survey around the Rufiji Delta, Tanzania, he identified archaeological sites of different periods linked to wet/dry periods (Chami 2003, 8). Early Iron Working (100 BC-AD 600) and Plain Ware (AD 900-1250) settlements were dominant on high ground while Triangular Incised Ware (AD 600-900) settlements were concentrated on valley bottoms that could be easily flooded, suggesting that it was wetter during the EIW and PW periods and drier during the TIW period. Chami also uses dietary data to define periods of wet and dry climate. Shellfish, he argues, are largely associated with times of stress when other food sources are scarce, and shellfish populations thrive in drier climates when salinity is higher (2003, 13). He mentions a series of East African archaeological sites with evidence of shellfish exploitation during specific time periods. He links the periods associated with large quantities of shellfish remains, such as the Triangular Incised Ware (AD 600-900) and Swahili (AD 1250-1500) periods, to drier climate.

Table 3.5: Comparison of wet/dry periods throughout Swahili history (based on Chami, Pwiti, and Radimilahy 2003, 13: Table 1.5; Verschuren, Laird, and Cumming 2000; Stager et al. 2005; Stager et al. 2009)

Cultural Tradition	Date Range	Chami	Naivasha	Victoria	Tanganyika
Post Swahili-ph 2	AD 1650-1800	Drier	Wetter	Wet/Dry	Drier
Post Swahili-ph 1	AD 1500-1650	Wetter	Wet/Dry/Wet	Drier	Wetter
Swahili Ware	AD 1250-1500	Drier	Wet/Dry/Wet	Wetter	Drier
Plain Ware	AD 900-1250	Wetter	Drier	Drier	Wet/Dry/Wet
Triangular Incised	AD 600-900	Drier	Wetter	--	Wetter
Early Iron Working	100 BC-AD 600	Wetter	--	--	Drier

To complicate matters, Chami's archaeological outline of wet and dry periods along the East African coastline does not correlate with the climatic shifts identified in the regional lake core data (Table 3.5). This discrepancy underlines the need for an independent climatic proxy for the coastline to understand local climatic trends and explain patterns in the archaeological record. As described in Chapter 2, the archaeological patterns we detect are subject to a series of taphonomic processes. Thus, it is important to use multiple lines of evidence to make a convincing case that changing patterns of subsistence and settlement occupation are influenced by environmental shifts and not a result of other factors, such as cultural innovation or preservation bias. Independent climatic data, such as regional lake-core data, can support hypotheses about the role of climate change in past communities.

One of the key indicators of human induced environmental change associated with marine exploitation is a decreasing mean trophic level of fish catch (explained in Chapter 2). Trophic levels represent the position of living objects in the food chain on a scale of 1 to 5, from producers (plants) to the highest predators. Fisheries data shows that the mean trophic level of a region decreases when the top predators in the ecosystem decline, potentially as a result of intense fishing (Pauly et al. 1998). Thus, a coastal region affected by intensive fishing exhibits a declining trend in mean trophic level of fish catch. In archaeological sources with long chronologies of fish data, declining mean trophic levels are not a direct measure of fishing intensity but can been used to interpret changes in subsistence and fishing patterns (Reitz 2004). Claims of anthropogenic environmental change can be supported by other possible indications of intensive exploitation of animal populations such as a decreasing average size of a targeted species. Decreasing size of fish catch, however, can also result from other factors, such as a shift in the exploited habitat or fishing grounds.

Shifting subsistence strategies can be traced archaeologically with evidence of changes in habitat use and fishing gears from the species composition of fish remains. These patterns alone are not indications of environmental change but rather indicate changes in the ways fishers interact with their environment. I analyse these dynamic interactions through space and time in the Swahili region noting shifting patterns in diet, trophic level, and habitat use (Chapter 5). I compare the results to independently derived records of regional climate change and consider whether these patterns were influenced by changing rainfall. Similarly, I explore the historical setting in which subsistence changes occur. Climate and culture are not competing factors for explaining subsistence change. I am interested in how they are intertwined in the ways people mitigate and influence climate change through their social behaviour.

3.6 Summary

This chapter is an effort to describe the conditions of the natural landscape exploited by past fishers, which can also be described as the life assemblage as it was defined in Chapter 2. I discuss the dynamic coastal environment in terms of spatial and temporal variability. Spatially, the East African coastline consists of a series of coastal habitats that are configured differently in the various regions occupied by Swahili towns. The association of particular fish species to specific coastal habitats is useful to determine the range of exploited habitats in the past. Specific aspects of fish behaviour, such as size/age and feeding behaviour, are also linked to particular fishing strategies. I present temporal variability in terms of environmental change affected by interrelated climatic and anthropogenic factors. Lake cores provide a regional picture of shifting dry and wet periods over a century to decadal time scale throughout Swahili history. A significant climatic shift is recorded at the end of the 12th century that may have affected coastal habitats. I evaluate the extent to which this regional climate shift affected fishing on the Swahili coast in a comparison of regional fish remains data in Chapter 5. Finally, I consider the types of archaeological evidence of environmental change on the Swahili coast. In essence, this chapter sets the (environmental) stage for investigating fishing practices along the East African coast. The transformation of marine products brought to Swahili communities in the hands of fishers is explored in the following chapter on ethnoarchaeology.

Chapter 4: Ethnoarchaeology in Vanga Area

"Kusomea kwa kweli sikusomea katika ofisi. Nilisomea hivyo hivyo Kiswahili, wenzangu wanafanya hivi na mimi nafanya hivi, wanakwenda hivi na mimi nakwenda hivi sasa na mimi nachukua pointi kwenya ile kazi ya uvuvi."

Studying, in fact, I did not study [fishing] in an office. I studied Kiswahili the same way: my colleagues do this and I do this, they go like this and I go the same; I take pointers as we fish.
-Jimbo fisher, 2009 (Translation mine) [2]

"Nampara, natoa matumbo, natoa mashavu, namnosha. Halafu namchemsha kwa kutia embe, chumvi, masala, na wa kukaanga namtia kitunguu saumu, masala."

I remove the scales [literally, scratch off it], I remove the intestines, I remove the gills, I wash it. Then I boil it while putting mango, salt, masala, and when it is fried, I put garlic, masala on it.
-Jimbo salesperson, 2009 (Translation mine) [26]

4.1 Introduction

In this chapter, I summarize the main ethnographies of Swahili fishing and how they apply to investigations of fishing and food consumption in archaeology. First, I explain the different forms of analogies between studies of past and present cultures to show that there is relevance in the continuation of practices through a region's history and through the functional characteristics of these practices. I illustrate these differences in my own ethnographic study in Vanga and surrounding area, in the southern Kenya coast next to the archaeological settlement of Vumba Kuu. Finally, I discuss the applications of my ethnographic work in the interpretation of the faunal archaeological assemblages.

4.2 Analogy in ethnoarchaeology

Analogy is not just at the core of the ethnoarchaeological approach but is the foundation of all archaeological interpretations, according to Nicholas David and Carol Kramer (2001, 1). The ethnographic study of living cultures from archaeological perspectives—ethnoarchaeology is one of the methodologies emerging out of New Archaeology, specifically related to Lewis Binford's Middle Range Theory. Binford (1978) combined the study of contemporary peoples with archaeology in his work with Nunamiut Eskimos in Alaska. From the beginning, the use of analogy—using contemporary cultures to understand the past—has been criticized for imposing modern models on past cultures, leading to discussion on the value and limits of ethnoarchaeology. In his reflection on the meaning and purpose of ethnoarchaeology, Stiles (1977, 87) places his argument in connection to contemporary trends in the development of New Archaeology, mentioning a drive to create a “more systematic model” for the use of ethnographic analogy. The acceptance of ethnoarchaeology for use in archaeological interpretation was influenced in part by the realization that most ethnographic accounts were not useful for archaeology and the potential for understanding past human behaviour. What ethnographic accounts lack, he underscores, is emphasis on material culture.

Stiles (1977, 88) offers some definitions provided by other scholars (Oswalt and Stanislawski) but concludes that ethnoarchaeology is “all the theoretical and methodological aspects of comparing ethnographic and archaeological data”. This would include obtaining information from ethnographic accounts, traveller logs, museum collections, and archaeological ethnographies. *Archaeological ethnography*, Stiles’ term for what Gould would call *living archaeology*, is “fieldwork in living human societies, with special reference to the ‘archaeological’ patterning of the behaviour in those societies” (Gould 1974, 29 cited in Stiles 1977; Gould 1980). Stiles’ definition of ethnoarchaeology includes both making and using the ethnographic sources described above.

Researchers studying the Swahili world have long referenced existing ethnographic and historical sources in their work, and there are examples of *living archaeology* research in several research areas. Ethnoarchaeological work by Donley [Donley-Reid] (1982; 1987; 1990) on the social meanings in the spatial layout of Swahili households is perhaps the best known example of Swahili ethnoarchaeology. Kusimba (1993; 1996b) contributes an ethnoarchaeological perspective on ironworking in Swahili history. In the realm of subsistence, two unpublished PhD theses exemplify the ethnoarchaeological approach: Msemwa’s (1994) research on shellfish collecting in this region and Walshaw’s (2005) work on the botanical remains from Pemba Island. Early examples of ethnographic descriptions of East African coastal fishing (Grottanelli 1955; Prins 1965) attest to the significant role of fishing and fish consumption in the lives of the coastal inhabitants in this region. Yet ethnoarchaeological work on Swahili fishing is only beginning to emerge (Christie 2011). My ethnoarchaeological approach references previous ethnographic studies but is mostly based on the *living archaeology* of Swahili fishing. I use analogy as a tool to understand the relationship between patterns of social behaviour and material remains in past and present fishing communities along the Swahili coast.

<u>Relational vs. Historical analogy</u>

Ethnoarchaeologists distinguish between two types of analogy depending on the degree of historical and geographical connections between the past and present cultures under study. The stronger the connection is between past and present cultures, the more valid the conclusions resulting from their comparison, according to Stiles (1977). Similarly, in *Symbols in Action*, Ian Hodder (1982) stipulates that analogy can be used to interpret archaeological remains when both cultures occur(ed) in the same geographical area and climatic zone, and have similar technological knowledge and social organization. This form of historical comparison, however, can lead to the oversimplification of correlated observations based on assumptions. Although continuity may appear to be evident, it is important to understand changes that occurred between past and present points of reference.

There are those who argue in favour of a discontinuous or relational analogy. Gould emphasizes the role of "relationships that explain how and under what conditions certain kinds of traditional behaviour may have been important in relation to overall processes of human adaptation" (1980, 44–5). Wylie defines relational analogies:

> *When analogs are compared for the relations that hold among the properties they share rather than for the simple presence or absence of these properties considered independently of one another; that is, analogies that incorporate considerations of relevance are typically "relational" analogies.* (Wylie 1985, 95)

Wylie defines "relevance" as the causal or deterministic effect of one thing on another. Thus, relational analogies offer models of behaviour that function within a defined set of interrelated conditions. These analogies, in turn, are criticized for the limits of their application and overgeneralization of human behavioural patterns. In both types of analogies, it is relevant to consider Gould's (1980, 28) warning against "the simple, direct comparison of living people with the physical remains they leave behind."

Walshaw (2005) adheres to relational analogy in her ethnographic description of plant processing techniques in coastal East Africa. She describes relational analogy based on the limited ways in which humans interact with natural resources, which suggests that the same food resources would be processed in a similar way given a similar environment. On the other hand, historical analogy assumes a continuation of practice in the same area given to cultural/ethnic ties and the passing of knowledge through generations. For example, in her study of symbolic artefacts in post-17th century Swahili houses, Donley (1987) emphasizes the continuity of cultural patterns based on a long tradition of Islamic religious practices and far-reaching lines of descendants inhabiting the households.

In the case of marine exploitation in the Swahili region, relational and historical analogies are intertwined. Analogy is based on principles of function and "relevance," as in the availability of certain types of trees needed to construct fish traps. At the same time, the chronological connection, that basket traps have been made in a similar manner for centuries, cannot be ignored. Perhaps both continuity and function testify to the adaptability and importance of fishing as a subsistence strategy in this region. Thus, ethnoarchaeology is a fruitful way of exploring food consumption in past Swahili settlements.

Prevalence of fishing ethnoarchaeology

It appears that ethnoarchaeologies of fishing are not just lacking in the Swahili region but worldwide. David and Kramer (2001) trace the history of ethnoarchaeology through a categorization of published articles from its beginnings in the mid-1950s to the late 1990s. These are classified according to topic and region, revealing trends throughout the development of ethnoarchaeology. The authors recognize that Sub-Saharan Africa is the most common setting for published ethnoarchaeological work. Additionally, the authors acknowledge that most ethnoarchaeological work associated with faunal remains concerns the exploitation of mammals (David and Kramer 2001, 117). An updated version of the *Ethnoarchaeology Bibliography* is available online and contains

995 records of ethnoarchaeological literature published until 2004 (David 2004). I found 27 published articles in the subject of faunal ethnoarchaeology in Sub-Saharan Africa—using the coded keywords ea/saf/faun. Of these, only one (Stewart and Gifford-Gonzalez 1994) relates to fish remains. World-wide, I found five articles concerned with the ethnoarchaeology of fishing—using the keywords ea and fish—until 2004. More recently, Jones (2009a; 2009b) has contributed a series of articles on the ethnoarchaeology of fishing in the Pacific Islands.

The list of bibliographic references reveals that the field of faunal ethnoarchaeology has focused largely on hunter-gatherers' acquisition and transportation of red meat. This trend is also noted by Gifford-Gonzalez (1993), who argues that ethnoarchaeologists overlook the effects of social distribution of food and cooking due to the andro-centric view of human foraging and the focus on prehistoric patterns of behaviour associated with faunal remains. Furthermore, David and Kramer (2001, 126) wonder if the absence of ethnoarchaeological models of complex societies leads to the "the relative lack of consideration of faunal remains in the archaeology of societies more complex than hunter-gatherers." My ethnoarchaeology of Swahili fishing contributes not only to the growing subfield of fishing ethnoarchaeology, but also to the study of faunal remains in complex societies.

4.3 Relational models

Resources available for comparing fishing communities are limited by the fact that very little ethnoarchaeological research has been published in this area, as noted above. One approach to overcome this is to delve into the realm of cross-cultural comparison. Acheson (1981) reviews anthropological research on fishing communities around the world, showing that fishers worldwide confront similar problems. Among fishers' common experiences are adaptations to enduring dangerous and unpredictable environments, gaining knowledge and skills to exploit a diverse set of resources, and spending time away from their families and communities (1981). These adaptations to a fishing livelihood shape how fishing communities are socially and politically organized. For example, one of the social measures to minimize risk found worldwide is the practice of sharing the catch among crew members as opposed to receiving an established wage (1981, 278).

Another example is the existence of strong ties to intermediaries (fish dealers and boat/gear owners) in many fishing communities, which helps spread the risk across various individuals (1981, 283). Clay and Olson (2007) offer another similar set of commonalities from cross cultural studies of fishing communities that includes: 1) spending time on land and at sea; 2) importance of fishing; 3) women's involvement; and 4) paying crew by share.

Cross-cultural comparisons of fishing communities are also possible with tools such as Murdock's *Ethnographic Atlas* (1957; 1967; 1986), although these usually discuss fishing as a type of foraging strategy. A compilation of 1267 world societies are codified into 106 variables that range from 'mode of marriage' and 'subsistence economy' to 'prevailing type of dwelling' (Murdock 1986; Fischer 1990; Gray 1998). A recent study (Pryor 2003) uses a subsample of the *Ethnographic Atlas* to understand social complexity among worldwide foraging communities—defined as obtaining at least 75% of their food from hunting, gathering, or fishing. Pryor (2003) uses cluster analysis to compare environmental and socio-political factors among five types of foraging communities. For example, the level of social inequality correlated with wealth inequality, and both were higher in foraging communities that were more economically oriented (418). This study, however, is limited to the exploration of correlations between factors, as the author admits, without understanding what links them (414).

Cultural models emerge from a more detailed understanding of the social dynamics underlying certain cultural characteristics. For example, Marlowe (2007) uses a similar subset of foraging cultures—defined as having <10% dependence on agriculture and animal husbandry—from the *Ethnographic Atlas* to investigate the development of sexual division of labour in foraging communities. Foods targeted by foragers were divided into categories (e.g., shellfish and small aquatic fauna, true fish, large aquatic fauna) to explore which food items are targeted by men and women in the various communities (175-8). Overall, women tended to target the foods that involve the least risk or danger (vegetal foods and shellfish) while men mostly targeted those with opposite traits (large land and aquatic fauna) (181). According to Marlowe's (2007) study, men use more flexible strategies than women: participating in gathering activities when these foods are abundant and hunting more when gathering is not as fruitful. Thus, there is a lower division of labour in foraging communities that live in rich stable environments where gathering is more reliable. Marlowe (2007) uses these observations to understand the development of sexual division of labour in early human history. In particular, he speculates that the use of different tools by males and females was key in the development of specialized gender roles by creating separate specialized roles between genders and by providing a surplus that prompted males to hunt more in addition to gathering, making them more attractive partners.

These comparative papers begin to disentangle the relationships between subsistence and social structure. However, they are limited by the biases inherent in both the sources of original data and the codification of the cultural catalogue itself. Furthermore, the differences between fishing and other foraging strategies are often ignored as these tend to be bundled into a single “forager” category. Because these comparative studies are focused on generalized models of human behaviour, the complex relationships among different members of a community are often overlooked.

What models of social behaviour are offered in the understudied area of fishing ethnoarchaeology? For a start, these studies tend to be more localized and are better connected to the material objects associated with human behaviour, what Gould (1980, 42) calls “the study of residue behaviour.” A survey of the limited number of published fishing ethnoarchaeology articles reveals some useful examples of behavioural models associated with materials. Although these articles range in time and space, they all employ a combination of qualitative and quantitative methods. I have summarized them around the following five common themes associated with fishing ethnoarchaeology: 1) fishing methods, 2) seasonal variation, 3) evidence of fish processing, 4) social aspects, and 5) variable use of space.

Fishing methods. Fishers employ their knowledge and skill to exploit particular types of fish, thus archaeological fish assemblages reflect not just the availability of resources but also fishers’ strategies. Working in the Arctic region, Glavatskaya differentiates between active (nets, lines) and passive (traps, weirs) fishing strategies (Jarvenpa and Brumbach 2006, 148). William Belcher (2009) reports that fishers in Pakistan targeted particular species using a variety of nets used at different depths and at specific fishing grounds. Fishers around Lake Turkana, Kenya, targeted littoral fish, catfish and tilapia with spears, clubs or nets while boats were needed to access perch and large catfish (Stewart and Gifford-Gonzalez 1994, 239).

Seasonal variation. Seasonality plays an important role in determining fishers' strategies and thus the resulting catch composition. For example, during the least productive season, Pakistani fishers stayed closer to shore to minimize effort, but during the most productive season when the sea was rough, fishers went farther out to sea despite the risks (Belcher 2009, 12).

Fish processing. Ethnoarchaeological studies reveal aspects of fish processing that may or may not leave traces on fish bones. Butchering techniques can vary according to fish species and size. Khanty fishers used different butchering techniques according to species, starting from the back for perch, and from the belly for rudd (Jarvenpa and Brumbach 2006, 142). In Pakistan, butchery strategies varied according to size: large fish had the heads removed, medium fish were cut into smaller pieces, and small fish were prepared and eaten whole (Belcher 2009; Belcher 1998). Around Lake Turkana, Stewart and Gifford-Gonzalez found deep and shallow cutmarks on the ribs of mostly large fish, over 100 cm in length, which they associate with chopping and filleting, respectively; smaller fish, less than 30 cm, were mostly processed intact (1994, 244, 247). Researchers have also found specific types of traces from particular processing techniques; for example, a connection between dry fish processing and cutmarks in the fish bones' medial interior sides (Belcher 2009, 13). Stewart and Gifford-Gonzalez found that fishers roasted fish heads of large to medium sized fish, leaving burn marks on cranial elements while small fish were more likely prepared by boiling (1994, 244). Certain forms of fish processing may leave no traces; for example, the preparation of shark liver oils for boat maintenance (Belcher 2009, 12), fish glue for repairing fishing gear, and fish oil to "dip bread into" (Jarvenpa and Brumbach 2006, 137).

Social aspects. Members of different social groups participate in a variety of fishing activities and can therefore be connected to the tools and spaces associated with those tasks. In arctic Russia, Khanty women performed all the processing tasks year round and carried out a large part of subsistence fishing, especially during hunting season when their spouses travelled for long periods of time; however, men had an important role in the construction of fishing equipment (Jarvenpa and Brumbach 2006, 138–144).

Space. Fish related activities take place in a variety of locations, resulting in different material signatures. Most subsistence fishing activities occur a short distance from settlements, within one hour travel in the case of Khanty fishers (Jarvenpa and Brumbach 2006, 145). Stewart and Gifford Gonzalez used the characteristics of fish bones to distinguish different types of fishing areas (1994, 246–7). Areas where consumption took place produced relatively high proportions of body elements (vertebrae), although more cranial elements were represented where people roasted fish heads. Processing areas resulted in the near absence of vertebrae, as fish bodies were mostly taken away for consumption elsewhere.

4.4 Historical models

Four main ethnographic works have provided descriptions of fishing and fish consumption from different parts of the Swahili coast. In the context of the colonial period, Ingrams (1931) published a description of Zanzibari culture that includes important chapters dedicated to aspects of fishing and sailing. Grottanelli (1955) published his account of Bajuni people from the southern Somali coast and northern Kenya based on observations during his four month visit to the area. Grottanelli's contemporary describes this work as "the first systematic ethnographic study of the Bajuni", an East African people of Arabian influence whose lives are based around the sea (Lewis 1956). A decade later, Prins (1965), a Dutch maritime anthropologist, provided what was called for his time one of "the fullest accounts we have of any maritime culture of the East African Coast" based around the Lamu area (Middleton 1967). More recently, Glaesel (1997) undertook her PhD research on changing management practices of marine exploitation in the coastal region of Kenya, particularly around Mombasa. These works, each with its own approach and regional focus, contain important observations and reflections of subsistence strategies in the Swahili coast that are useful references for the past.

These authors generally agree that fishing played an important economic role in the coastal communities they studied. Fish, Ingram states, “form the chief food of the natives” (1931, 299). According to Grottanelli (1955), fishing is the basic Bajuni economic endeavour, animal herding and agriculture having secondary importance. He mentions sheep, goats and cattle as the principal livestock. Prins describes fishing and fish consumption in the framework of “maritime-ness”, in which he includes economic aspects as well as social perspectives such as “the attitude towards fish” (1965, 4). Prins calculates that 60% of the Lamu economy was maritime (based on shipping, mangrove harvesting, and fishing) (1965, 8). However, fishing, he declares is not the only and foremost economic endeavour undertaken by Lamu inhabitants. The attitude towards fish and fishing is exemplified in two local proverbs:

Hii si nyumba ya wavuvi.
This is not the home of fishers.
Mtafi-tafi hula swi, mtulivu hula nyama.
The over eager often eats fish; the patient one often eats meat.
(Prins 1965, 131)

The first proverb, which is said in the context of noise and disorder, portrays fishers in a condescending tone. The second implies that red meat has higher value and is less commonly available, while fish are easy to come by. The sense is that while fish are a regular part of coastal diet—and thus, fishing an important subsistence strategy—fish and fishing are not held with high esteem, perhaps as a result of their ubiquity.

The consideration of fishing material culture by the authors of these coastal ethnographies is notable. For example, Grottanelli (1955) includes several chapters on economic activities and techniques around the Kenya-Somalia border, in which he describes the principal fishing methods and the crafts for constructing fishing gear and vessels. Ingrams (1931) describes a similar set of local fishing methods, types of sailing vessels and a brief description of rituals associated with fishing in Zanzibar. Prins (1965) also includes a description of fishing methods around Lamu, which he describes in relation to the types of vessels and number of crew involved (Table 4.1). Glaesel (1997), on the other hand, divides traditional fishing gears into two categories: environmentally sustainable (hook and line, basket traps) and unsustainable (harpooning, fence traps, gleaning, poisoning), noting that sustainable methods have endured longer. Newer methods tend to be unsustainable (synthetic nets, spear guns).

However, the line between old and new is not clear cut. For example, around the 1940s, handmade handlines of cotton, bark, or sisal fibres were replaced by nylon handlines. Although raw materials were replaced by manufactured materials, the gears themselves were still created using "old" techniques. More and more, handmade gears and equipment have been replaced by manufactured versions, which Glaesel points out, goes hand in hand with a loss of traditional skills and knowledge.

The authors of these ethnographies touch on the interplay between social and environmental aspects of fishing. Of particular interest is Glaesel's account of fishing gears, where she states gear choice is based on fisher knowledge, environment and resource management (1997, 74). Choice of gear is also linked to ethnicity and age. She claims certain fishing methods are associated with particular ethnic groups (e.g. Digo use octopus on sticks to fish lobster while Bajuni use large basket traps) (Glaesel 1997, 77). Age plays a role in the form of knowledge and physical capabilities—older fishers are more likely to use traditional weirs and harpoons because they have more experience with these gears and cannot participate in more dangerous and exhausting methods.

Table 4.1: Principal fishing methods summarized in ethnographic literature (Based on Prins 1965; Grottanelli 1955; Glaesel 1997; Ingrams 1931)

	Gear	Description	Vessel	Crew	Notes
other	gleaning	collecting small fish, shellfish, or crabs	none	variable	often women
	tando	extended veils used to catch fish at low tide	none	small group	often women
	konzo	a stick used to lure animals out of shelter	none	N/A	
	munda	spear two metres long with semi barbed head, harpoon	none	variable	
	mshale/njoro	spear	none	N/A	
	bunduki	spear guns	none	N/A	introduced to East Africa in the 1950s
	utupa	poison	none	N/A	
	taza/chaza	remora attaches itself to the throat of the turtle and is pulled up with a line	dau	3	
traps	*tata*	weir trap set across tidal currents	dau	1	often elderly men
	uzio/wando	weir trap set across tidal currents (stationary)	dau	1	often elderly men
	yema/dema/lema	baited basket trap sunk at high tide and collected at low tide	mashua, ngalawa	N/A	
lines	trolling	moving lines with baited hooks	mashua, dau, mtumbwi	N/A	
	handline	static lines with baited hooks	mtumbwi	1	often poor men
nets	*juya*	seine or drag net	dau	10 to 20	
	jarifa	gill net	mashua	4	strenuous and expensive
	yasi/nyavu	smaller haul seine	dau	2 to 4	
	kimia	casting net	none	1	

Because certain fishing methods require more capital to obtain and maintain gears and vessels, socio-economic status also plays a role in choosing fishing method. Particularly, fishing methods that take place farther distances from shore require larger and more expensive boats. If fishers cannot afford to buy and maintain a boat, they will first rely on a family support system for a loan before relying on a trader so that a larger percentage of the profits can benefit their own families. Boat owners not only get a share of the profits without having to fish, they can also, and usually do, engage in other profitable activities (Prins 1965; Glaesel 1997; Nakamura 2011). Glaesel (1997, 59-60) shows that even the type of boat can be related to type of owner in Zanzibar, where captains own more than half of canoes, over a quarter of boats, and less than a quarter of motor boats, of which more than half are owned by traders. Thus, traders tend to own the larger, more expensive boats, while captains, who are more directly involved in fishing, own the smaller boats.

The three earlier ethnographies of Swahili fishing portray a view of East African coastal communities frozen in time. In contrast, Glaesel's PhD thesis investigates the declining role of elders in marine resource management through the changing social dynamics of fishing on the Swahili coast. The main trend that she observes is a decline in the number of fish stocks, particularly closer to shore, which reduced fishing gear variety and fisher elder knowledge. At the same time, the Kenyan economy declined in the 1970s and 80s, leading to an increase in the use of cheap, unsustainable gear. This subsequently led to a reduction in a local marine tenure system based around permanent fishing areas. The organization of fishing around marine environments close to shore seems to be linked to a long history of use of fishing gears adequate for these types of habitats. Increasing inshore fishing intensity has led to decreasing fish populations, motivating fishers to venture farther from shore. However, Glaesel is careful not to solely lay blame on overfishing. A rising sea level can increase the erosion of protective reefs, allowing stronger waves to crash into the shore habitats. An almost opposing problem is beach erosion that widens lagoons and increases the water temperature. Regardless of the reasons for the decline, it is clear that fishers have increased the exploitation of areas beyond the shores and lagoons.

In sum, Glaesel paints a picture of contemporary changes in fishing on the Swahili coast. She describes a declining inshore fishery that encourages fishers to venture to deeper and more dangerous waters and diversify their methods. This in turn increases a reliance on boats, decreasing the use of inshore fishery methods (such as trap fishing) that are associated with elders' knowledge and are being replaced with manufactured materials. At the same time, recent economic problems have encouraged an increasing amount of unemployed young men to join the coastal fisheries. As a result, increased competition and aggressiveness of fishing is evident in a rising number of thefts associated with fishing gear, vessels and even catch (Glaesel 1997, 79). Glaesel's observations of the social and environmental consequences of fishing intensification are valuable for understanding the complexities of this trade. For example, one sees a tendency for fishers to expand their range of exploitation in the face of competition and decreased fish stocks.

These ethnographic studies illustrate the kinds of information an archaeologist can gain from the study of living cultures. The examples outlined above describe the principal fishing methods and the role of fishing in various East African coastal communities. These sources portray how fishers capture and collect marine resources, but the trajectory of these objects from capture to deposition remains obscure. The distribution of marine resources in a community and the transformation of these during the processes of cooking, eating, and discarding are also important factors leading to the composition of faunal assemblages recovered during excavation. In the following case study, an ethnoarchaeology of Vanga and surrounding villages, I take on the study of contemporary fishers with archaeological questions in mind, emphasizing the trajectory of faunal remains and what we can learn about society from these material objects.

4.5 Ethnoarchaeology in Vanga area

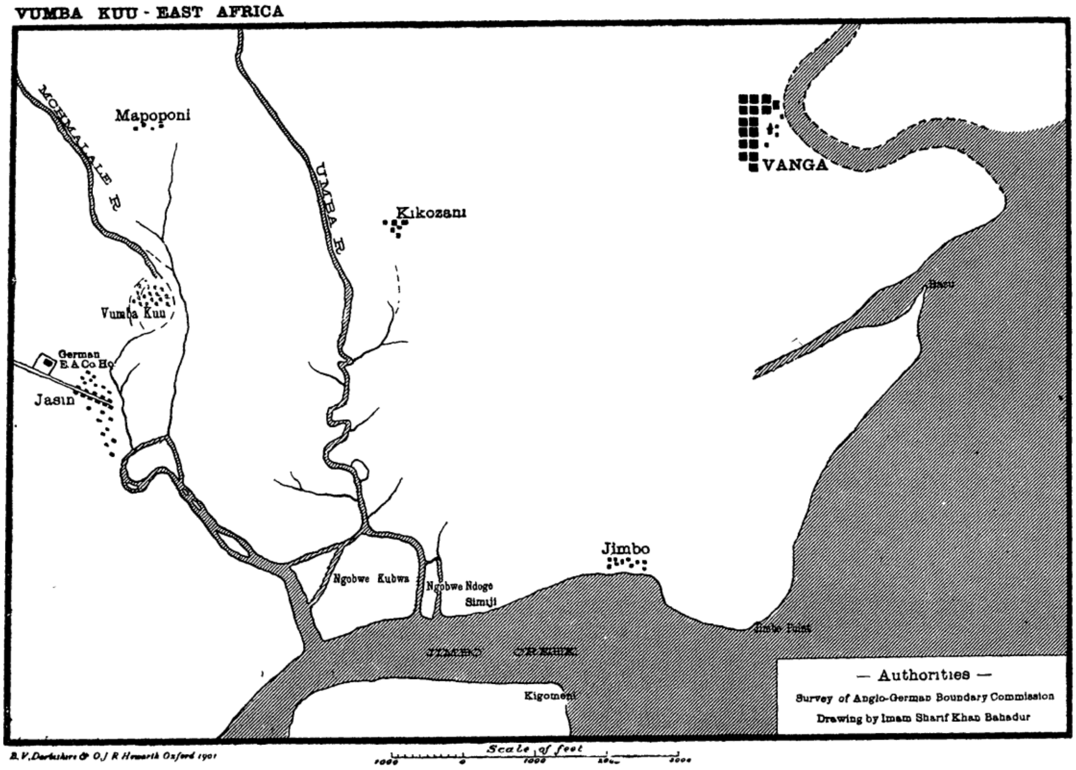


Figure 4.1: Map of Vanga town and surrounding area, including Jimbo and Jasini (Hollis 1900)

Vanga town lies on the mainland coast of southern Kenya surrounding the Umba river delta (Figure 4.1). This resource-rich coastal environment once sustained the inhabitants of the 14th to 16th century town of Vumba Kuu and is now home to a series of communities with mixed economies, some of which depend largely on fishing. The Vanga area provides an ideal setting for ethnoarchaeological research on Swahili fishing and fish consumption from both a relational and historical perspective. Firstly, the environment surrounding these (past and present) communities consists of typical marine habitats found along the East African coast: mangrove, mudflats, estuaries, seagrass beds, coral reefs, and open seas (more details in Chapter 3). Although there are certainly unique local environmental traits, the same general dynamics—seasons, currents, fish behavioural patterns, etc.—are at play along the East African coastline. Secondly, there are historical ties between the past and present communities in this area. The current population includes some of the same ethnic groups that are believed to have occupied this area throughout its history, when the now ruined city of

Vumba Kuu was thriving (the history and archaeology of Vumba Kuu are discussed in Chapter 7).

Excavations at Vumba Kuu led by Stephanie Wynne-Jones (2009) yielded numerous fish bones and other animal remains, which I have analysed as part of my doctoral research. Other traces of past fishing and fish consumption practices are difficult to recover archaeologically, which underscores the importance of understanding the traces of patterns of behaviour associated with the use and transformation of fish. I carried out a variety of ethnoarchaeological strategies during two field seasons in 2009 and 2010 at three coastal fishing communities in Vanga area to record the social dynamics and taphonomic processes of fishing and fish consumption in an East African coastal environment. My aim was to use this understanding to aid the interpretation of excavated fish remains at Vumba Kuu and other Swahili settlements.

Two main questions were the basis for this study:

1. What is the trajectory of use and transformation of fish and materials associated with fishing and fish consumption in this area?
2. What are the social and environmental dynamics related to traditional fishing practices on the Swahili coast?

Setting

The communities included in this study, Vanga town and nearby fishing communities Jasini and Jimbo, fall within Msambweni District at the southern Kenyan border with Tanzania. In Vanga town, there are 4,230 people in 640 households. Jimbo has less than 50 households and Jasini less than 30.[2] It is important to consider that Jasini lies across the border between Kenya and Tanzania; therefore, the number of households mentioned here refers only to those on the Kenyan side, which represents less than half of the total settlement. Thus, Jasini is a larger village than Jimbo.

Comparative observations between different size settlements were possible. I observed traditional fish processing methods, particularly in Jimbo, where running water and electricity had not reached the settlement. In Vanga,

[2] These numbers were collected in 2009 as a precensus for the 2009 census and were obtained from the administrative chief of Vanga location.

there had been electric power for five years, but traditional processing methods continued to be used, especially because not everyone could afford these modern facilities (Figure 4.2).

Figure 4.2: The waterfront at Vanga town

Methodology

Fieldwork was carried out over two periods to observe differences between the two principal monsoon seasons. The first field season took place during June and July 2009, in the middle of the *kusi* season (southwest monsoon), which occurs between April and August and is characterized by strong winds and rain. I returned in November 2010, during the calmer weather of the *kaskazi* (northeastern monsoon), which lasts from September to March. I worked with a team of three field assistants: Mohamed Mchulla, a representative of National Museums of Kenya; “Chai” Mjahiya Rashid, a local resident and informant; and Mwatime Abdallah, an anthropology student at Moi University. We employed the following forms of data collection: semi-structured and structured interviews, focus groups and participant observation (Figure 4.3; refer to Appendix C for Ethics Statement).

Figure 4.3: Ethnoarchaeology in action
Clockwise from top left: semi-structured interview, participant observation, structured interview

A total of 89 interviews were carried out over the course of two field seasons (refer to Appendix D for a summary of interview data). During the first field season, we recorded 59 semi-structured interviews (Table 4.2) and made observations of any activity involving fish, from the moment fish are captured out at sea to when they are sold, eaten, and thrown away. Three themes were used to organize the semi-structured interviews: symbolic and ethnic, social structure and technology. During the second field season, we documented 30 structured interviews with more focused strategies: ranking food items, food diaries, and household diagrams (Table 4.3). During both field seasons, I kept a journal to write down daily thoughts and observations, and took photographs and video footage of fishing and fish consumption materials and activities. Abdallah subsequently transcribed the recorded interviews.

Table 4.2: Summary of 2009 interview data

Landing site	Sample size	Gender		Age		
		F	M	Min	Max	Avg
Jasini	12	6	6	25	60	43
Jimbo	27	10	17	22	75	48
Vanga	20	8	12	30	80	51
Total	**59**	**24**	**35**	**22**	**80**	**48**

Table 4.3: Summary of 2010 interview data

Landing site	Sample size	Gender		Age		
		F	M	Min	Max	Avg
Jimbo	10	5	5	23	71	40
Vanga	20	13	7	22	70	39
Total	**30**	**18**	**12**	**22**	**71**	**39**

In the following sections, I use a series of steps to trace the use and transformation of fish in human hands. I highlight various socio-environmental dynamics at play during each stage.

Results: Capture

Fishers first bring fish directly into their social realm when they capture them. Capture is influenced by three interrelated variables: time, place and technology; which in turn, depend on social and environmental factors. Fishers experience time on different scales; for example, through the daily tides and seasonal monsoons. Certain fishing methods that can be used closer to shore abound during the rainy *kusi* season and others are more suited for the calmer *kaskazi*. One fisher from Jimbo puts it this way:

> *Iko wakati kwa huu wakati wa kusi tukuwa huku tunatumia madema[,] uko wakati kama wakati umeshakwisha wa madema ndo[go] tunatumia mshipi wakati wa kaskazi ule.*
>
> When it is around the time of *kusi* season here we use *madema*, when the time has finished for small *madema*, we use *mshipi* during the *kaskazi* season. (Translation mine) [2]

On a weekly timescale, many fishers in Vanga area chose to rest on Fridays, a holy day in Islam. On Fridays, it was common to see fishers mending sails and repairing fishing gear along Jimbo's waterfront. These observations portray how the timing of fishing events is influenced by both social and environmental conditions.

I divide the principal types of gears I observed in Vanga area into five categories: *lema* (basket trap), *uzio* (fence trap), *bunduki* (spears), *mishipi* (fishing lines), and *nyavu* (nets). Each type of fishing gear has both environmental and social ranges. In Chapter 3, I discuss the environmental characteristics of fishing methods, such as how different net mesh sizes, hook sizes, and trap sizes target particular groups of fish in various habitats. Additionally, each gear consists of a set of social characteristics, such as the cost of materials, number of crew needed, risk involved, and necessary experience. Both environmental and social characteristics influence which technology fishers choose to use as well as where and when to fish. The following paragraphs describe the main fishing gears in more detail.

Lema (plural *malema*; also known as *madema*) is a basket trap woven with pieces of local trees (Figure 4.4). The materials needed to construct these traps are neither rare nor expensive, but construction of *malema* requires skill. They are made in one to three days and must be replaced every three to six months. *Malema* are used by one to four fishers, depending on the size of the trap and how far from shore they are used. They allow flexibility because a single fisher can manage a series of small traps next to the mangroves without the need for a boat, or fishers can take the large traps farther from shore with boats and sink them near coral reefs. The target catch varies depending on the habitat and bait used. The size of the catch is restricted by the size of the trap opening, thus larger traps catch larger fish. Because of its flexibility, this fishing method has the largest range in age of fishers (28 to 80), and it is used during calm and windy seasons, as noted above.

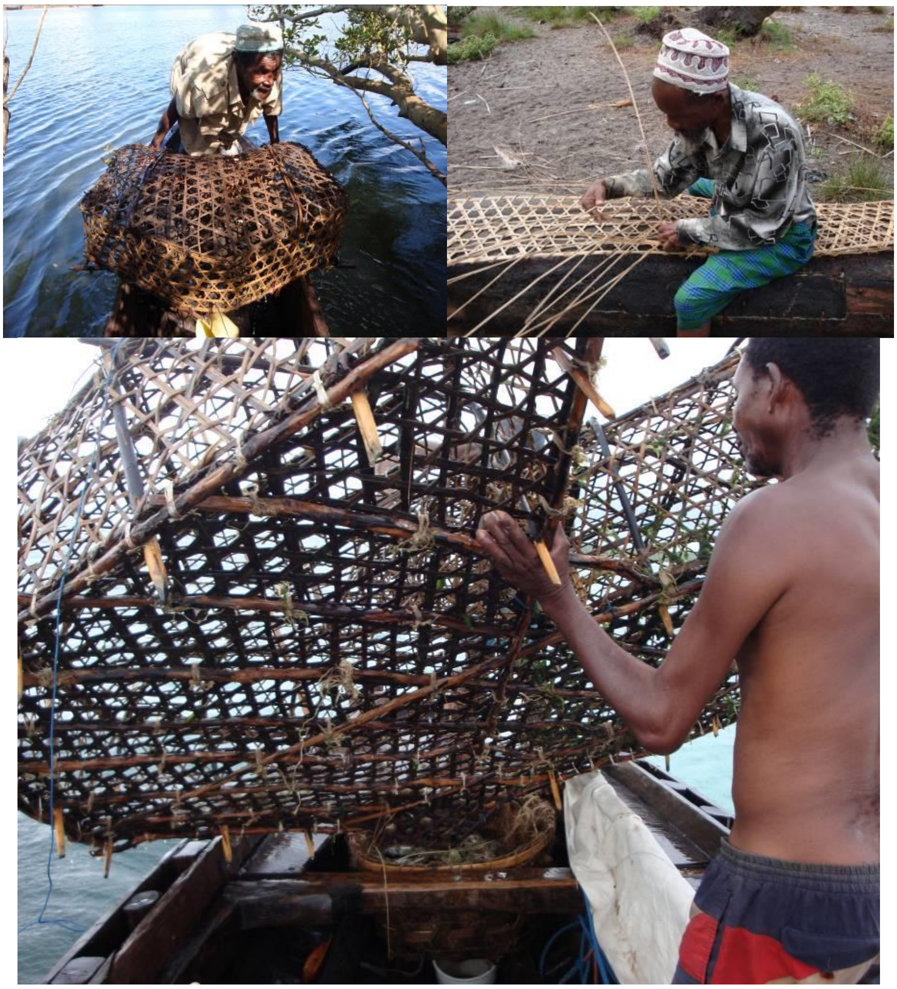


Figure 4.4: *Malema* fishing
Checking a small *lema* trap near Vanga (left), weaving *lema* trap in Jimbo (right), and collecting the catch from a large *lema* out at sea (below)

Uzio (also known as *wando* in Tanzania) is another type of trap made with mangrove poles and strands of palm fibre to form weirs (Figure 4.5). These weirs are placed angled away from the edge of mangroves to take advantage of the rising and falling of the tides. Fish are directed into the trap by a long fence and are caught within it as the tide falls. Like basket traps, *uzio* are made with locally available material, but require lots of labour and skill to construct. The *uzio* fishers interviewed reported 15 to 50 years of experience with this type of fishing method. These traps can be managed by one to two fishers without a boat, but a small boat is useful to carry the catch back to shore. *Uzio* fishers carry a small net called *senga* to gather the catch from within the trap and sometimes a stick to check for stingrays caught in the corners of the trap.

Figure 4.5: ***Uzio*** **fisher and his tools**
Holding the *senga* basket next to the small *mtumbwi* boat (left), close up of local materials (top), and *uzio* trap near mangroves by Jimbo channel (below)

Bunduki is a handmade spear consisting of a wooden pole propelled by a rubber band that is used by single fishers that dive at different depths in the channels or inshore waters (Figure 4.6). A small boat is useful but not necessary. These fishers swim out into the channel with a small net tied to their waist for collecting their catch. Another similar form of fishing is to lure lobsters and octopus out of their hiding places with a stick. Unlike trap fishers, who had a large range in age and many years of experience, speargun fishers I interviewed were in their early forties and reported less than five years of experience with this fishing method. Spearguns appeared more recently on the East African coast around the 1950s (Glaesel 1997, 98). The use of snorkels, masks, and sometimes even oxygen tanks, has made this method increasingly popular among younger men.

Figure 4.6: ***Bunduki*** **on the shore in Jimbo**

Mshipi (plural *mishipi*) is a general term for line fishing, which includes a variety of techniques including trolling, long lines, and single lines that can be used inshore and offshore (Figure 4.7). Offshore *mshipi* fishers use larger boats to go up to 60 km away from the shoreline. Several types of bait, such as small fish, squid, and octopus, are used to catch a variety of fish at different depths. The largest of these include sharks, large jacks (Carangidae), and tuna (Scombridae). The *mshipi* fishers I interviewed and observed in Vanga area worked in a crew of one to five, depending on the type of fishing line, vessel and distance from shore. The crew of five, for example, used long lines to catch larger offshore fish.

Figure 4.7: *Mshipi* fishing
***Mshipi* fisher catches a barracuda on an *ngalawa* boat (left), and line and hook (right)**

Nyavu is the Kiswahili word for net. In this category, I include prawn nets, called *chachacha* or *kimia*, ring nets, and *jarife*, a widely woven net used for shark fishing (Figure 4.8). The latter two are used farther out at sea and require boats and a larger crew to operate—I recorded up to 24 crew members needed to operate one ring net, using a larger motor boat. Like spearguns, ring net fishing is increasingly popular among younger men as a form of commercial fishing—the ring net fishers I interviewed were all in their thirties. I observed and interviewed only one *kimia* fisher on the Vanga shores. Prawn fishing can be done with one or two people close to the shore without a boat. Another form of net fishing is done by small groups of women close to shore. One woman I interviewed described that at dawn she and one or two friends use a mosquito net to catch *duvi*, a small prawn. They spread a mosquito net and drag it towards the shore in about knee to waist deep water. Afterwards, they dry the prawns by the shore and prepare them for sale.

Figure 4.8: ***Nyavu*** **fishing**
A ***kimia*** **fisher casting his net (left), hand weaving a** ***jarife*** **net (right), and ring net stretched out to dry (below)**

The distribution of fishing gears differed among the three locations. Jasini had a majority of ring net fishers, which appears to be a more recent trend linked to the growing commercialization of fish in the area. In Jimbo and Vanga, fishing methods were more varied; I suspect that two different factors influence this pattern in each case. In Jimbo, fishing continued to be subsistence based or part of a small-scale commercial network, although construction of a sea wall and fish storage facility indicated an increasing emphasis on commercial fishing. In Vanga, the users of more traditional inshore gears were men over 60 years old.

One of the last *malema* fishers in Jasini described why he changed to net fishing,

> *Sababu baba nalije/nduje? aliyekuwa mjuzi wa malema alipofariki nikaamua neti sababu sikuwa na ujuzi wa malema.*
>
> Because when my father [word?] who was an experienced malema fisher passed away, I chose to use nets because I don't have the skills to use malema fishing. (Translation mine) [56]

Fishing, in effect, is learned primarily through practice in the company of more experienced fishers. One fisher explained,

> *Kusomea kwa kweli sikusomea katika ofisi. Nilisomea hivyo hivyo Kiswahili, wenzangu wanafanya hivi na mimi nafanya hivi, wanakwenda hivi na mimi nakwenda hivi sasa na mimi nachukua pointi kwenya ile kazi ya uvuvi.*
>
> Studying, in fact, I did not study [fishing] in an office. I studied Kiswahili the same way: my colleagues do this and I do this, they go like this and I go the same; I take pointers as we fish. (Translation mine)][2]

Ritual behaviour was a difficult topic to discuss with fishers as it was typically looked down upon if it did not follow modern Islamic beliefs. One fisher was able to describe a ritual called *mzimu*, which is an offering of food made to spirits to break a spell of bad luck. He said some fishers generally do this after a series of bad catches.

<u>Results: Distribution</u>

Once the fish is captured, it is weighed and redistributed as soon as it reaches the landing area. It is common for each fisher to keep one to two kilograms of fish for himself and his family. The rest is mostly sold through a network of dealers that take the fish from town to town. A few kilograms may be bought by women who cook and then resell the fish in the evening market or at a café. Those who are not involved in the fishing business may buy their fish at the local fish market from a dealer. A model shows the principal paths through which fish reach the plate (Figure 4.9).

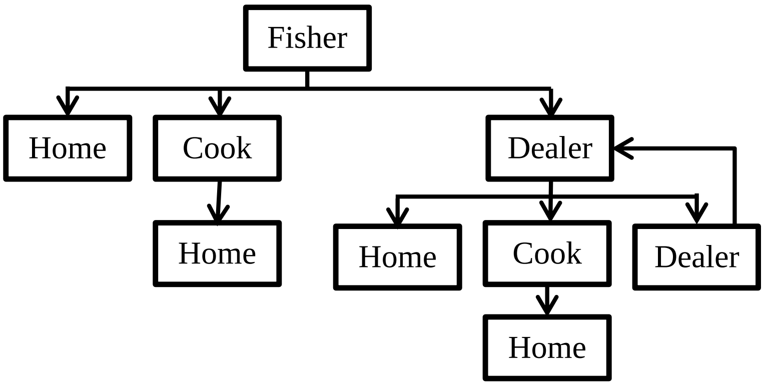


Figure 4.9: Model of the distribution of fish in Vanga area
Arrows indicate the direction in which fish catch is distributed from the fisher to people who eat, transform, and/or redistribute the fish.

The principal environmental restrictions in the distribution stage are time and distance; fresh fish can only travel so far and must be distributed quickly upon landing. Vanga town had facilities to hold fish in ice, most of which was then transported to other towns by road. Without these facilities at Jimbo, fish was quickly distributed; dealers transported fresh fish to sell or store in Vanga. This was mainly accomplished through a short bicycle trip carrying a woven basket full of fish through a series of dirt paths. The basket used to transport these fresh fish is woven in the same pattern as the *malema* (Figure 4.10).

Figure 4.10: Principal tools for transporting fish from Jimbo to Vanga
Left: path travelled between Jimbo and Vanga
Right: the basket is placed over the back tire to carry fish

The organization of fishers and dealers was structurally similar in both Vanga town and Jimbo village, as they are both part of the same network of exchange. Commercial fishers in both locations tended to associate themselves with a particular dealer or gear/boat owner. This relationship serves as a sort of security for both parties. Dealers are responsible for fixing damaged gear and supporting their fishers during problems, such as loaning money for gear repairs. In return, dealers can expect a reliable source of fish. Sometimes gear and boat owners were not involved in fishing at all while they loaned fishing equipment to groups of fishers and received a portion of the profit. Fish exchange was also on a more personal level. Many people mentioned receiving fish from a friend, family member or neighbour. The grand majority of dealers were men—only one dealer in Jimbo was a woman of high social position having the role of chairlady of the village. However, one should not overlook the importance of women in the distribution of fish through the sale of cooked products. Over one third of the women I interviewed sold cooked fish at market stands or cafés (Figure 4.11). In fact, women’s role in the distribution of goods included other products. I found that most women managed some sort of small business from their home, including the sale of coconuts, cooked breads, fresh vegetables and sections of roof thatch.

Figure 4.11: Fresh vegetables and dried fish sold outside a home

Results: Preparation

I use preparation to describe the processes of fish transformation through cooking and preservation methods. The stage of preparation is one dominated by women, but men also cook fish if they live alone or in the case of seasonal fishers travelling away from their families. Fish are usually bought whole, unless the fish is very large like sharks and rays. During preparation, the gills and organs are pulled out with a knife or finger after making a small slit in the bottom line of the fish:

> *Nampara, natoa matumbo, natoa mashavu, namnosha. Halafu namchemsha kwa kutia embe, chumvi, masala, na wa kukaanga namtia kitunguu saumu, masala.*
>
> I remove the scales [literally, scratch off it], I remove the intestines, I remove the gills , I wash it. Then I boil it while putting mango, salt, masala, and when it is fried, I put garlic, masala on it. (Translation mine) [26]

Many of the women I interviewed described similar methods of cooking fish, using the same set of spices for particular dishes, like the ones described above (a Vanga recipe for cooking fish is included in Appendix E). The four principal ways of preparing fish were boiling, frying, grilling, and drying. The size of the fish was the most important factor in determining how it was prepared. In most cases, fish were cooked whole or divided into two to three parts, if larger than the cooking bowl. Oftentimes, the cook would cut slits along the body of the fish so that the flesh would absorb the aroma of the spices as it cooked (Figure 4.12). These slits could leave shallow cutmarks on the surface of vertebra.

Figure 4.12: Whole fried fish and boiled fish divided into sections
The flesh on the body is cut to absorb the flavour of the dish.

Two types of cooking vessels were used to boil fish (Figure 4.13). The *kikaango* is a clay pot traditionally used for boiling fish. It is generally preferred over the modern alternative, the metal *sufuria*, because the taste is better and the pot is more resistant to cooking wear. Those who do prefer the *sufuria* choose it because it cooks the fish faster and is not prone to breaking. Only a minority (17%) of the women surveyed said they liked both equally.

Figure 4.13: Two main fish cooking vessels
Clay kikaango (left) and metal sufuria (right)

Small fish and prawns, rays and shark were preserved by drying and salting so that they could be transported farther inland. For example, small fish, called *dagaa* (likely sardines [Clupeidae] or anchovies [Engraulidae]), were boiled in a basket submerged in salted water and then dried in the sun (Figure 4.14). These preserved fish are later cooked in soups and other dishes.

Figure 4.14: Preparation of small *dagaa* fish

Results: Consumption

I assessed the extent to which fish are part of the daily diet in these coastal communities through food diaries and food ranking. Thirty adult participants from Jimbo and Vanga were asked to list all the food items consumed in their three most recent meals to create these food diaries. Participants were asked to omit

Friday meals, which traditionally include more red meat dishes because Friday is a holy day in Islam. Food items were tallied and ranked to show the most commonly eaten food items at each meal. Fish made the top of the list at all three meals: in second place after tea in the morning (12), and first place during both midday (21) and evening (22) meals. These participants were also presented with images of eight categories of food items and asked to order them from most to least important in their daily lives. The overall average ranking resulted in the following order: rice, fish, cow, goat, chicken, shellfish, and antelope (Figure 4.15). Dugong (nguva) obtained a score of zero since no one I spoke to had seen or eaten this animal, which is now an endangered species in this area.

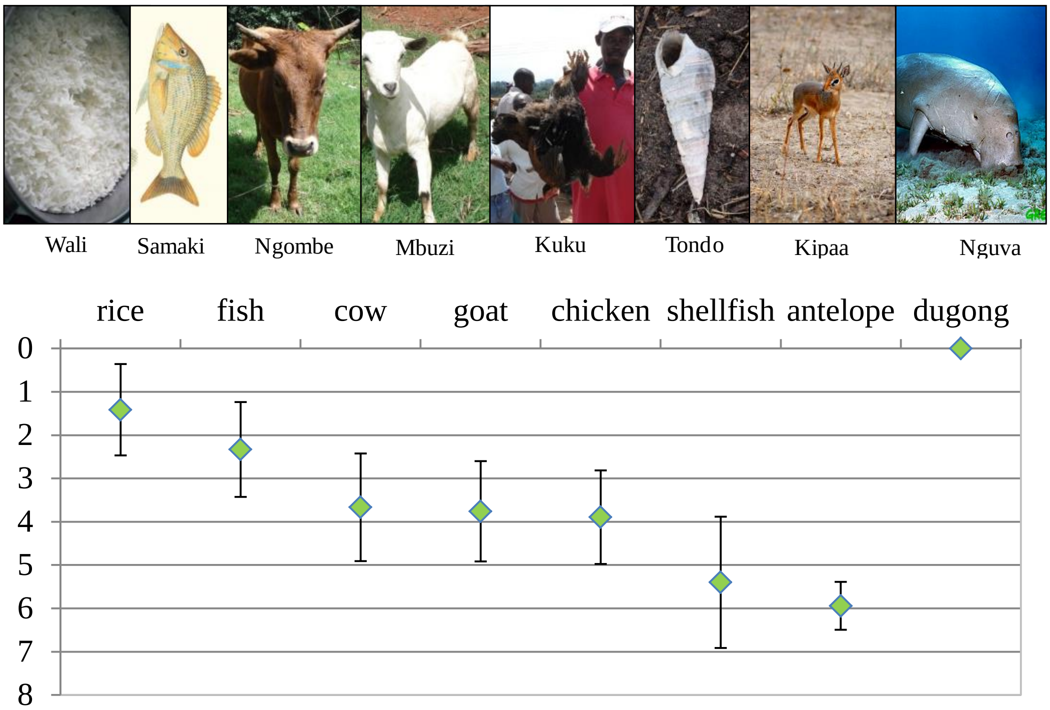


Figure 4.15: Average ranking of seven principal food items
Pictured above in order with Kiswahili name. The line represents the standard deviation of the average rank (diamond).

In order to evaluate preferences for certain types of fish, the same procedure was carried out for nine fish families found in the area. These fish were chosen based on the range of fish families represented in the archaeological assemblage from nearby Vumba Kuu to test if they were still eaten in this area. The resulting overall rank lists: jacks (Carangidae), emperors (Lethrinidae), grunts (Haemulidae), parrotfish (Scaridae), snappers (Lutjanidae), groupers (Serranidae), requiem sharks (Carcharhinidae), surgeonfish (Acanthuridae), and grunters

(Terapontidae) (Figure 4.16). The results show that these fish families are eaten in the Vanga area today as they were in the past. Furthermore, the highest and lowest ranked families correspond to the fish families with the highest and lowest representation (number of remains) in the archaeological assemblage (refer to Chapter 7). This suggests a continuous trend in fishing and fish consumption practices between past and present communities of this area.

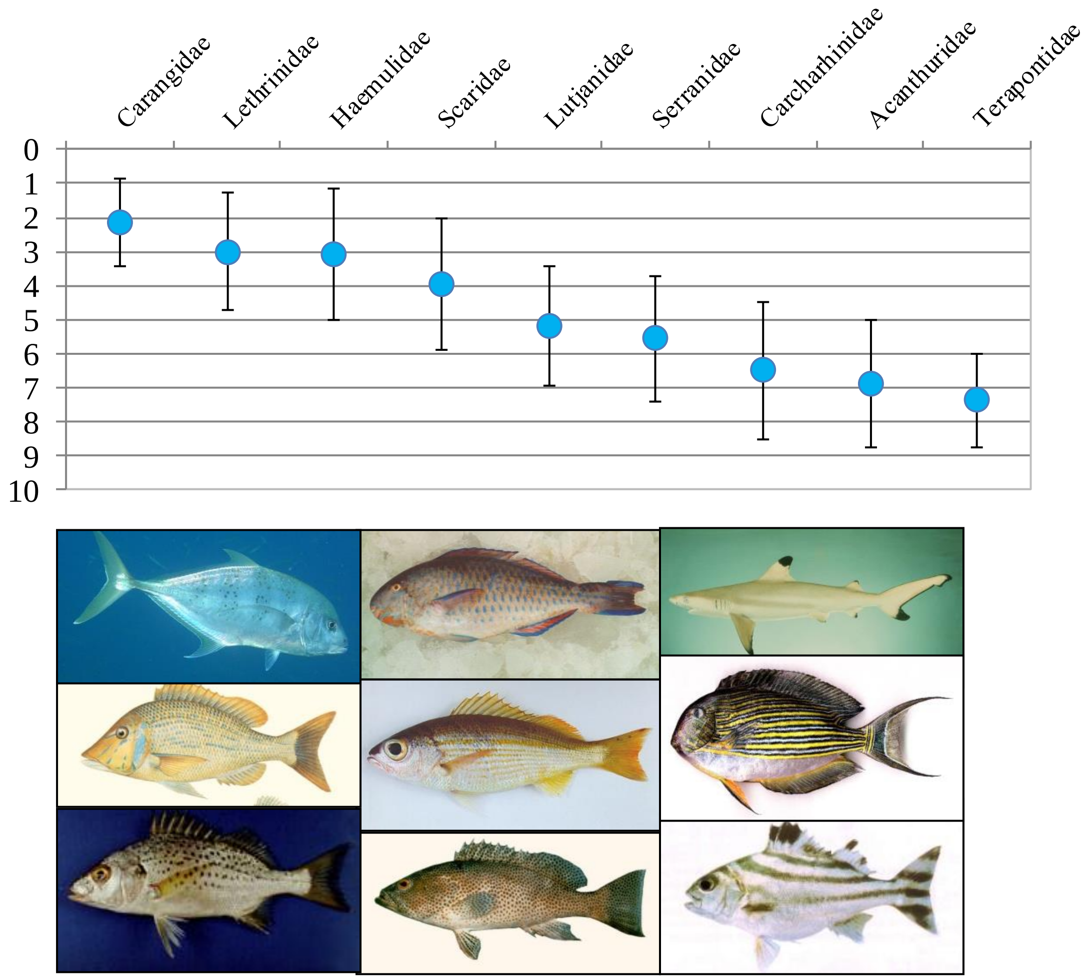


Figure 4.16: Average ranking of nine common fish families
Images in order top to bottom, across rows from left to right. The line represents the standard deviation of the average rank (circle).

Interviewees preferred certain fish that had more flesh and fewer bones. For example, the head of a family of 14 said,

> *Huwa tunanunua samaki kama kilo mbili au kilo na nusu. Sana sana tunapenda tafi na changu sababu ya minofu.*
>
> Usually, we buy about two or one and a half kilos of fish. We like mostly tafi and changu because of their flesh. (Translation mine) [55]

Following similar criteria, many of the respondents stated that although they mostly served goat meat during special occasions, when they did serve fish, they used the meatiest types. Most respondents preferred the head over any other part of the fish in any species, although they ate any fleshy part from the head to the tail. I observed people removing the meat from the head with their fingers and sometimes chewing on cranial bones. One person preferred the middle of the fish because of its flesh: "*Napenda kati kati sababu ya minofu*." I like the middle because of the flesh (Translation mine) [38]. Different versions of the same story about fish heads were related by several respondents: "*Nasikia vichwa vya samaki haviliwi na wasomi.*" I hear fish heads are not eaten by scholars (Translation mine) [26]. The story only varied in that either students or learned people became slower or sleepier by eating fish heads, and sometimes a particular fish, parrotfish, was involved.

It is clear that fish are an important part of the daily diet of the inhabitants in this area, however important differences emerged from a comparison between Vanga town and Jimbo and Jasini villages. I compared the average daily amount of fish eaten by respondents from the three places as stated during the interviews. The results show that the number of fish eaten per person per day (1.2) in Vanga was nearly half compared to the surrounding villages (2.3). This pattern may be a result of the higher amount of capital and opportunities for exchange in Vanga. Vanga is the main town in the area with the largest population, composed of more than 12 times the number of households than Jimbo. As a main trading centre, Vanga has a wider variety of foods available that are brought from larger cities and the interior. People in Vanga eat more meat and vegetables to supplement a diet of fish. In Jimbo, for example, this more diverse diet was only observed at the chairlady's home. Being both a dealer and an administrative representative in her village gave her more contact with Vanga and cash to exchange for foods other than fish.

Results: Discard

From what I could observe, there was no established system for disposing of food remains and other trash in Vanga area. The streets between houses were often swept and the household trash deposited in a common trash area, generally a nearby open area of land that was not developed (Figure 4.17). These areas were routinely burned or buried.

Figure 4.17: Rubbish pit outside a home in Vanga

I never saw dogs around these communities, which is not surprising because dogs are generally considered impure in Islam. On the other hand, cats were the most visible scavengers I observed, sometimes feeding in rubbish pits. Evidence of this type of scavenging can be traced from the gnaw marks found on animal bones.

Small shell middens occurred more frequently near the shore, where visiting groups of fishers set up temporary camps (Figure 4.18). Otherwise, fish and shell remains were thrown over the seawall back into the water and slowly carried out by the tides. One shop owner described how she cooked and discarded the *kombe* shellfish, "*Tia sufuria ya maji kwa kutoa nyama zake, makombe tunayatupa baharini*." Place [kombe] in a pot of water to remove their meat; we throw away the shells in the sea (Translation mine) [28]. Some women collected shells to sell as decorations, and the shell caps to sell as buttons. These observations of shellfish use and disposal are opportunistic and would be difficult to trace archaeologically.

Figure 4.18: Small shell midden on Jimbo's shoreline

Results: Use of space

Another aspect that is important to discuss from an archaeological point of view is the use of space throughout the various stages of fishing and fish consumption. During my research, I noted the spatial layout of fish processing activities around the communities. The most notable difference between the larger (Vanga) and smaller (Jimbo) settlement types was the use of space. In Jimbo, the area around the shoreline was occupied by fishers mending their sails, making traps, and exchanging fish with dealers. In Vanga, this area had been limited by a town wall that borders the shoreline. New buildings had been erected along the wall, pushing fishing activities to the margins. In Vanga I observed fishers working on their traps near their homes rather than in a communal space. In order to study the distribution of activities in private spaces, I used household diagrams to explore the spatial dimension of food consumption activities around the household (Figure 4.19). During the structured interviews, I drew the basic outlines of 30 houses and noted where food consumption activities took place: cooking, eating, and discarding.

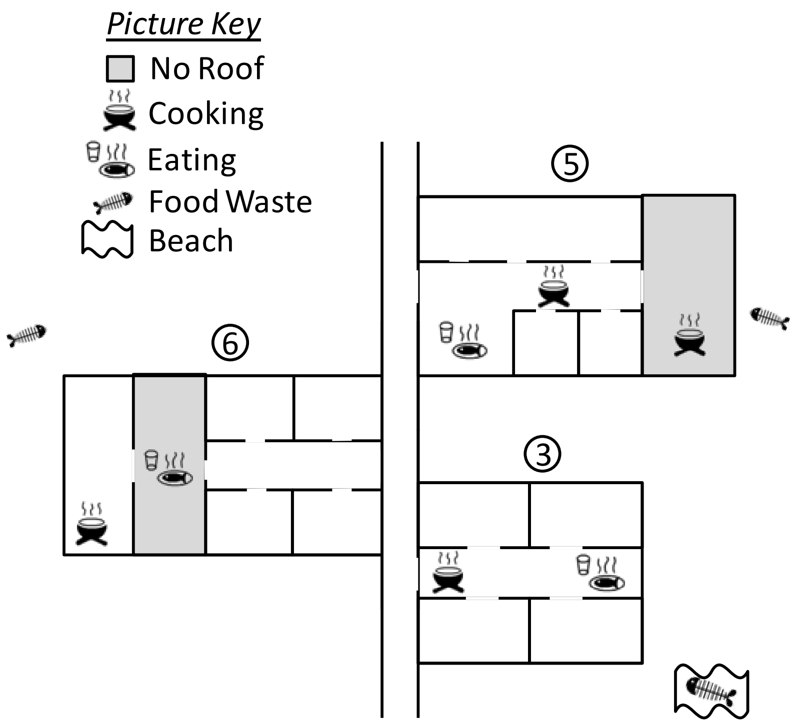


Figure 4.19: Three examples of household diagrams
Showing the distribution of consumption activities around the house

Similar to the food diaries, I tallied the totals in order to show the most commonly used spaces for each activity. This approach follows that of Hayden and Cannon (1983) in their study of Mayan refuse disposal where they categorize refuse according to type and location of disposal. The results show that cooking took place mainly in the backroom (14/30) or other room (8/30) of the house. Food was eaten primarily in either a room (11/31) or the hallway (11/31); food waste was collected and disposed of just outside the household (12/28) or in a nearby dumping site (11/28). This preliminary study shows the patterning of behaviours within a household structure associated with certain types of material traces that may or may not be recognized archaeologically. A cooking area, for example, might be distinguished by evidence of burning or the remains of a hearth whereas an eating area leaves no permanent distinct traces.

Discussion: Fish as cultural objects

Important patterns in social organization emerged from the ethnoarchaeology of Vanga area. Fishers in this area had low status and earned barely enough to support their families through their trade, especially if they did not own their fishing equipment or vessels. On the other hand, boat and gear owners hired fishers and gained a percentage of the total profit. At the same time, people in this position were less likely to eat fish, since they had more resources and access to meat and other foods. These unequal positions are reflected materially in the use of boats and the consumption of different food items.

Although there seems to be a trend in the amount of fish consumed based on status, I found no relationship between status and fish species. It appears that people ate the fish species that were most available and had a preference for the fleshiest species. There was a strong preference for fish heads among all social groups despite the fact that most people ate the entire fish. There were also distinct gender roles in the fish process: men were more involved in fishing, and women prepared and sold cooked fish. Apart from the physical hardship involved in fishing, this may also be due to the separate gender spheres in these largely Muslim communities. In the few examples of women fishing, they stayed close to shore in groups of women. The division of tasks by gender points to a strong involvement of women in commercialization through the sale of processed fish.

4.6 Applications to Swahili Archaeology

Like other authors of recent fishing ethnoarchaeologies (e.g., Belcher 1998; Jones 2009), I relied on both qualitative and quantitative methods to study fishing and fish consumption in the Vanga area. I combined a series of systematic studies—such as food diaries, house diagrams and food ranking—with active observations and dialogue in order to render the complex web of socio-environmental factors associated with the consumption of fish in this area. Unlike other ethnographic studies of coastal East Africa, I emphasize the ‘lives’ of fish as cultural objects as they form part of the social world in which they are obtained, used, transformed and discarded. This serves to identify any physical markers of these processes that could be picked up archaeologically. Likewise, the social and environmental factors associated with these processes are illuminated in order to capture some of the complexities of daily life that are lost to the archaeological record. The result is a series of cultural observations linked to material “residues” that can be useful in the interpretation of archaeological remains.

4.7 Summary

This chapter presents examples of the application of ethnoarchaeology to the interpretation of past fishing strategies and food consumption. I carried out an ethnoarchaeological study in the Vanga area to document the taphonomic processes involved in the exploitation of fish and the role of food consumption in the social organization of Swahili communities. The principal tools of the fishing trade, gear and vessels, are generally missing from the archaeological record of the Swahili coast. Cooking tools, although they are more commonly found, are related to other activities. This leaves shell and fish bone middens as the principal source of information about fishing practices and marine food consumption. In places like Vanga where there is a continuing fishing trade in an area of archaeological fish remains research, ethnoarchaeological research has provided important insight into the relationships between material remains and human behaviour. Beyond descriptions of trends in excavated remains, zooarchaeologists must try to understand the social implications related to these patterns. Ethnoarchaeology allows us to recognize social behaviours in patterns of archaeological material that are not evident at first glance.

Chapter 5: Regional Patterns of Fishing and Subsistence

"I hope that this fledgling attempt encourages others to exploit the archaeological possibilities that spatial analysis and regional settlement pattern studies offer for the sites on the East African Coast, and that our understanding of the history and society of the area may be increased thereby."

-T.H. Wilson, 1982 (p. 216)

5.1 Introduction

The aim of this chapter is to document regional trends in fishing and fish consumption in space and time through Swahili history. I review and consolidate available/published sources of fish remains data on the East African coast, considering the limitations of comparative analysis because of their different taphonomic histories. I analyse subsistence strategies and the range of exploited habitats along the Swahili coast. Comparing settlements with long term faunal data, I consider changes in subsistence and fishing strategies throughout the span of Swahili history. This collective analysis provides a regional and historical background in which to place the local socio-environmental histories of the case studies in this thesis, but also highlights the potential for developing a more cohesive methodology to understand the Swahili region more generally, in order to appreciate both the common threads that link these communities as well as the unique characteristics of each settlement.

5.2 A history of Swahili zooarchaeological research

Almost a century of research on the Swahili coast has taken shape in a variety of disciplines, including linguistics, archaeology, and anthropology. The history of Swahili archaeology can be traced back to the expeditions of early antiquarians and colonial archaeologists in the mid-1900s. Considering the large body of published work on Swahili archaeology, the number of published zooarchaeological reports in this region is very limited—less than ten. The following sections provide an overview of seven published reports and four other unpublished sets of faunal analyses in chronological order to highlight the history of Swahili zooarchaeological research. A survey of the limited examples of published fish remains data from Swahili settlements provides a picture, albeit incomplete, of marine consumption trends in the Swahili region. I summarize these data in their own ecological and cultural contexts, and consider their archaeological biases. This overview is followed by a comparison of the characteristics of the available regional zooarchaeological data (summarized in Table 5.1 and Table 5.2).

***Manda* (Chittick 1984)**

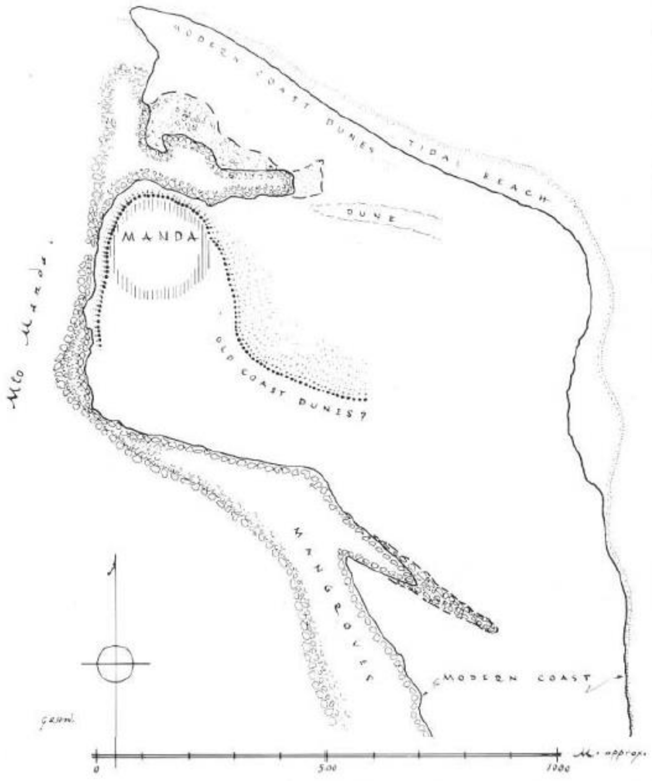


Figure 5.1: Map of Manda town
(Chittick 1984, 6: Fig. 3)

Early archaeologists and antiquarians during the colonial exploration of the Swahili coast seldom mentioned animal remains in their publications (e.g., Dorman 1938; Kirkman 1954; Mathew 1959; Kirkman 1966b). When faunal remains were mentioned, these were often collected unsystematically and relegated to appendices, such as in the Kilwa monograph (Chittick 1974, 252: Appendix II). The publication of excavations at the town of Manda (Chittick 1984) is a turning point in the way faunal remains were studied and presented. Even though the faunal material from Manda was still hand-collected, it was retrieved from all excavated units around the town and analysed to understand patterns in animal processing and consumption.

Of the faunal remains hand-collected during the 1978 excavations at Manda, a total of 706 non-human bones were identified by Nina Mudida at

National Museums of Kenya (Chittick 1984, 215). Chittick dedicates an entire chapter, albeit short, to what he describes as the "the-first detailed analysis made of the fauna from an excavation on the coast" (1984, 215). These finds, which come mostly from fill levels across the site, are presented as percentages of the total number of animal remains across three periods spanning around the 10th to 14th centuries (1984, 215: Table V).

Manda town lies on the northeastern tip of an island by the same name in the Lamu archipelago (Figure 5.1). It is surrounded by large expanses of mangrove stands along a deep inlet to the west, and sand dunes and coral outcrops to the east (Chittick 1984, 5). To the north, there is a nearby reef and "a narrow mangrove-filled creek" that dries at low tide, where Chittick observed fishing weir traps (1984, 7). The size of Manda town is unknown; Chittick (1984, 9) estimates that the area of stone structures covered over 7 ha, but the town probably extended beyond that.

The faunal assemblage constituted of mostly goat/sheep and cattle bones; with smaller amounts of fish, turtle, and wild ungulates; followed by small quantities of dugong, game and domestic fowl, cat, and camel (Chittick 1984, 215–16). Over time, the numbers of fish and wild ungulate bones increase as those of turtle and dugong decrease. Chittick portrays a culture that relied most heavily on domesticated animals, which made up between 60-75% of the identified remains in each period while fish remains amounted to 4-12%. However, the number of fish remains and other small vertebrates could be largely underrepresented because hand-collecting retrieves mostly larger bones such as those of cattle, goat, and sheep. Chittick notes examples of modified bone, such as polished and pierced vertebrae of large fish, and evidence of cutting and burning. He describes a "curious class of bone objects" that represent fish elements exhibiting hyperostosis—excessive bone growth (1984, 216). Until now, hyperostosis is rarely described although it occurs in Swahili fish assemblages.

***Comoros Islands* (Wright et al. 1984; Wright 1992)**

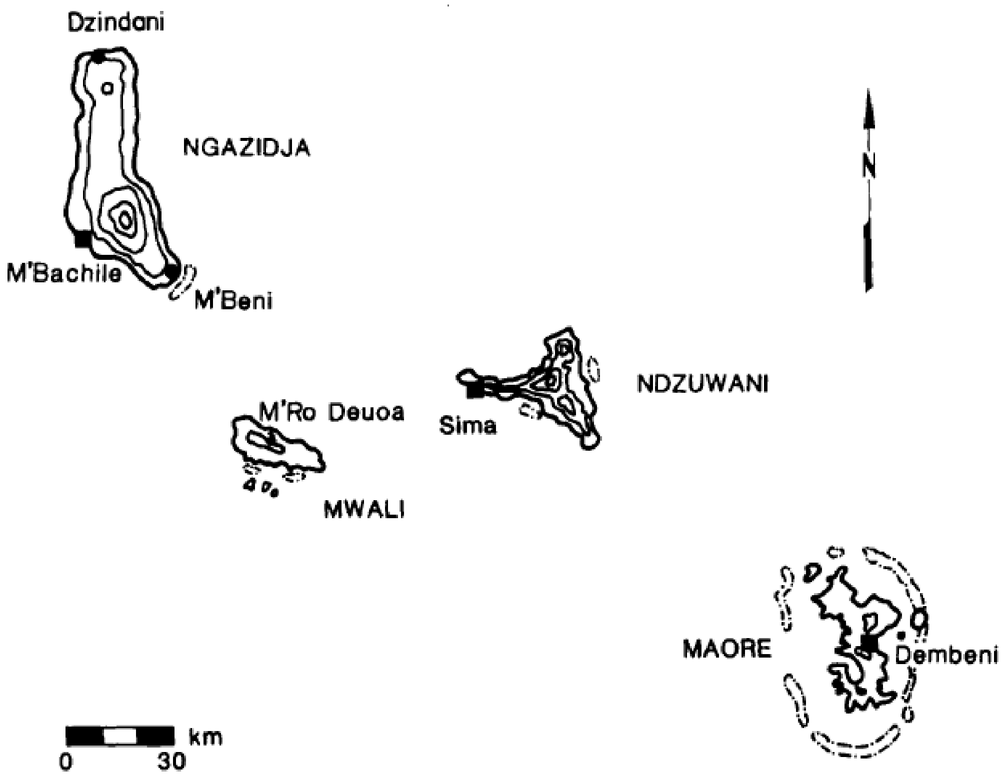


Figure 5.2: Map of Dembeni Phase settlements on the Comoros Islands (Wright et al. 1984, 56: Fig. 17)

The same year that Chittick published the faunal analysis from Manda, Wright and colleagues (1984) published a detailed report of faunal remains from a set of sites in the Comoros Islands. These islands lie on the northern end of the Mozambique Channel approximately halfway between the mainland of East Africa and Madagascar. The authors describe faunal assemblages from three excavated settlements dating to the 9th and 10th centuries, a period they call Dembeni Phase (Wright et al. 1984, 13). Dembeni (Operation V) lies on a steep ridge overlooking the largest stream on Maore Island, surrounded by a marshy, mangrove-filled estuary environment. The authors estimate that the occupation covered 3-4 ha (1984, 16). Old Sima (Operation III), a slightly larger site of 5 ha, is located on the western peninsula of Ndzuwani island near a patchy reef close to the coast with small lagoons (1984, 19–20). A third assemblage comes from M'Bachile, which lies on a protected beach on the "very humid west coast" on Ngazidja Island (1984, 21). This assemblage was excavated in a refuse-filled deposit labelled Operation 1. The size of the settlement is unknown, but the surface scatter covered 4 ha.

Another set of faunal assemblages, published in a later report, represent later phases of occupation (11^{th}-15^{th} c.) in the Comoros island of Nzwani/Ndzuwani (Wright 1992). Sima, which is also represented in the earlier phase, grew from 6 to 11 ha by AD 1500; this later assemblage (Operation II) was excavated from the NW corner of the mosque (1992, 87–88). Another settlement called Domoni, lies on the east side of Ndzuwani island near a small harbour; its size is unknown but similar to Sima (Wright 1992, 124). The Domoni assemblage was excavated near the south and east walls of the mosque.

Faunal remains were collected from the Comoros Islands as part of a series of salvage excavations. Four flotation samples represent the early Dembeni phase, which were screened with 6 mm mesh (Wright et al. 1984, 23). A total of 937 fish bones were collected, of which 45 were identified to order or family by Susan L. Scott (1984, 49). Richard W. Redding and Steven M. Goodman identified 158 bone fragments of other vertebrates from these flotation samples (1984, 51). The faunal remains from Sima and Domoni, representing the later six centuries of occupation in the Comoros, were floated and wet screened through 6 mm mesh and identified by Redding and Goodman. The bulk of faunal material came from a 10^{th}-12^{th} c. midden in Sima, a 13^{th} c. midden in Domoni, and the 15^{th} c. mosque porch at Sima (Wright 1992, 113).

The Dembeni Phase assemblages show that "fish provided the regular day-to-day protein source for early Comoreans" (Wright et al. 1984, 56–7). Types of fish represented indicate that fishers used spears, hooks and lines, and nets along the coast and in nearby reefs (1984, 56). The authors note that differences arise between islands because of their particular environmental settings, although the settlements share important similarities in their environments, such as "sandy beaches or mangrove-covered mudflats in the protected bays..." and their proximity to lagoons (1984, 14). In the earlier period, fish remains were more common and diverse in Dembeni, which lies in proximity to a richer marine environment (1984, 51). The majority of identified mammal bones were from bovids, particularly sheep/goats and no cattle. The finds indicate that early

Comoreans hunted tenrec, a species of indigenous small mammal (*Tenrec ecaudatus*).

Overall, the composition of vertebrates from the later phases is similar to the early phases, except that chicken is present only in the later phases (Wright 1992, 126). The most common domestic animal is sheep/goat, mostly represented by young individuals (1992, 126). In the analysis of fish remains, the authors associate the higher density and diversity of fish at Sima than Domoni with its proximity to coral reefs (1992, 115). Thus, early on researchers note a relationship between the environmental features surrounding a settlement with the composition of animal remains retrieved from its excavation.

<u>*Shanga* (Horton and Mudida 1993; Mudida and Horton 1996)</u>

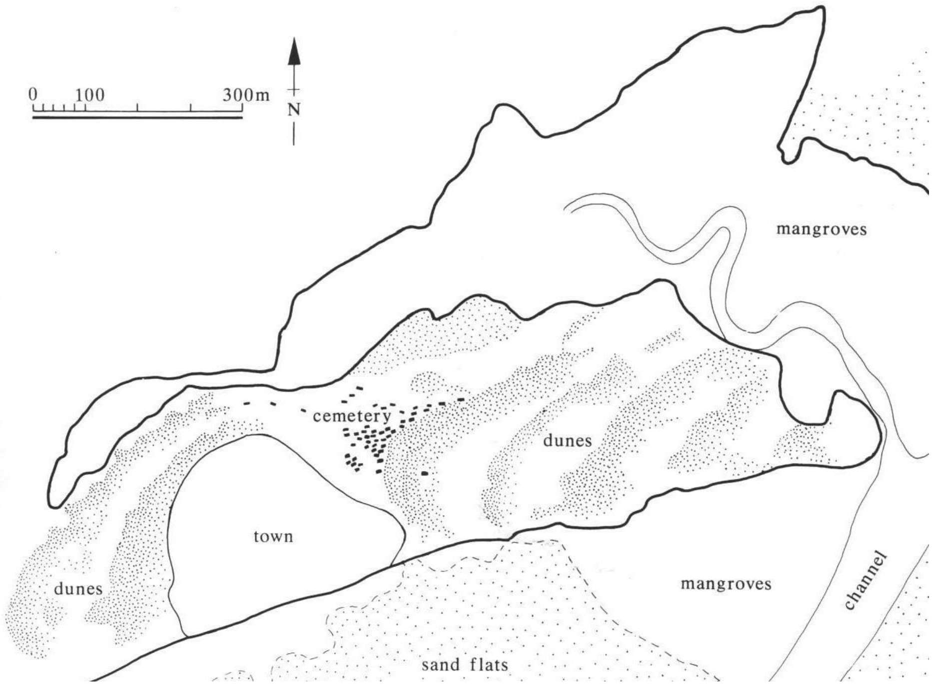


Figure 5.3: Map of Shanga and surrounding area (Horton 1996)

Another set of detailed published faunal reports followed those of the Comoros Islands. The Shanga faunal material is particularly exemplary because of the large size of the sample and its association with a long chronological timeline spanning the 8th to 15th centuries.

At the time of its abandonment c. 1425, Shanga covered 15 ha with a concentration of over 200 houses and 300 stone tombs (Horton 1996, 5). A long series of phases and levels show continuous occupation to the earliest levels dated to the 8th century (1996, 7). The fish material analysed is from Trench 2, a deposit of domestic midden material that was sieved through 5 mm mesh; out of tens of thousands of fish bones, 6009 were identified to species or taxa of local marine fish (1996, 380). About ten percent of the fish bones from each context were identified to species level. MNI was attempted but was found to be unreliable. Identified bone counts (NISP) rather than biomass was found sufficient to do analyses of trends since fish bone weights correlated to identified bone numbers (Horton and Mudida 1993, 678).

Horton and Mudida note the effect of sample size, such that the larger the sample, the larger the variety of fish (1993, 680). Changing trends in the composition of fish bones, they proclaim, could indicate changes in the structure of fish populations in addition to cultural and technological changes. Lethrinids, or emperor fish, are the most commonly identified taxa, their proportion increasing over time. In the parrotfish family, Scaridae, *Leptoscarus vaigiensis* decreased over time and gave way to *Scarus ghobban* (1993, 678). Horton and Mudida believe the appearance of poor quality (venomous and trash) fish in phase eight may indicate a food shortage (1993, 679). Some clues about technology and processing were found during analysis. Butchery marks on the cleithra of large fish were seen as indication that large fish were decapitated and small fish cooked whole (1993, 678). Horton and Mudida deduce that offshore fishing develops in the later part of the site's history since evidence of "substantial exploitation of sharks and barracudas began around 1100" (1996, 380). They believe trap fishing occurred from an early stage because of the large numbers of *L. vaigiensis* from earlier phases onwards; this is inferred from their observation of trap fishing used to capture this fish in contemporary fishing in the Shanga area (1996, 380).

Horton and Mudida compare the proportions of fish and other animal remains represented in Trench 2 to investigate the changing significance of fish in the diet at Shanga (1993, 681; Mudida and Horton 1996, 391). Smaller quantities of faunal remains mark the beginning and end of occupation at Shanga with a peak around the 13th century at the height of the town's history. In the final phases represented in Trench 2, domesticated animal meat replaces fish as the main protein source while chicken is found throughout the levels. In another area of the excavation at Shanga, the same pattern holds true but in the earlier phases there were more hunted animals in the absence of domesticates.

Horton and Mudida analyse the spatial distribution of faunal remains. In two southwest trenches there is an almost identical pattern of fauna composed of more cattle and turtle but little fish, while in trench 2 in the northwest there is more chicken, sheep, goat and fish. Horton and Mudida interpret this as people with different subsistence strategies living in different parts of the settlement: hunters and agriculturalists in the northwest and pastoralists in the south; pastoralists may have disliked the idea of eating fish so they consumed other marine animals instead (Mudida and Horton 1996, 392–3).

The extent to which the patterns found at Shanga are representative of the coast remains in question, as few other faunal studies with a similarly large sample exist for comparison. However, in many of the faunal analyses that followed, the Shanga material serves as a basis for comparison. In addition to the impressive size of the sample, the Shanga fish assemblage is notable in the thoroughness of its analysis, which Horton and Mudida accomplished by creating an important fish reference collection for the region, housed in the Osteology Department at NMK, Nairobi. Subsequent analyses, including my own, have relied on this reference collection.

***Pate* (Wilson and Omar 1997)**

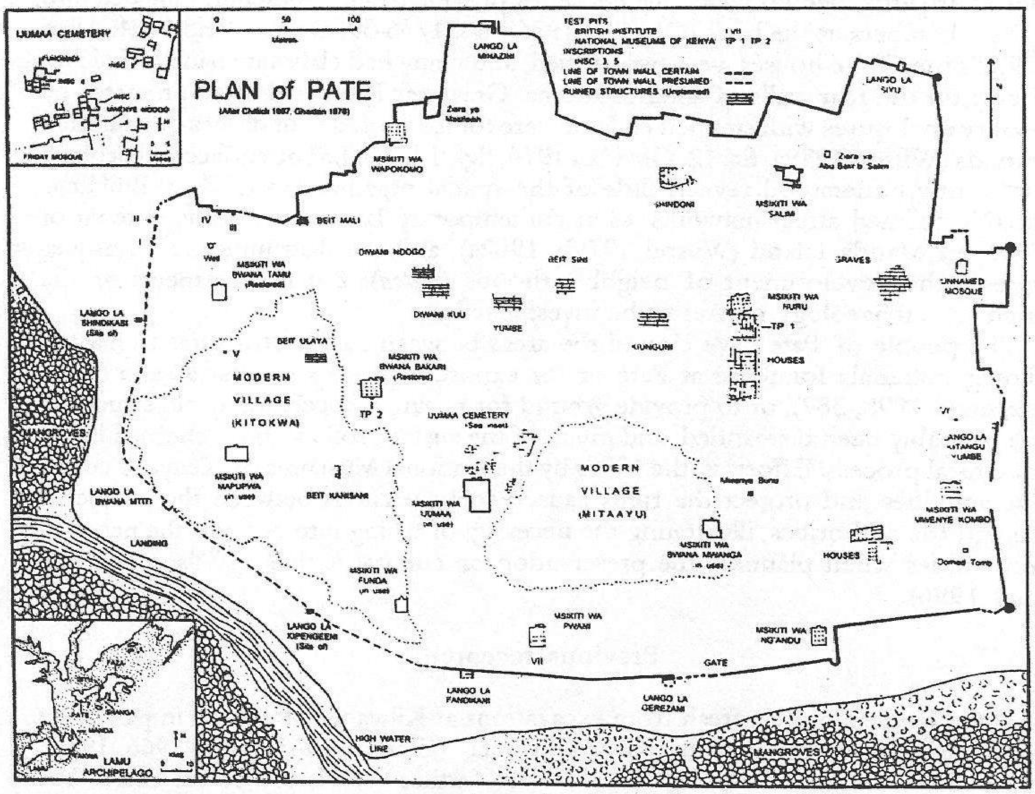


Figure 5.4: Plan of Pate
(Wilson and Omar 1997)

Pate lies on the same island as Shanga, Pate Island, accessible through a large channel surrounded by coral reefs and mangroves. Faunal analysis was carried out by Martin Pickford for Test Pit II, Periods I-III, below the Bwana Bakari Mosque in the west-central part of the site (Wilson and Omar 1997, 59). The pit was 4 m^2 at the top and reduced to 1.35 m^2 below level 6 (Wilson and Omar 1996, 546). The lower three meters of the 5.2 m deep test pit dated from the 8^{th} to the mid-13^{th} century; all deposits were sieved (Wilson and Omar 1997, 35). The level right below the mosque provided the highest concentration of material remains, which the authors interpreted as a 12^{th} to 13^{th} c. midden (1997, 38). The data is published as a presence/absence table. Fish are present throughout all the levels (AD 750-1250), but there is no real description of the magnitude of the "numerous remains recovered in most levels" (1997, 60). The limited data portrays an increasingly larger array of mammal types present in later deposits. Wilson and Omar describe the chronology of subsistence at Pate:

> *The people of Pate in Period 1a and the first half of Period 1b were eating fish, turtle and infrequently, perhaps chicken. Goats appear in Period 1b, and by the middle of the period, certainly by the late tenth to the early eleventh century, both they and cattle were present. Crustaceans, whatever their role in the life of Pate, appeared about the same times as goats and cattle and continued throughout the sequence. (Wilson and Omar 1997, 60)*

Their analysis shows the appearance of major domesticated animals—goat and cattle—in the faunal record after the 11th century, but the lack of numerical detail make it difficult to compare the relative importance of the different food sources.

***Mahilaka* (Radimilahy 1998)**

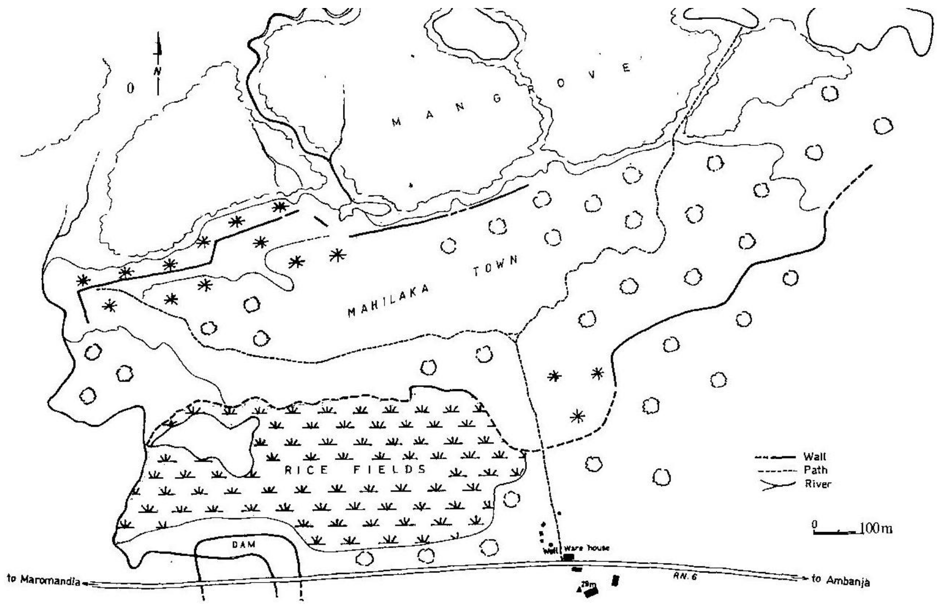


Figure 5.5: Map of Mahilaka town (Radimilahy 1998, 68: Figure 4.2)

The 10th-15th century settlement of Mahilaka was located in the Sambarino valley in NW Madagascar, an area rich in marine and terrestrial resources (Radimilahy 1998, 39). The littoral area along the bay contains mangrove swamps while the coastal plain has good land for grazing animals and rice cultivation (1998, 56, 59). The inhabitants of this port city along the Ampasindava bay have access to a variety of fish available at different times throughout the year (see Radimilahy 1998, 56: Table 3.3 for list of seasonally available fish). Radimilahy (1998, 48) collected ethnographic data in the area around Mahilaka and identified two main periods of fishing—high season (Feb-Jul) and low season (Jul-Oct)—

and three principal fishing methods: hooks or nets in deep water, and tidal traps (*valankira*—a type of fishing weir) close to the beach.

Remains of a wall surround the ancient town of Mahilaka, which is estimated to have extended over 70 ha at its height (1998, 73). Around 112 kg of faunal remains were recovered from 12 trenches excavated across the site that amount to 208 m^3 of analysed deposits screened through 2mm mesh (1998, 195, 124, 125: Table 6.5). The faunal remains reported in the publication were identified by Lucien M.A. Rakotozafy, from the University of Antananarivo, and reported as minimum number of individuals (MNI) (1998, 195).

Radimilahy (1998) traces changing food consumption trends through four phases in the history of occupation at Mahilaka. The first level was mostly associated with the fort and contained higher amounts of domesticated animals than hunted animals and fish (1998, 196). The second level yielded a wider variety of animals, in particular aquatic birds such as ducks (*Anas* sp. and *Dendrocygna* sp.) and heron (*Ardea purpurea*) (1998, 196). The third phase, when the population at Mahilaka reached its height, contained the highest concentration of remains. It is characterized by a "great consumption of bird species, either hunted or domesticated" (1998, 196). Radimilahy notes differences in the spatial distribution of animal remains stating that the fort was characterized by more domesticated animal remains and a limited and selective range of hunted species, while the area along the mangrove swamps contained a wider range of hunted animals as well as domesticated animals (1998, 196–7). In the last phase, the overall quantity of animal remains decreased and the composition of species changed significantly. The water birds, which dominated the category of hunted animals in the previous phases, are nearly absent and seem to be replaced by land species, such as partridges (*Margaroperdrix madagascariensis*) and turtledoves (*Streptopelia picturata*) (1998, 197). Radimilahy believes this change could have resulted from environmental change from a wetter to drier climate. The phases identified at Mahilaka are not connected to specific chronological periods, making it difficult to compare consumption trends at Mahilaka with other sites in the Swahili region. The faunal analysis of Mahilaka, nevertheless, provides a glimpse into the daily lives of its inhabitants.

***Kizimkazi* (Kleppe 2001; Van Neer 2001)**

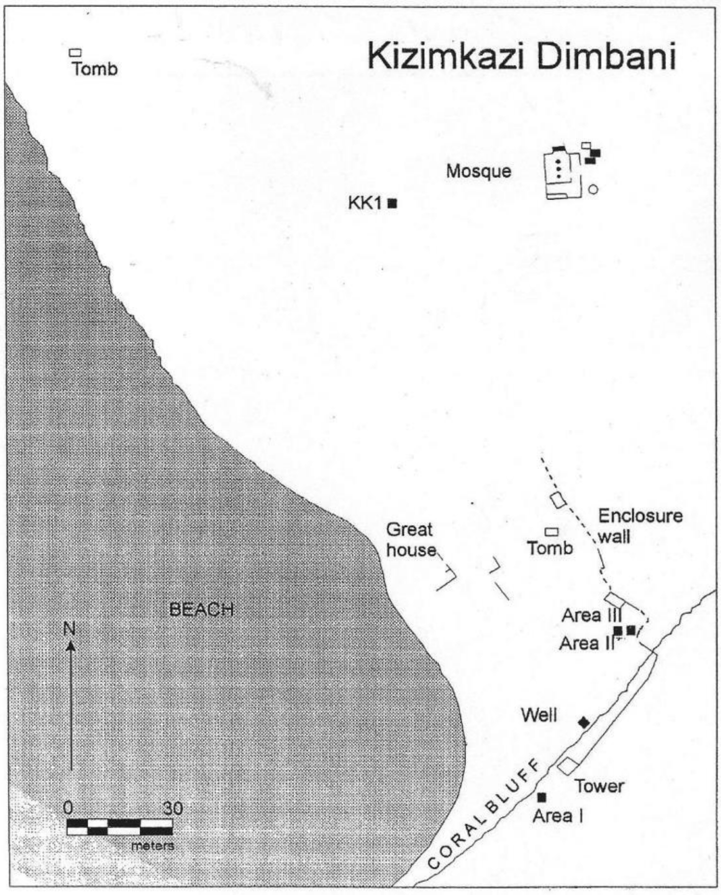


Figure 5.6: Location of Kizimkazi Dimbani (Kleppe 2001)

Kizimkazi Dimbani lies at the southern end of Zanzibar. It has one of the earliest mosque inscriptions, dated to AD 1107. Excavations conducted in 1989 by Else Johansen Kleppe (2001) revealed connections to the Indian Ocean trade since the beginning of the 12^{th} century, most likely as a stop for food supplies. The collection of faunal remains comes from two 4 m^2 test-pits with deposits sieved through 5 mm mesh (Van Neer 2001, 385). Identification was carried out by Van Neer at the Royal Museum of Central Africa at Tervuren. The fish were identified to family level using a reference collection from specimens of the Gulf and Red Sea. Seventy-six percent of all identified vertebrate remains were identified as fish taxa (2324 bones in total), mostly representing coral and rocky reefs (2001, 387). The main domestic animal remains were composed mostly of goat and sheep with only 4% frequency of cattle, few chicken remains and several wild animals that indicate hunting (2001, 387–94). Van Neer concludes that fishing and harvesting molluscs were the main subsistence activities during the occupation of the site.

Van Neer analysed the fish remains by habitat preference based on family level and reconstructed lengths. Ninety-eight percent of the identified fish are found around coral reefs (2001, 392). He divides these into two groups in order to identify the fishing technique: 35% inhabiting the reef and 63% living over or near the reef. The first group, he argues, were likely caught using hook and line and not nets because nets get tangled in the coral (2001, 393). The other group found near and above the reef may have been caught by nets. The analysis of Kizimkazi fish stands out as an example of the use of fish characteristics—age, habitat, and depth—to interpret fishing techniques from archaeological fish samples on the East African coast. I base my analysis of exploited habitats on this example.

Chwaka**,** ***Kaliwa*****,** ***Mduuni*** **(Fleisher 2003)**

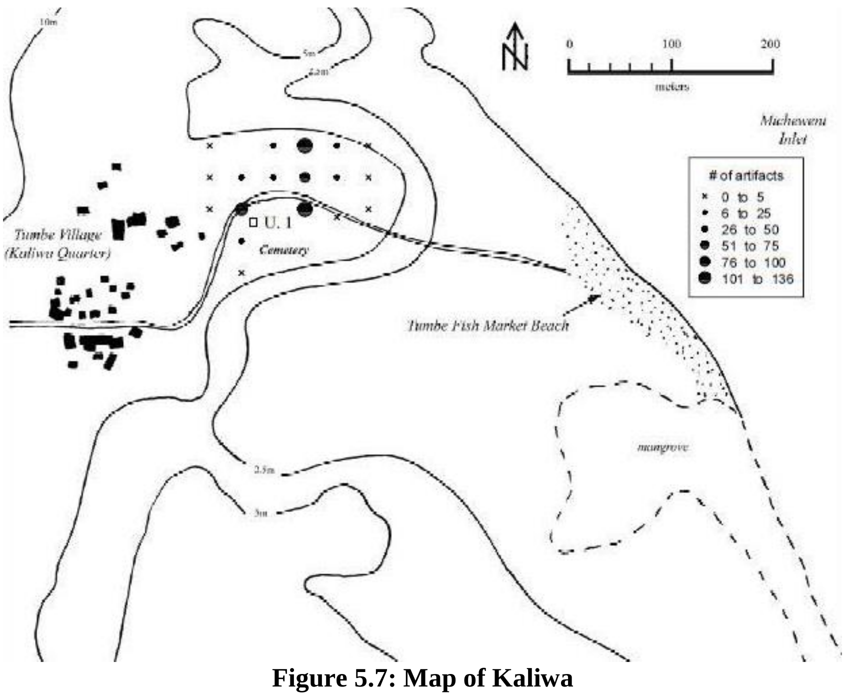


Figure 5.7: Map of Kaliwa
(Fleisher 2003)

Three settlements along the coast of Pemba Island are the focus of a review of Swahili subsistence practices in Fleisher's (2003) unpublished PhD thesis. The faunal assemblages from Pemba Island represent the period from AD 1000-1500. Chwaka covers that entire range; Mduuni ranges from AD 1200-1500 and Kaliwa between AD 1300-1500 (Fleisher 2003, 364). After the 11th century, several urban centres emerged on Pemba Island—including Chwaka and Mduuni--that drew in the population from the countryside (2003, 406–7). These three settlements represent different levels of urbanism: Chwaka is a first-order town, Mduuni a second-order town, and Kaliwa a village (2003, 119).

Ogeto Mwembi analysed the faunal material from these sites with the reference collection at National Museums of Kenya. Kaliwa had the highest percentage and overall number of fish remains: 2597 bones, 2011 identified to species (86% of all identified fauna); in contrast, the Chwaka material included 568 identified fish bones from a total of 1033 fish bones (35% of all identified fauna), and at Mduuni, 44 fish bones were identified from 57 total fish bones analysed (32% of all identified fauna) (2003, 382, Tables 8.10, 8.11 and 8.12). Like at several other sites, the fish represent inshore and coral reef habitats. A few families dominate the samples: Lethrinids, Scarids, Serranids, and Acanthurids (particularly in Kaliwa). Kaliwa differs from the other two sites, Chwaka and Mduuni, because it has a larger amount of Acanthurids and the presence of 'trash fish' (e.g. Tetrodontids) (2003, 375). Fleisher speculates these differences exist because of different consumption patterns between urban and rural settlements, Kaliwa being an example of a rural settlement. The residents at Kaliwa may have had more specialized knowledge needed to prepare poisonous fish (2003, 375). Additionally, the higher proportions of domesticates at Chwaka and Mduuni indicate that the residents of these towns had better access to these resources than the inhabitants of Kaliwa (2003, 382).

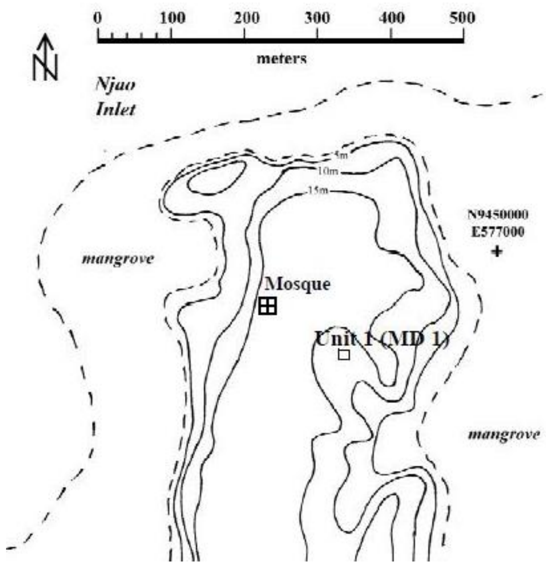


Figure 5.8: Map of Mduuni
(Fleisher 2003: 196)

Cattle and chicken were the most common domesticated animals present in all levels of the three analysed units, sheep and goat being present but rare. Small numbers of wild animals were reported, including dugong, turtle and rat. Fish bones create the largest contrast of ratios to other animals, Kaliwa having a significantly larger portion of fish than the other two sites. Chronological analysis is possible using data from these three sites because the data is divided into four layers associated with a chronological sequence. In all three sites, there is an increasing amount of domesticates relative to fish; however, at Kaliwa, the change is much more gradual, unlike Chwaka where there is a substantial shift around AD 1200 (2003, 382–3). Fleisher points to a similar trend at Shanga, where fish "drop off dramatically" after the 12th century (2003, 383). A difference between Shanga and Chwaka, nonetheless, is the lack of wild animals in the earliest levels of Chwaka. Fleisher explains this might be because the people at Chwaka (who settled slightly later than Shanga) may have already adapted to a coastal subsistence (2003, 384). Additionally, the quantity of wild animals living on the island is limited; most of the four-legged mammals are believed to be introduced because this island separated from the mainland much earlier than other islands along the Swahili coast (Walsh 2007, 86–7).

***Unguja Ukuu* (Juma 2004)**

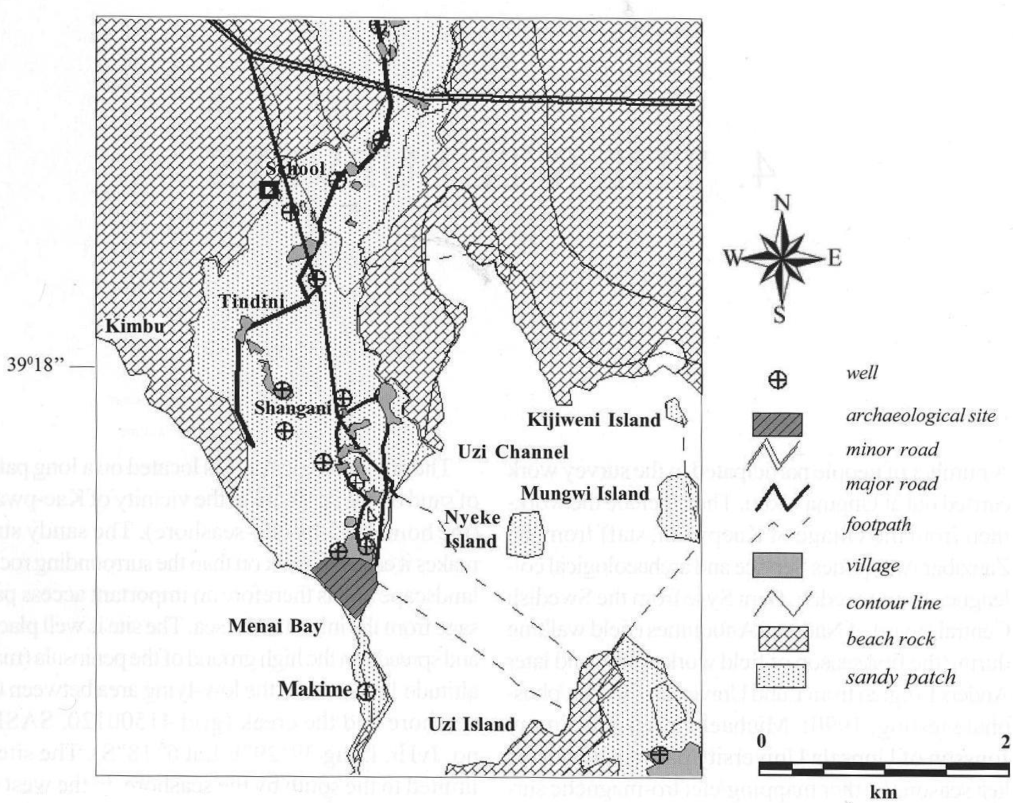


Figure 5.9: Map of Unguja Ukuu and surrounding area (Juma 2004)

Unguja Ukuu is located in the southern part of Zanzibar Island (formerly known as Unguja). The site was occupied from the late 8th to 10th century. Seven excavation units making up about 222 m^3 of sediment was dry sieved through 3 mm mesh (Juma 2004, 67). Unit K contained a dense deposit of shell remains and has been interpreted as a shell midden. J. Kimengich of National Museums of Kenya identified 1750 animal remains that represents four occupation periods in the history of Unguja Ukuu (Ia, Ib, IIa, IIb). Fish remains were not identified to species although they composed a significant proportion of the remains, such that the author described, “fishing is among the most important activities of the community judging from the large quantity of remains recovered from all periods” (2004, 149). Of 293 fragments in period Ia (AD 500-750), 125 are from marine organisms, including four kinds of fish: parrotfish, lethrinids, wrasse, and groupers (2004, 129–30). Crabs, turtles, pygmy whale, and dugong remains are also present. Sheep, goat, and chicken remains represent the domestic animals, and a variety of wild animals are included as well. The overall trends identified include a decrease in the range of fauna in Period Ib (AD 750-900) with a slight increase in IIa (AD 1050-1100) and then a decrease in IIb (AD 1450-1600), particularly in cattle, goat, chicken, and some wild animals (2004, 134). The last two periods are interpreted as independent occupations. Period IIa is a relatively brief series of events with an increase in forest animals. Period IIb is the last reoccupation of the site.

***Chibuene* (Badenhorst et al. 2011)**

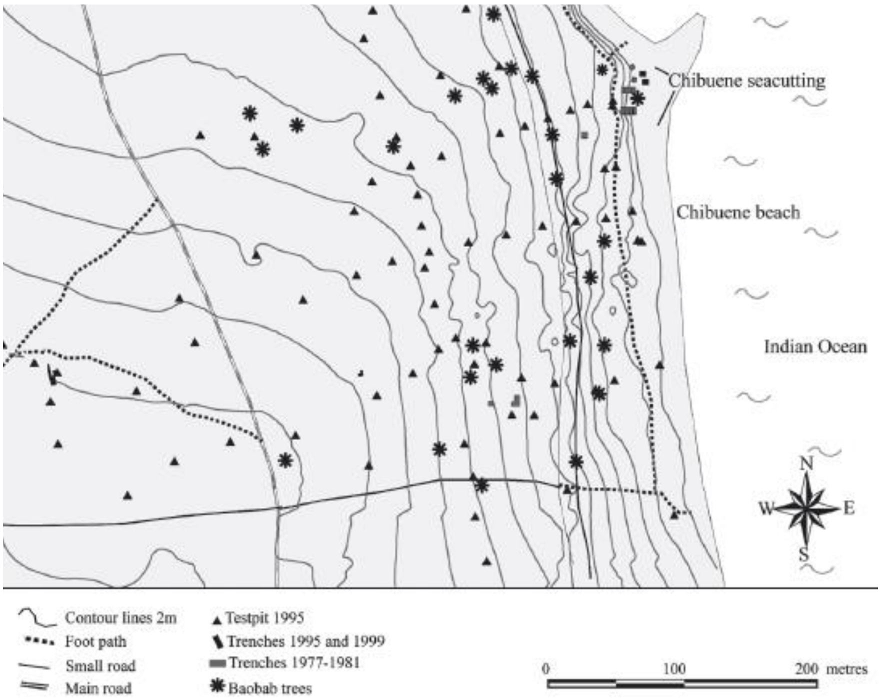


Figure 5.10: Excavations at Chibuene (Badenhorst et al. 2011, 4: Fig. 3)

The ancient community of Chibuene was set in Vilanculos Bay, Mozambique. Badenhorst and colleagues (2011, 1) describe the vegetation surrounding the past settlement as “savannah-forest mosaic”, but there is no mention of the types of marine habitats that could have been exploited by past fishers. The extent of the site is an area of about 10 ha, defined by high densities of finds (2011, 2).

The published faunal assemblage comes from a series of 66 test pits across the site and two trenches excavated in 1995 (Badenhorst et al. 2011, 2–3). The data is divided into two phases of occupation: an early phase (approximately AD 700 to 1000) and a late phase (approximately 1300-1700). Data was quantified using NISP and MNI; further details on methods of collecting and analysing faunal material were published separately.

Although fish remains are not examined in detail, the authors conclude that "marine resources were of major importance throughout the occupation" (2011, 7). Of the 1141 identified specimens, 812 were unidentified fish. The only identified fish were 68 remains of musselcracker—likely *Cymatoceps nasutus*, a species from the Sparidae family that inhabits rocky coastal waters (2011, 11). Other exploited marine resources include turtle—believed to be loggerhead turtle (*Caretta caretta*)—and shark. Domestic animals represented at Chibuene include cattle, sheep, goats and chickens. Few specimens of wild animals are present in the assemblage; these include rhinoceros, vervet monkey and small bovids. The degree of importance of wild animal remains could not be determined because of the small sample size. Overall, the authors conclude that the subsistence practices represented in the Chibuene assemblage more closely resemble those of Swahili coastal towns than other farming communities in the southern African region.

<u>Sites on Pemba and Zanzibar</u> **<u>(Mudida and Horton n.d.)</u>**

Excavations on Pemba and Zanzibar islands have yielded five faunal assemblages that are summarized in an unpublished chapter by Horton and Mudida (Mudida and Horton n.d.). Although relatively small quantities of remains are reported, these samples provide comparative data of sites in this region for the 6th to 16th centuries: Fukuchani (6th-8th c.), Unguja (7th-10th c.), and Tumbatu (12th-14th c.) are found around Zanzibar island while Ras Mkumbuu (9th-16th c.) and Mtambwe Mkuu (9th-14th c.) are found along the Pemba coastline. These finds were collected from sieved material using 5 mm mesh screens and analysed at National Museums of Kenya.

Horton and Mudida present data for estimated fish sizes, an analytical tool that is used in just one other example of published coastal fish remains (Van Neer 2001). They derive the estimated sizes of identified fish from direct comparison with reference specimens and show that mostly adult fish were caught, with an average size of 700-800 mm length (around 5-10 kg) and some specimens over 1000-2000 mm. Additionally, they provide a description of examples of hyperostosis found in the archaeological remains, such as elements of the skull and spine of *Alectis indicus* and cleithra likely from *Caranx sexfasciatus*.

Horton and Mudida point out similarities between the range of fish taxa in the Zanzibar/Pemba samples and Shanga to show that fishers in these areas exploited similar habitats—mostly inshore waters that include fringing reefs, lagoons, and creeks—and used similar fishing methods. However, differences in the species within the top families represented at the various sites indicate that fishers exploited coastal habitats to different degrees and/or used different tools. For example, in the Scaridae family there are higher numbers of *Scarus ghobban* in the samples from Pemba and Zanzibar while *Leptoscarus vaigiensis* is more represented at Shanga. Horton and Mudida speculate that these differences arise from the exploitation of different habitats since *S. ghobban* is found mostly in coral reefs and *L. vaigiensis* in seagrass beds. Additionally, two fish hooks were found at Unguja Ukuu, providing direct evidence that hand line fishing occurred in this area.

Important differences emerge from the comparison of non-fish remains at the five sites. At Unguja and Fukuchani, the non-fish bones are dominated by wild animal bones, mostly of hunted antelope, whereas at Tumbatu, the non-fish remains are composed mainly of domesticated animals. Mtambwe Mkuu and Ras Mkumbuu, the sites from Pemba, have very similar patterns to each other, showing a majority of cattle remains in the non-fish assemblage and few wild animals. Horton and Mudida explain these patterns in relation to differences in the surrounding environment. The high number of cattle remains at the Pemba sites, for example, could be related to the "lusher environment" of that island. They also note a higher number and wider range of hunted animals in the earlier assemblages than the later ones.

***Kua* (Christie 2011)**

Kua ruins, dated to around the 14th-16th centuries, are located on Juani Island in the Mafia Archipelago, off the coast of Tanzania. Excavations at Kua were undertaken as part of Christie's (2011) PhD research. Faunal remains were recovered from two areas within the town of Kua using 0.5-2.5 mm mesh screens in Area 1, and 3 mm mesh screens in Area 2 (Christie 2011, 249). Christie analysed the terrestrial faunal remains with the comparative collections at the University of York. She identified fish remains using ten cranial elements with a comparative sample of 57 specimens collected during fieldwork (Christie 2011, 306).

Different proportions of fish and terrestrial taxa in each area suggest differential access to resources that could be associated with social status (2011, 330). Area 2 (high status) contained more terrestrial animals and fish from near-shore and sea grass areas, while Area 1 (low status) contained more fish, mostly from coral and rocky reefs. The identification of different consumption patterns between two areas of Kua shows the potential of intra-site analysis of the distribution of faunal remains. However, the different mesh sizes used to recover the faunal material could underlie some of the differences between the two samples; for example, Area 1 contained larger amounts of fish remains and was sieved through finer mesh screens.

Vumba Kuu, Songo Mnara (case studies)

Recent excavations at Vumba Kuu and Songo Mnara have provided faunal material that I have analysed as part of this thesis. These contemporaneous sites, occupied around the 14th to 16th centuries, occur in slightly different environmental settings: Vumba Kuu along a mainland creek and Songo Mnara on the tip of a nearshore island. They also represent different settlement types: Songo Mnara contains the remains of numerous coral-stone buildings—houses, mosques, and a palace structure—while Vumba Kuu contains a single coral-stone mosque and likely contained mostly mud-thatch houses. At both sites, excavations took place across the site to provide spatial data, and all deposits were sieved (details on methods can be found in Chapters 2, 6 and 7). The results show variation in the composition of faunal remains between sites and within each settlement that reflect local subsistence practices linked to their unique environmental and social settings. These settlements are discussed in more detail in Chapters 6 and 7.

Summary

In the thirty-year-old history of Swahili zooarchaeology, since Chittick (1984) first published a chapter summary of faunal remains from Manda, the methodological approach to faunal analysis has been wide-ranging, from the categorization of hand collected remains to the detailed identification of all material from sieved contexts. A decade after the Manda assemblage was published, Horton and Mudida (1993; Mudida and Horton 1996) published the most extensive faunal analysis of a Swahili settlement to date, setting the precedent for future studies and establishing an important reference collection of fish skeletons at National Museums of Kenya (NMK), Nairobi. Other Swahili faunal assemblages have been analysed and published, adding to our current understanding of Swahili subsistence practices.

More generally, faunal analysis in the Swahili region reveals that coastal inhabitants obtained their protein from a combination of fish, domesticated and wild animals. Upon closer examination, however, we see differences in the proportions and types of animals found at the various settlements. At several sites, such as Shanga, Kaliwa, and Chibuene, fish remains are especially abundant and were likely the principal source of protein. At Mahilaka, in contrast, there is an abundance of birds, both wild and domesticated, that sets it apart from other Swahili sites. Cattle plays a particularly important role at certain sites, such as Chwaka, and is absent in others, such as the coastal settlements of the Comoros Islands. Chronological trends also vary among the different sites. Chicken remains, for example, are found early in the histories of Shanga and Unguja Ukuu (before the 10th c.), but appear only in the later phases (after the 10th c.) in Sima and Domoni, in the Comoros Islands.

Furthermore, although fish remains are abundant at most excavated Swahili settlements, they are not always analysed in detail. The Shanga and Kizimkazi fish remains analyses are available in published articles (Horton and Mudida 1993; Mudida and Horton 1996; Van Neer 2001). The analyses of fish remains from three sites on Pemba Island (Fleisher 2003) and one site on Juani Island (Christie 2011) are summarized and discussed in two unpublished PhD theses. Five other records of analysed fish remains from Swahili sites on Pemba and Zanzibar Islands that are included in the regional analysis presented here are in the process of publication (Mudida and Horton n.d.). Additionally, I include two assemblages that I recently analysed and discuss in detail as case studies in this thesis. In the regional analysis presented in this chapter, I include the collective set of available records of fish remains in the Swahili coast.

5.3 Comparative approach: metadata

Archaeologists gain important information about the construction, occupation and transformation of particular settlements and their material culture from a focused investigation of specific sites. The summaries of Swahili zooarchaeological research above exemplify this approach. These settlements, however, collectively form part of an interconnected historical and geographical landscape. Thus, it is equally important to consider the implications of these links by analysing regional trends. Regional analysis not only reveals similarities among interconnected settlements but also emphasizes the unique characteristics of each. I use available data to create a picture of the socio-environmental landscape of the Swahili region.

Comparative analysis is limited by the challenge of compiling data from a variety of archaeological sources, each with its own taphonomic history. In order to know the extent to which different sets of data can be compared, one must be aware of the characteristics that make up each assemblage. I compare the characteristics of various Swahili faunal assemblages in the following categories: assemblage size, context represented, collection method, and mode of analysis (Table 5.1). Although each assemblage is discussed more thoroughly in the summaries above, here I present relevant metadata in tabulated form in order to assess the comparability of these assemblages. Fish remains were not always fully analysed beyond the category of fish— they were identified in 14 of the 19 assemblages. I limit the regional analysis to 12 assemblages of identified fish remains (site names in bold in Table 5.1) with similar methods and types of deposits (see Appendix F for map and chronologies of sites in regional analysis). I investigate regional patterns in the capture and use of animals as food items, but to what extent do other taphonomical processes—such as deposition, preservation, and archaeological methods—affect the composition of taxa represented by each assemblage? For example, the size of a sample can affect the variety of species it represents. I discuss the possible effects of different taphonomical histories on the regional patterns of fishing and fish consumption in the following paragraphs and in the discussion of the results of the regional analysis.

Table 5.1: Comparison of regional faunal metadata
Names of sites included in the regional analysis appear in bold.
CM=collection method (HC=hand collected, or sieve mesh size),
RC=reference collection (NMK=National Museums of Kenya, UA=University of Antananarivo, RMCA=Royal Museum of Central Africa at Tervuren, MNHN=Muséum national d'Histoire naturelle, UY=University of York), ?=not specified

Site	Assemblage	Sample Size	CM	Sample Context	Fish ID Level	RC	Analyst
Manda	across site	706 NISP total	HC	across site, fill levels	category	NMK	Nina Mudida
Sima	Operation II	41 fish + 195 other NISP	6 mm	midden along N and W walls of mosque	family	?	Redding and Goodman
Shanga	Tr 2 (5x5x3.5m)	6009 fish + 681 other NISP	5 mm	domestic midden associated with a series of houses	species	NMK	Nina Mudida
Pate	Test Pit II (~2x1x2m)	presence/ absence	sieve	occupation levels below mosque	category	NMK	Martin Pickford
Mahilaka	Trenches 1-12	56 fish, 675 total MNI	2 mm	across site	category	UA?	Lucien M.A. Raakotozafy
Kizimkazi	Areas II and III (each ~4x2x1.5m)	1075 fish + 328 other NISP	5 mm	II: coral structure (well), III: living floors associated with coral stone structure	family	RMCA	Van Neer
Kaliwa	Unit 1 (2x2x1.2m)	2597 fish + 427 other NISP	5 mm	midden along southern boundary of site	species	NMK	Ogeto Mwebi
Chwaka	Unit 7 (2x2x2.75m)	1033 fish + 1955 other NISP	5 mm	large domestic midden in mud-thatch house area	species	NMK	Ogeto Mwebi
Mduuni	Unit 1 (2x2x1m)	57 fish + 121 other NISP	5 mm	midden in center of site	species	NMK	Ogeto Mwebi
Unguja Ukuu	Units A-M	633 fish, 1278 total NISP	3 mm	across site	species	NMK	J. Kimengich
Chibuene	66 test pits, 2-4 trenches	812 fish, 1141 total NISP (+ shell)	?	across site	species	?	unknown
Mtambwe Mkuu	TB12, 14-16	58 fish + 302 other NISP	5 mm	across site	species	NMK	Nina Mudida
Ras Mkumbuu	MK07-09	30 fish + 310 other NISP	5 mm	across site	species	NMK	Nina Mudida
Fukuchani	FK02, FK08	20 fish + 122 other NISP	5 mm	across site	species	NMK	Nina Mudida
Tumbatu	TU01-07	542 fish + 924 other NISP	5 mm	across site	species	NMK	Nina Mudida
Unguja Ukuu	UU01-03	384 fish + 254 other NISP	5 mm	across site	species	NMK	Nina Mudida
Kua	Areas 1 and 2	184 fish + 844 other NISP	0.5-3 mm	across site	family	UY	A. Christie
Vumba Kuu	VMB 7, 8, 10-12	872 fish + 548 other NISP	5 mm	domestic middens and open spaces across site	species	NMK, MNHN	me
Songo Mnara	SM 10-11, 13-15	987 fish + 304 other NISP	2 mm	domestic middens and open spaces across site	species	UY, MNHN	me

Deposition

The assemblages chosen for regional analysis are mostly associated with domestic middens or a mixture of domestic middens and open spaces across the sites. The use of a single context to represent an entire settlement conceals the possible variation in subsistence practices across a site (e.g., Shanga; also discussed in the case study chapters). However, for several sites, faunal data is only available from a single excavated unit, so for the purposes of regional analysis, these are assumed to represent subsistence practices at these settlements. In cases, such as Shanga and Chwaka, where assemblages cover a range of occupation dates, the entire data set is used for comparison with other sites in the spatial comparison, but the chronological data is explored in a section on temporal change.

Preservation

Preservation could play a role in the number of represented remains in each faunal category, which can be affected by different rates of diagenesis. This taphonomic aspect is difficult to compare across the different assemblages because it is rarely discussed in the published sources of Swahili faunal remains. For the purposes of this regional analysis, the differences in preservation are not considered.

Archaeological methods

In methods of collection and analysis, the 12 chosen assemblages show important uniformity, such as the use of NISP (number of identified specimens) to quantify data and collecting sieved material with 5 mm mesh screens—only the Songo Mnara assemblage was collected using 2 mm mesh screens. A similar sieve mesh size ensures that the data include the same range of represented sizes of remains, while using the same quantification measure allows the comparison of numerical data. The authors of the published assemblages are not always clear about the details of analysis, such as which elements were identified and to what level of taxonomic identification. This information is particularly important in the study of fish, as some analysts use all identifiable elements while others focus on cranial elements. Although sometimes not explicitly stated, it appears the majority of assemblages were identified to the highest taxonomic level possible because of the level of identification presented in the data. Four reference collections were used in the identification of material, and eleven assemblages were identified, at least in part, using the Osteology collection at National Museums of Kenya (NMK), providing a similar point of reference for the varied assemblages.

Sample size

Within the subset of assemblages with comparable methods, the range of sample contexts and sizes varies. Sample size may be affected by preservation and depositional differences affecting the density of finds as well as methodological choices such as the extent of excavation. Shanga has the largest sample of faunal remains with 6690 total identified remains, excavated from a single trench. Kaliwa and Chwaka each have close to 3000 identified remains, from individual trenches. Five assemblages have a range of 1000 to 1500 identified remains: Tumbatu (1466), Kizimkazi (1403), Vumba Kuu (1421), and Songo Mnara (1291); these are made up of contexts excavated across each settlement. Assemblages with less than 1000 identified remains include: Unguja Ukuu-Horton (638), Mtambwe Mkuu (360), Ras Mkumbuu (340), Mduuni (178), and Fukuchani (142), all excavated from several units at each site.

Other authors recognize that sample size affects the representation of species richness because larger samples include a wider range of taxa (Horton and Mudida 1993, 680; Fleisher 2003, 367–8; Badenhorst et al. 2011, 6). Because there is a wide range of sample sizes in the collection of regional samples, I refrain from comparing species richness or diversity among the samples. Instead, I am interested in tracing the representation of general categories of the most common faunal remains—such as domesticates, wild animals, or fish from particular habitats. Robust patterns emerge in the analysis of settlements with larger samples that include over 1000 identified specimens. The patterns revealed in the five samples with less than 1000 identified specimens can be considered preliminary representations of subsistence and fishing strategies at these settlements.

Overview of selected samples for regional analysis

Table 5.2: Comparison of settlement types represented in regional analysis
(Refer to Appendix F for regional map and outline of settlement chronologies)

Site	Size (ha)	Occupation	Region	Location	Location Type
Shanga	5-15 ha	8th to 15th c.	Visiwani	Lamu Archipelago	nearshore island
Vumba Kuu	5-15 ha	14th to 16th c.	Mrima	Southern Kenya	mainland coast
Kaliwa	2.25 ha	14th to 16th c.	Mrima	Pemba Island	offshore island
Chwaka	12-15 ha	11th to 16th c.	Mrima	Pemba Island	offshore island
Mduuni	7 ha	13th to 16th c.	Mrima	Pemba Island	offshore island
Mtambwe Mkuu	125 ha	9th to 14th c.	Mrima	Pemba Island	offshore island
Ras Mkumbuu	12 ha	9th to 16th c.	Mrima	Pemba Island	offshore island
Tumbatu	20 ha	12th to 14th c.	Mrima	Zanzibar Island	offshore island
Fukuchani	10 ha	6th to 8th c.	Mrima	Zanzibar Island	offshore island
Unguja Ukuu	15 ha	7th to 10th c.	Mrima	Zanzibar Island	offshore island
Kizimkazi	0.5 ha	12th to 14th c.	Mrima	Zanzibar Island	offshore island
Songo Mnara	>15 ha	14th to 16th c.	Ngoa	Kilwa Archipelago	near shore island

The assemblages chosen for regional analysis represent a variety of settlement types in their sizes, occupation histories and environmental settings (Table 5.2). Several moderately sized settlements are represented, ranging 5 to 15 ha in size, as well as smaller settlements of less than 2.25 ha, and one very large settlement of 125 ha. Chronologically, the span of Swahili history is represented—from the 6^{th} to 16^{th} centuries. Although the Mrima coast is especially well represented, there are assemblages from three regions representing the length of the East African coastline from the Lamu Archipelago to southern Tanzania, including Visiwani, Mrima, and Ngoa. The settlements are located in a variety of coastal types, such as on nearshore islands, offshore islands, and on the mainland coast. Considering the limitations of the data sets, I analyse regional trends to explore how subsistence practices varied among this diverse and representative set of Swahili settlements. This regional analysis is divided into spatial and temporal dimensions in order to accommodate the different types of data and explore patterns in space and time.

5.4 Comparative analysis: the spatial dimension

Historical and archaeological records of consumption practices indicate that people living along the Swahili coast ate a combination of fish, domesticated and wild animals. However, little research has been done to explore how these subsistence strategies varied among the different settlements and why. I compare subsistence strategies and exploited fish habitats across the Swahili region and discuss variable patterns of subsistence strategies in relation to differences in the settlements' histories and environments.

Subsistence strategies

In the comparison of subsistence strategies, I divide identified fauna into three main food categories: domesticates, wild animals, and fish. There is a limited number of domesticated species found in the region that are represented in the faunal data: sheep, goat, cattle, and chicken are the principal domesticated species, and rarely camel. Cat and rat are also present in small numbers, and it is not clear if they scavenged on the collected food waste or were also eaten. The range of represented wild animals is larger, especially because these can vary according to the surrounding environment. The wild animal category includes but is not limited to: monkey, monitor lizard, dugong, mongoose, and turtle. There is a large number of species of fish found along the coast that ranges depending on the size of the assemblage from 9 to 56 fish taxa. In order to be as consistent as possible across all sites and categories, only identified remains were included in the analysis. The samples are represented in order from north to south along the coast and show the proportion of the three principal food categories (Figure 5.11).

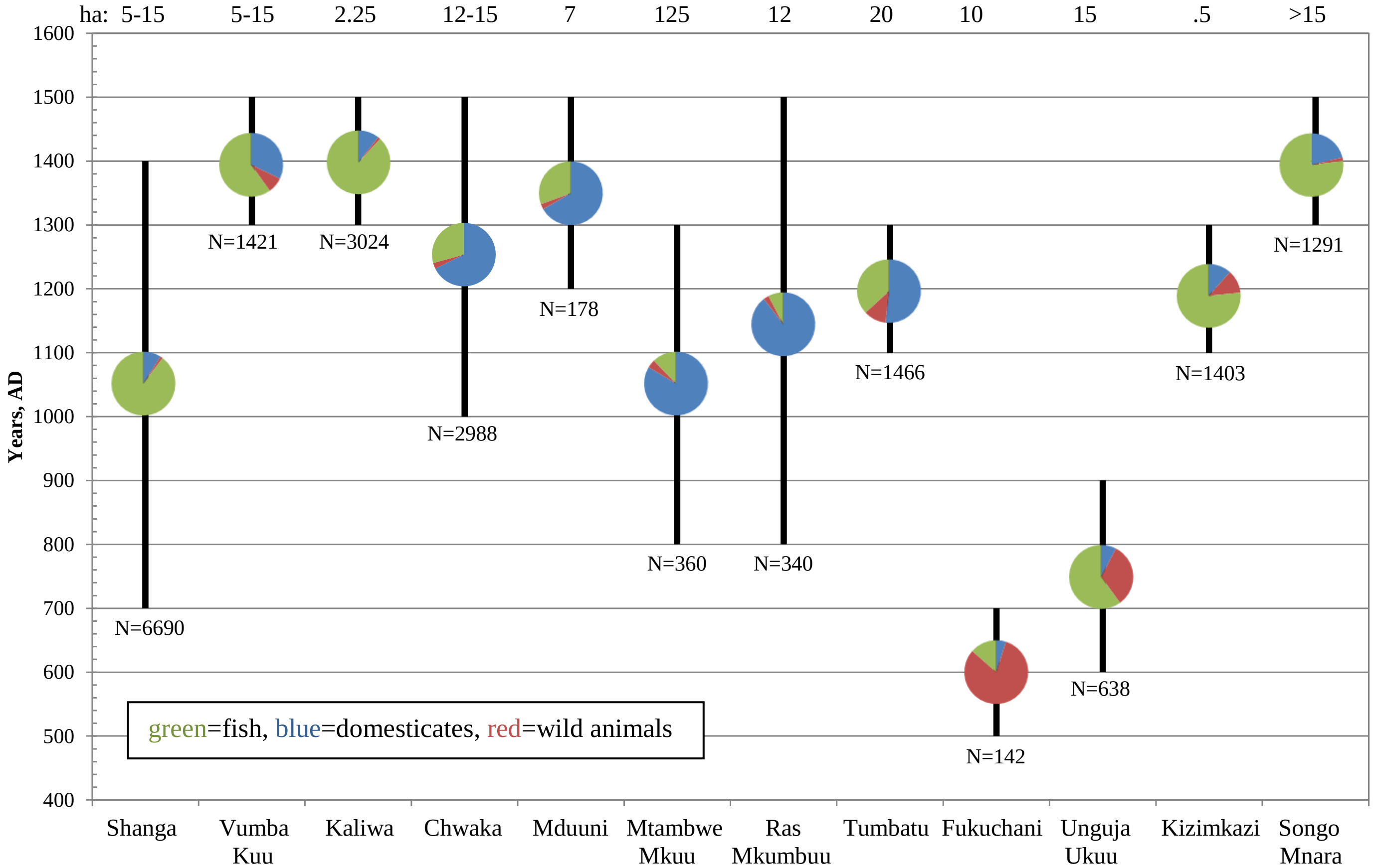


Figure 5.11 Regional comparison of fish, domesticates, and wild animals (%NISP)

Settlement size (ha) at top of chart. Sample size indicated below each bar. Data from published sources: Shanga (Horton and Mudida 1993); Kaliwa, Chwaka, Mduuni (Fleisher 2003); Mtambwe Mkuu, Ras Mkumbuu, Tumbatu, Fukuchani, Unguja Ukuu (Mudida and Horton n.d.); Kizimkazi (Van Neer 2001).

The overall composition of faunal remains in the regional analysis shows a heavy reliance on fishing for subsistence, supplemented by different degrees of hunting and rearing of domesticated animals. Although only a few of the sites in the regional analysis provide fish remains data divided into chronological phases (discussed in the next section), it is possible to discuss some temporal trends from the analysis of all the sites because they each represent different occupation spans throughout Swahili history. The general trend indicates that the earlier inhabitants of the coast relied more heavily on hunted animals than later inhabitants; Fukuchani and Unguja Ukuu, the only two sites in the sample not occupied after the 10th century, show significantly higher proportions of hunted animal remains. Otherwise, there is not a clear pattern that shows a link between a higher reliance on a particular food group and the period of occupation or the size of the settlement. Samples representing long-term occupations range from a dominance of fish (e.g., Shanga, fish=90%) to a dominance of domesticates (e.g., Ras Mkumbuu, domesticates=90%). Similarly, samples representing shorter occupations in the later periods include examples with high and low percentages of fish bones: Kaliwa, fish~90%; Tumbatu, fish<40%. Size also does not seem to make a difference in the proportion of food groups. For example, a similar proportion of fish remains (80%) is found in the samples from both Songo Mnara (>15 ha) and Kizimkazi (0.5 ha). There is also no spatial trend that relates subsistence strategies and location types (nearshore, offshore or mainland) or regions (Visiwani, Mrima, or Ngao).

Habitat analysis

I compared the representation of exploited habitats in the samples using the identified fish remains from each site. Particular fish species generally inhabit different sections of the marine environment, and the composition of these species at each site can be used to estimate the variable exploitation of these habitats. The habitats associated with different species were identified using widely-used references on marine fish in the Western Indian Ocean (Fischer and Bianchi 1984; Froese and Pauly 2012; more details on habitat analysis in Chapter 3). The same habitat-species index is used to classify habitats in all samples (Appendix B), except at Kizimkazi. In this case, the fish remains are mostly identified to family level, but an estimation of the habitats is provided by the author and represented as such in the analysis (Van Neer 2001).

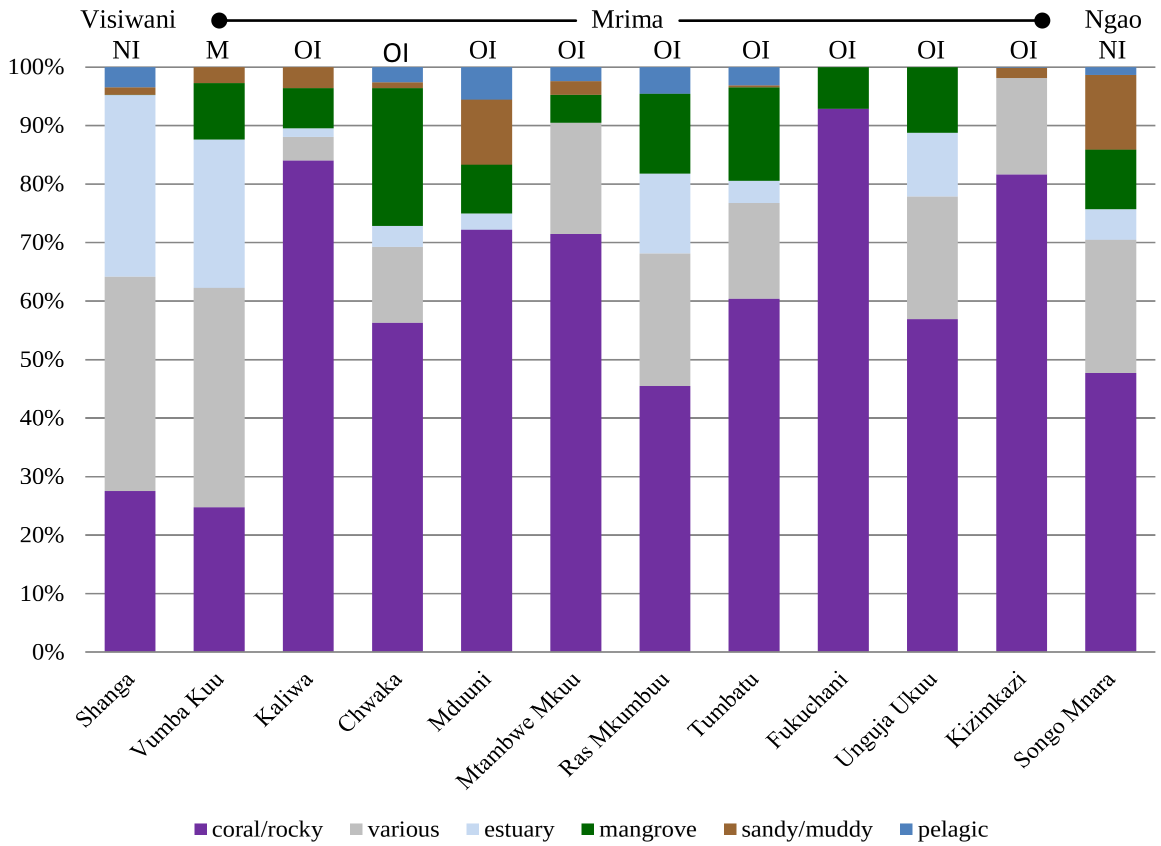


Figure 5.12: Regional comparison of marine habitat exploitation (%NISP)
NI=nearshore island, M=mainland, OI=offshore island.
Data from published sources: Shanga (Horton and Mudida 1993); Kaliwa, Chwaka, Mduuni (Fleisher 2003); Mtambwe Mkuu, Ras Mkumbuu, Tumbatu, Fukuchani, Unguja Ukuu (Mudida and Horton n.d.); Kizimkazi (Van Neer 2001).

Overall, the analysed samples show a heavier reliance on fish found around coral reefs than other habitats; however, the proportions of exploited habitats vary among samples (Figure 5.12). Shanga and Vumba Kuu have the highest proportions of fish remains from estuaries (>20%), and the lowest proportions of coral reef species (<30%). Only two other samples have <50% fish remains from coral reefs: Songo Mnara and Ras Mkumbuu. All other samples show a higher reliance on coralline fish (~55-90%). Fukuchani has a particularly high proportion of coral fish (>90%). The general pattern indicates that samples from offshore islands have higher representations of fish from coral/rocky habitats. This is not surprising given that these offshore islands are surrounded by extensive coral reefs and have smaller rivers that carry freshwater to the coast creating the conditions for an estuary habitat. In contrast, samples from mainland and nearshore islands show a lower reliance on coral species. The samples from Shanga and Vumba Kuu, in particular, show a heavier reliance on fish from estuary habitats. These settlements are located near the mouths of larger rivers that carry freshwater from far inland into the coastline. Also, coral reefs are more difficult to access along these shorelines. Although Songo Mnara lies on a nearshore island, there is an accessible fringing reef along its eastern shoreline, which might explain why the Songo Mnara sample shows a higher number of coral than estuary fish. These observations are limited by the small number of nearshore and mainland samples in the analysis, but provide a baseline from which to compare future analyses of mainland samples.

The composition of fish species reveals other differences in the exploitation of marine habitats. The majority of open sea species in all samples are requiem sharks (*Carcharhinus* spp.). Much smaller counts (<5 remains) represent other open sea species such as tunas (*Euthynnus affinis* and *Katsuwonus pelamis*) and white-fin wolf herring (*Chirocentrus nudus*). Estuary fish at Shanga are mostly marbled parrotfish (*Leptoscarus vaigiensis*), dark-fin eel catfish (*Plotosus limbatus*) and cock grunter (*Pomadasys multimaculatus*). At Vumba Kuu, estuary fish are composed mostly of red snapper (*Lutjanus argentimaculatus*) and cock grunter (*P. multimaculatus*). Common coral species also vary across the samples; emperor fish (*Lethrinus* spp.) associated with reefs represent the majority of coral species at Vumba Kuu, Kizimkazi, Shanga, and Tumbatu while blue-barred parrotfish (*Scarus ghobban*) dominates the coral category in the Chwaka, Mduuni, Kaliwa, Unguja Ukuu, and Fukuchani samples. However, both parrotfish (*Scarus* spp.) and emperor fish (*Lethrinus* spp.) make up a large part of the coral/rocky category in all samples. These two types of fish are related to distinct fishing gears: parrotfish are often caught in traps, and emperor fish with hand lines. Other important species in the rocky/coral category are the yellow-spotted trevally (*Carangoides fulvoguttatus*), sleek unicornfish (*Naso hexacanthus*) and groupers (e.g., *Epinephelus fuscoguttatus* and *Epinephelus lanceolatus*). The regional analysis shows that similar habitats are exploited along the Swahili coast, although to different degrees. Furthermore, the species exploited from these habitats overlap but are not the same in all samples. These differences could represent variability in the natural distribution of fish along the coastline, the use of different fishing technology or a combination of both.

Horton and Mudida deduce that offshore fishing developed at Shanga after the 12th century (1993, 679). Regional analysis shows that this trend is consistent across the samples; all the sites with open sea species—Shanga, Chwaka, Mduuni, Mtambwe Mkuu, Ras Mkumbuu, Tumbatu, and Songo Mnara—have occupations beyond the 12th century. Furthermore, samples dated to before the 12th century, Fukuchani and Unguja Ukuu, do not include open sea species. However, not all samples dated after the 12th century have open sea fish species—Vumba Kuu, Kaliwa, and Kizimkazi.

Discussion

Why do some contemporary coastal settlements have evidence of offshore fishing while others do not? The later settlements without offshore fishing also have the lowest levels of domesticated animals (<10%) (see Figure 5.12). One possible explanation is that the inhabitants of these settlements lacked the capital/position needed to manage or obtain livestock and invest in more expensive equipment to engage in offshore fishing. Historical accounts describe the use of livestock as important ritual food used in feasting (e.g., Hollis 1900) and as gifts to visitors (e.g., Freeman-Grenville 1962, 57; also described in Chapter 1), showing that these were not just markers of high status but cultural tools through which status was created and reinforced (see Fleisher 2010). Ethnographic and ethnoarchaeological research on the coast indicates that higher socioeconomic classes have more access to domesticated animals and invest in larger boats required for offshore fishing (described in Chapter 4). Thus, the conditions associated with large consumptions of domesticated animal remains (people with higher prestige and socioeconomic power) also favour the investment in offshore fishing.

The samples from Shanga and Vumba Kuu are exceptions to this pattern: Shanga has <10% domesticates and evidence of offshore fishing while Vumba Kuu has >10% domesticates and no evidence of offshore fishing. However, Shanga has high numbers of imported ceramics and coral-stone architecture, which indicate that some of its inhabitants had high economic status (Horton 1996). In contrast, excavations at Vumba Kuu have yielded relatively small quantities of imported ceramics and there is little evidence of coral-stone architecture (Wynne-Jones 2010). Thus, the link between evidence of high socio-economic power and offshore fishing holds true in these cases. Furthermore, in the samples that can be compared chronologically (described in the next section), the relative abundance of domesticates increases at the same time that offshore fishing becomes more prevalent on the coast.

5.5 Comparative analysis: the temporal dimension

The Shanga and Chwaka samples have comparable quality and range of data representing the 11th to 16th centuries, which provide zooarchaeological data to explore regional fish consumption trends throughout the development of Swahili settlements (Quintana Morales n.d.). Both samples were collected from a single domestic midden using 5 mmm mesh screens and quantified by number of identified specimens (NISP) (Horton and Mudida 1993, 675; Fleisher 2003, 321, 365). The total number of fish at Shanga is not reported—only the number of identified fish. For consistency, I use only the identified faunal remains to compare both sites. A chronological comparison was possible because the faunal data sets from both settlements are divided into excavation layers associated with chronological sequences.

Subsistence strategies

I focus on four main food groups—fish, chicken, goat/sheep, and cattle—that make up over 95% of the total number of identified fauna at each site. I plotted the chronological distributions of the four main food groups as the total number of identified specimens (NISP) in each phase to compare changes in the proportion of each food source throughout the occupation at each settlement.

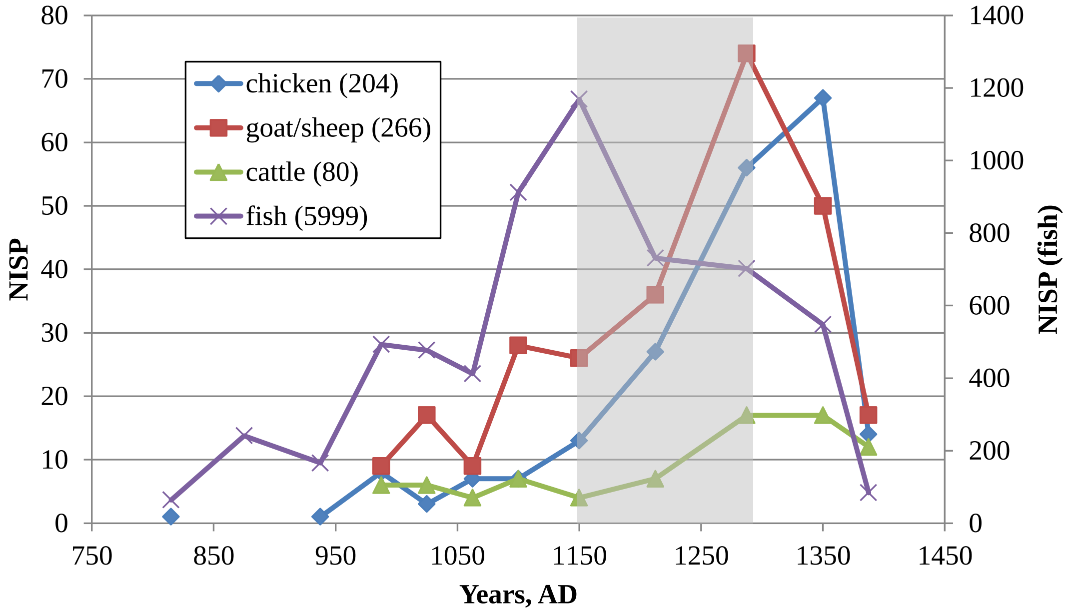


Figure 5.13: Chronological distribution of four main food sources at Shanga shows a decreasing number of fish and increasing number of domesticated animal remains in the 12th to 13th centuries, a period of shifting climate (marked in grey). Fish are on secondary axis to compare overall trends among all food items. The total number of identified specimens (NISP) for each food type is indicated in parentheses. (Data set from Horton and Mudida 1993)

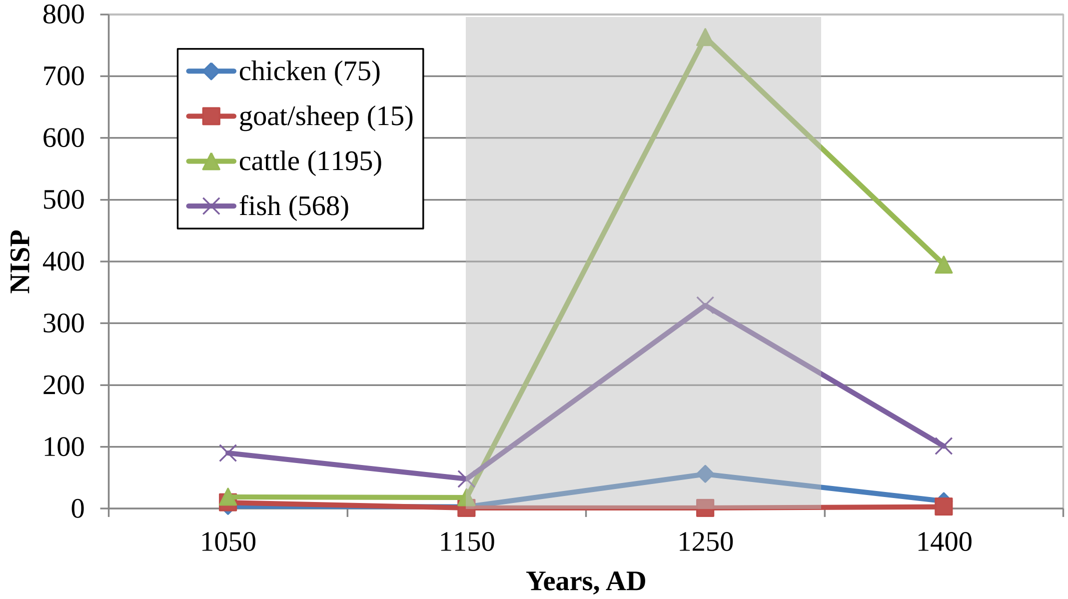


Figure 5.14: Chronological distribution of four main food sources at Chwaka shows the increasing numbers of cattle compared to fish remains during the 12th to 13th centuries, a period of climate change (marked in grey). The total number of identified specimens (NISP) for each food type is indicated in parentheses. (Data set from Fleisher 2003)

Overall, both Shanga and Chwaka show a pattern of initially increasing faunal remains, peaking between AD 1250 and 1350, and decreasing at the end of the 14th century, reflecting the intensity of human occupation during the development and subsequent abandonment of each settlement (Mudida and Horton 1996, 394–406; LaViolette and Fleisher 2009, 445). Within that backdrop, both settlements show evidence of a relative decline in the importance of fish compared to domesticated animals beginning around the end of the 12th century. At Shanga, where the data are more detailed, the decreasing representation of fish compared to domesticated animal remains is more evident; between the 12th and 13th centuries the amount of fish declines as the numbers of domesticated animals increase (Figure 5.13). At Chwaka, in contrast, all four animal groups increase and then decline during that time period. However, the rate of increase in fish remains is not as steep as the other groups and is surpassed by that of cattle remains around the turn of the 12th century (Figure 5.14). The group of goat/sheep at Chwaka is represented by only 15 remains that cannot be considered as evidence of any clear pattern. Fleisher (2003, 383) notes that between AD 1000-1200, fish remains make up around 65% of the faunal assemblage, and in the periods that follow fish make up less than 30% of the assemblage; after AD 1200, the majority of bones is instead composed of domesticated animals.

Mean trophic level (MTL)

High chronological resolution and a large fish remains assemblage lend Shanga to more detailed studies of changing fishing strategies over time. Research on contemporary fisheries has demonstrated a link between a declining MTL and overfishing, resulting in the underrepresentation of high trophic level species (Pauly et al. 1998). In archaeological samples, MTL is not a direct measure of fishing intensity, but can be used with other forms of evidence—e.g., decreasing size, habitat use—to indicate changes in the composition of fish that may be related to intensified fishing (Reitz 2004). Analysis of variation in MTL provides information in potential changes in the strategies and tools used to exploit particular types of fish or changes in the availability of certain fish types in the exploited marine ecosystem. I calculated the MTL of fish identified to species and genus level for each phase of occupation at Shanga using published trophic levels for each species (Froese and Pauly 2012; for methods see Wing 2001 and Chapter 2). The data set of identified fish remains represents approximately ten percent of the total sample from Trench 2 at Shanga (Horton and Mudida 1993; Mudida and Horton 1996). In cases where the fish remains are identified to just genus, which occurs in 5 out of 51 cases, I averaged the trophic level of all species present in the region (e.g., *Lethrinus spp*.).

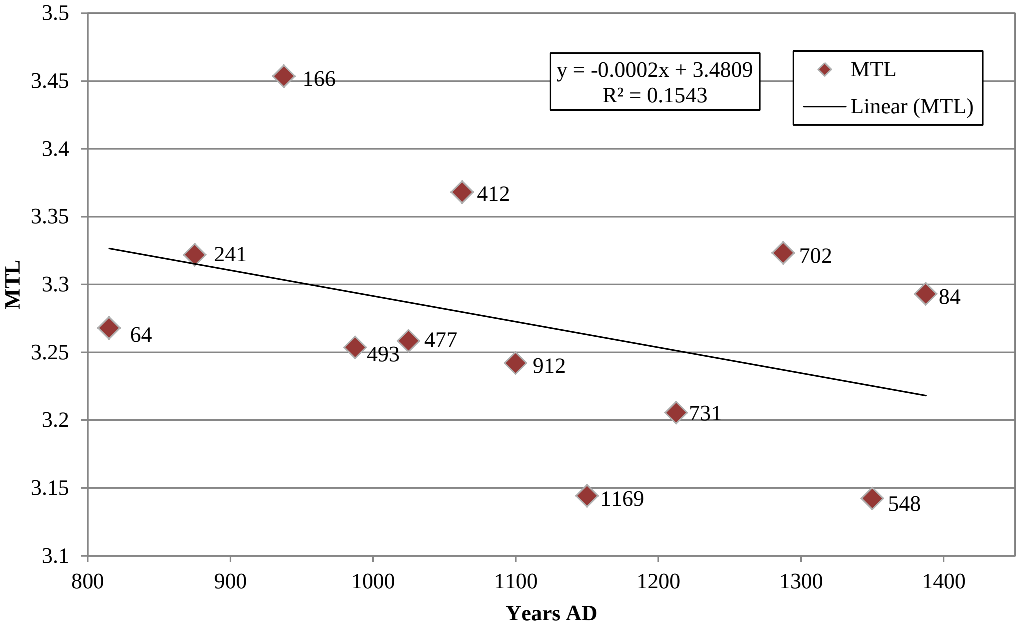


Figure 5.15: Shanga mean trophic level (MTL) over time with linear trend line Samples sizes (NISP) indicated next to each MTL value. (Data set from Horton and Mudida 1993)

Analysis of the composition of fish taxa throughout the occupation at Shanga shows a declining trend in MTL, a possible indication of pressure on the local marine ecosystem from fishing intensification (Figure 5.15). The fluctuating pattern around the trend line is a reflection of the total number of fish remains, which could be a result of sample size effects: larger samples have a wider range of species, which can include higher numbers of low trophic level species. Overall, the sample size is increasing over time, peaks at the end of the 12th century and then declines rapidly. If the MTL trend is a result of sample size effect, one would expect the smaller sample sizes—at the beginning and end of the data sequence—to correspond to the higher MTL values, but that is not always the case. For example, the lowest MTL value corresponds to a mid-range sample size of 548, occurring towards the end of the data sequence.

Habitat analysis

I compared the representation of commonly identified fish species at Shanga to identify changes in fishing strategies, such as an increase in the number of pelagic fish remains. The presence of open sea fish indicates the use of a different set of fishing tools and strategies suitable for catching larger fish farther from the shoreline. I used the habitat index, linking identified fish species to five principal marine habitats, to explore changes in the exploitation of these habitats over time. The category of fish taxa found in various habitats is especially well-represented in the Shanga analysis because it includes a large number of emperor (*Lethrinus* spp.) fish identified to just genus. Species of this genus inhabit particular environments, but because the exact species is not indicated, I combined these into the 'various' category. The large number of remains in this category makes it difficult to get an overall picture of changing habitat exploitation. However, it is clear that estuary and coral habitats were important fishing areas overtime and that there is a significant increase in open sea fish (mostly shark) after the 11th century (Figure 5.16). Interestingly, as the MTL declines, the percentage of shark remains to total fish remains is rising, although shark species have high trophic levels.

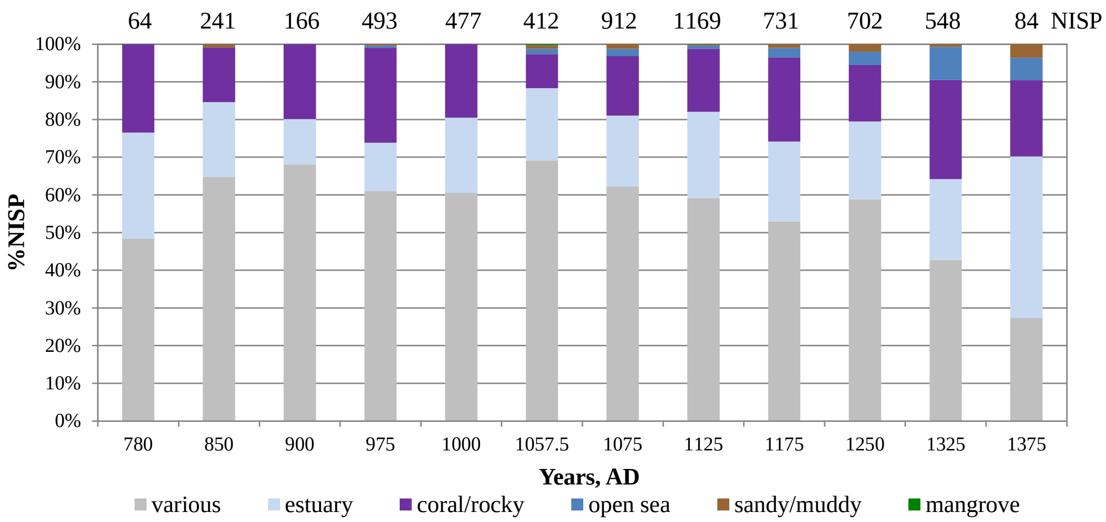


Figure 5.16: Chronological representation of fish habitats at Shanga
Total NISP per phase indicated at top. Data set from Horton and Mudida 1993.

Most of the fish represented in the Shanga assemblage are associated with inshore fishing; emperors (Lethrinidae) and parrotfish (Scaridae) make up 56% of the total identified fish at Shanga (Horton and Mudida 1993, 676). Species from the family Lethrinidae, which on average have a moderate trophic level of 3.61, increase after AD 1000. In the family Scaridae, *Leptoscarus vaigiensis*, which has a slightly higher trophic level than other species in its family, decreases over time, while *Scarus ghobban* increases at the end of the 13th century. Horton and Mudida (1993, 678) link changes in the representation of these species to the exploitation of different habitats; for example, *L. vaigiensis* is more commonly found in seagrass areas while *S. ghobban* is found near reefs. McClanahan and Omukoto's (2011) analysis of life history characteristics of the taxa from the Shanga fish remains suggests that earlier phases are composed of more nearshore species with longer lifespans, and later phases are composed of species that inhabit deeper waters and tend to have larger bodies; they associate these changes with the increasing use of offshore technologies. Thus, it appears that in the last phases of occupation at Shanga, fishers continued to exploit estuarine and coralline environments but also ventured farther offshore. This suggests that the change in MTL is due to changing fishing strategies or changing distributions of fish within the exploited habitats, possibly as a result of fishing pressure. Further analysis, such as comparing the average sizes of caught specimens throughout the phases of occupation at Shanga, could help us understand the changing characteristics of Shanga's fishery over time.

Discussion

Faunal remains reveal an important dietary shift around the end of the 12th century at Shanga and Chwaka, two Swahili settlements with comparable chronological data. Both show a downwards trend in the ratio of fish to domesticated animals. The decreasing importance of fish in diet at Shanga is accompanied by evidence of changing fishing strategies. A closer look at the chronological distributions of fish species reveals that there is a pattern of declining MTL at the same time as Shanga fishers are fishing in deeper waters. Additionally, off-shore fishing strategies that result in higher numbers of shark remains become especially widespread during the period of shifting diet around the 12th century, but not to the extent that it influences the overall downwards trend in MTL.

Paleoclimate data from three regional lakes provide evidence of a dry climate, interrupted by an abrupt wet period, during the 12th and 13th centuries (refer to Chapter 3). Although the link between regional and coastal climate trends is not well understood, a sudden shift between dry and wet conditions may have had an effect on coastal environments through the combined effects of erosion and runoff into the sea. An increased amount of sedimentation and decreased levels of salinity in the water due to river influx threaten the delicate balance of conditions needed for a viable coral reef (Wilkinson 1999; described in Chapter 3). The environment around Shanga, which lies at the mouth of three rivers, would be susceptible to this type of runoff. Such an event could increase reliance on other food sources, such as domesticated animals, or lead inshore fishers to resort to alternative strategies, such as going farther out to sea. Additionally, an onset of wet conditions during a drought period could create more favourable conditions for domesticated land animals that graze on green pasture, such as cattle, sheep, and goat.

The period of shifting diet during the 12th and 13th centuries occurs as both Chwaka and Shanga reach a peak in their development as coastal trading cities with increasing prestige and growing populations to feed. An increased consumption of domesticated animals could also be linked to these changing social conditions. Feasting is seen as an important practice through which elites in developing Swahili towns exercised political power during this period (Fleisher 2010). The consumption of cattle, goat, and sheep are considered an important part of these feasts.

5.6 Summary

It is generally accepted that inhabitants of the Swahili coast engaged in a combination of fishing, rearing of domesticated animals, and hunting, but how these activities varied across the region is not well understood. Zooarchaeological data on subsistence practices across the region are scattered across a few published and unpublished sources. I have compiled as many of these data samples into a single collective analysis of regional trends in order to provide a preliminary overview of subsistence practices on the Swahili coast. These data show that although there are similar marine environments along the coastline, the inhabitants of the various settlements exploited these habitats differently. Some of these differences are linked to environment, such as the exploitation of more estuarine fish at mainland and nearshore settlements where these resources are more abundant. Some differences are linked to culture, such as the relationship between open sea fishing and a high socio-economic class with more capital to invest in domesticated animals and boats. The regional analysis demonstrates that although the Swahili coastline contained settlements that shared basic characteristics, important differences among these settlements resulted from a combination of their particular cultural and environmental conditions. The following case studies provide a picture of intra-site patterns of fishing and subsistence strategies that show variability within single settlements.

Chapter 6: Songo Mnara Case Study

"Whatever may be the origin or antiquity of Songomanara, there is no doubt that the buildings still standing are of higher architectural attainments than anything in Kilwa, but that Kilwa was the power in the land."

-M.H. Dorman, 1938 (p. 70)

6.1 Introduction

On the surface, Songo Mnara embodies some of the key features of a typical Swahili town: a town plan of coral-stone architecture including a large structure called the palace and a decorated mosque. The preservation of clearly identified architectural boundaries makes this Swahili town a good case study to explore the use of space during its relatively short period of occupation.

This chapter discusses the environmental and historical context for the occupation at Songo Mnara. I outline the history of research in this region that shows that there is a gap in our understanding of the nature of occupation at Songo Mnara, particularly in relation to subsistence activities. I address this gap by trying to understand the role of food consumption and fishing at Songo Mnara through the analysis of faunal remains excavated across the town. I discuss intra-site subsistence patterns in relation to the local environment and society.

6.2 Songo Mnara in context

The daily lives of the inhabitants of Songo Mnara played out as part of the socio-political atmosphere as much as the environmental conditions of the world around them. This atmosphere can be reconstructed through our knowledge of the regional history of southern Tanzania and its relationship to the Swahili world. Current sources of environmental data around the Kilwa archipelago portray an image of the environmental conditions during the occupation of Songo Mnara, although further studies are needed to trace environmental changes over the last few hundred years. For example, the changing expanse of dense mangrove forests on the western side of the island is not well understood. However, information about the current environment shows the variety of environmental zones that could have been available for past exploitation.

Environment

The Kilwa Archipelago lies at the southern end of the Tanzanian coastline. Kilwa Kisiwani and Songo Mnara are the largest islands within the estuary at the mouth of three rivers: the Mavuji, Msekera and Gongo Rivers. Kilwa is separated from the mainland to the north by a deep (up to 60 m) channel known as the Kilwa Kisiwani Harbour and from Songo Mnara to the south by another deep channel called the Sangarungu Harbour (Pollard 2008a).

The environment surrounding Kilwa, Songo Mnara's neighbouring island, can be summarized as "inland sea covered by mangroves to the West and an open sea with a fringing reef to the East" (Nakamura 2011). The eastern side of Kilwa Island that faces the open ocean is characterized by a variety of environmental zones: cliffs and sandy beaches at the littoral fringe of the shoreline; wave-cut platforms, lagoons and fringing reefs on the eulittoral zone; and "sand terraces and spits with associated sandy littoral fringes [that] have formed in sheltered areas between bays, islands and where currents converge" (Pollard 2008). The environments around Songo Mnara Island follow a similar pattern: the eastern side contains sandy beaches and coral bluffs; the western side is dominated by mangrove forests (Figure 6.1) (Stoetzel 2011).

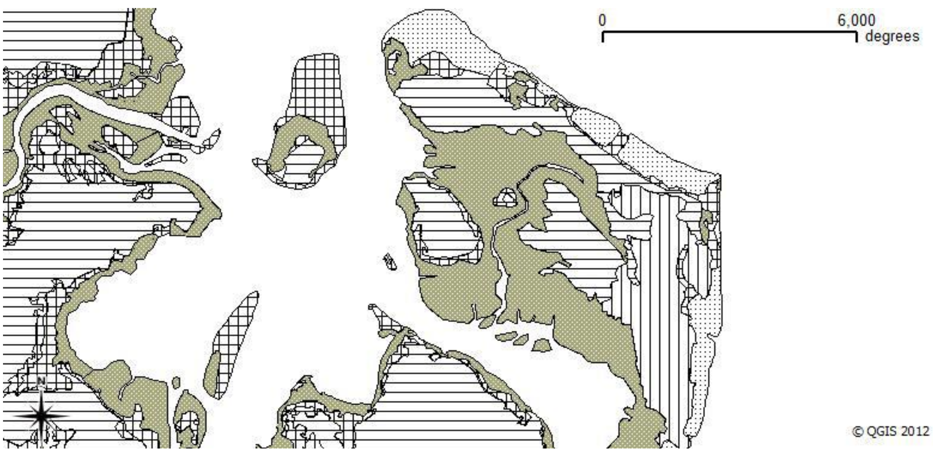


Figure 6.1: Environmental zones around Songo Mnara Island
Mangrove (black with white dots), Land Thicket (vertical stripes), Coral (white with black dots), Sand and Mud (checks), and Land Scrub (horizontal stripes)
(Stoetzel 2011: 10)

A deep understanding of the environmental zones around the island and the natural resources associated with each can help us connect particular subsistence strategies to the surrounding landscape. This has been successfully applied to the anthropological study of Kilwa fisheries by Nakamura (2011), which divides the marine environment around Kilwa into three ‘eco-zones’ that represent different sets of targeted marine resources with particular strategies and tools practiced by various groups within Kilwa society. Although the relationship between different ‘ethnic’ groups is over-simplified into ‘arab’ and ‘bantu’ groups, this study effectively captures spatial differences in marine subsistence strategies around the island and links them to social patterns visible in the organization of the village. This example of the application of ‘socio-ecological’ diversity introduces important questions such as the role of ecology in the formation of Swahili ports. A similar type of study can be applied to the parallel environmental areas around Songo Mnara island and extended to the past. The association of fish species to particular ecological zones (Chapter 3) and subsistence strategies serves to interpret the archaeological evidence of past marine resource use.

Historical background

The history of Songo Mnara can be traced through a series of projects carried out in the region that go back to the first half of the 20th century and link it to its glamorous contemporaneous neighbour, Kilwa. Early antiquarians were drawn to the area by the impressive standing coral-stone architecture on Kilwa. In his romanticized account of “The Kilwa Civilization and the Kilwa Ruins,” Dorman (1938, 61,64) describes Kilwa as an important trading port and dominating regional cultural centre that was founded by “a Persian adventurer” [Ali bin Husein] in the 10th century and ruled by a series of sultans who “derived extortionate revenues” by taxing the trade between the African hinterland and the Indian Ocean fringe. Dorman’s study is primarily a survey of the main architectural features of Kilwa and Songo Mnara. He makes an important distinction between the “number of distinct unconnected buildings, of varying ages and varying styles and purposes” at Kilwa and the ruins at Songo Mnara “of approximately one age and one style” (1938, 68). Dorman admits that little is known about the origins of Songo Mnara and concludes that it must have had close ties to its neighbour Kilwa. A few years later, Mathew (1959) published an essay on Songo Mnara from his archaeological survey of the Kilwa archipelago. His observations of the architectural features and ceramic types lead Mathew to conclude that Songo Mnara can be divided into two areas: Site A, which includes the Nabahani mosque, the palace, the watch tower/prison, concentrations of tombs, town wall, tower and a possible marketplace along with fine quality imported porcelain; and Site B, composed of three mosques, two wide gateways and a considerable number of small houses built in coral rag and older ceramic types but no porcelain (1959, 157). These early efforts to describe the ruins of Kilwa and its surrounding area were based mostly on architectural surveys and provide vivid descriptions of numerous coral-stone structures but little understanding of the history of this region.

The archaeology of Songo Mnara

The first extensive excavations and the busiest period of archaeological work in this area took place in the 1960s when Neville Chittick excavated Kilwa and Peter Garlake did an extensive survey of Swahili architecture, which contributed a detailed plan of Songo Mnara. It should be noted that also around this time, Freeman-Grenville (1962) studied the chronology of the Kilwa sultanate through its coinage and the *Kilwa Chronicles*, a pair of 16th century written accounts reconstructing the history of Kilwa. At the end of the 20th century, Sutton (1998) summarized the history of Kilwa through an overview of its architectural features, largely based on the earlier work by Chittick (1966; 1974) and Garlake (1966). The 14th century, he explains, was a particularly rich period in the region because of the rising demand for gold, which was linked to the adoption of gold coinage in Europe (1998, 113). Kilwa was a key node in the flow of gold coming from the Zimbabwe plateau through the more southern coastal town of Sofala. This 14th to 15th century "boom" saw a flourish of stone architecture at Kilwa, including the great palace known as Husuni Kubwa, and could perhaps be related to the establishment of Songo Mnara on the neighbouring island. Many of the town house walls at Kilwa were destroyed and reused in the construction of later buildings on the island, but at Songo Mnara, "the form of such fifteenth-century houses, as well as a town plan, are preserved" (1998, 115).

More recently, a team of French and Tanzanian researchers led a conservation project on Kilwa and Songo Mnara (Pradines and Blanchard 2005). Between 2002 and 2005, they surveyed the islands around the Kilwa Archipelago, including the island of Songo Mnara, and excavated nine trenches across the ancient town of Songo Mnara. They describe Songo Mnara as a small, 4 ha, town with clearly defined town limits that was abandoned towards the end of the 16th century (2005, 25). They found a relatively small amount of imported pottery compared to other Swahili towns, which led them to conclude that Songo Mnara was not directly involved in overseas trade. According to Pradines and Blanchard (2005), current evidence of farms and plantations on Songo Mnara Island show its potential use as a secondary supply centre for Kilwa, with Songo Mnara town established for the "notables de Kilwa" who oversaw the operation (2005, 25).

The culmination of over half a century of various archaeological endeavours at Songo Mnara has given us an image of a small town with a well-defined architectural plan of coral-stone structures that were occupied for a relatively short period around the 14th to 16th century. However, there is not a clear picture of who the inhabitants of Songo Mnara were and how they lived. The Songo Mnara story remained a mystery because these projects were conducted as part of larger archaeological ventures that focused on Kilwa and sought to understand Songo Mnara from the Kilwan perspective.

Only recently has Songo Mnara been a subject of research in its own right. Current excavations at Songo Mnara, led by Stephanie Wynne-Jones and Jeffrey Fleisher (Wynne-Jones and Fleisher 2010; Wynne-Jones and Fleisher 2011), take on a collaborative multi-disciplinary approach to investigate the nature of occupation at Songo Mnara. This project aims to understand the use of space across the town, looking at material culture associated with private and public areas. In addition to extensive excavations inside domestic structures and in open areas across the site, a team of researchers from various institutions have participated to address these aims through different methodologies including but not limited to micromorphology, magnetometry, macro- and micro-botanical studies, and zooarchaeological analysis. The combined perspectives resulting from these specialist studies are forming a more complete picture of what life was like in this ancient Swahili town.

Food subsistence and consumption in the Songo Mnara region

As I discussed earlier (Chapter 1), our knowledge of Swahili diet comes from a few examples of zooarchaeological research and the historical descriptions of foreign visitors to the coast. Unfortunately, previous archaeological projects in the region of Songo Mnara have produced little to no information about food subsistence and consumption. Dorman (1938: 64) describes a subsistence of "millets, rice, cattle and honey" at Kilwa, based largely on the historical accounts by early 16th century Portuguese visitors da Barros and Duarte Barbosa. He argues that Kilwa depended on its connections not only to sustain its richness, but also for its basic subsistence, since main food products were imported from the mainland (1938, 64). Behind the dazzle of riches at Kilwa, he adds, there were "the poorer classes, native slaves living in wooden or mud houses existing on millet, rice, different kinds of cultivated roots and a large quantity of wild fruit" (1938, 64). These historical notes indicate that the inhabitants at Kilwa exercised mixed subsistence strategies including both domesticated/cultivated products and wild/hunted ones. Interestingly, there is no mention of fish consumption or local fishing in Dorman's retelling of the historical accounts. Archaeological evidence of subsistence at Kilwa is limited because faunal remains were not systematically collected and analysed throughout the history of archaeological research in this region. In the publication of the Kilwa excavations, non-fish remains are identified and reported, but although fish remains were commonly excavated, they were not analysed (Chittick 1974). Recent anthropological work describes fishing as an important aspect of society on Kilwa Island (Nakamura 2011). At Songo Mnara, which has been less extensively excavated and lacks an associated body of historical records, there is no previous information about food consumption. However, large numbers of excavated fish remains from Kilwa and Songo Mnara attest to significant amounts of fish consumption in the past. Despite the wealth of information available in the form of fish remains, our historical knowledge of the nature and importance of fishing on these islands has been limited.

6.3 Methodology

Excavation summary

The town of Songo Mnara is primarily composed of a series of house complexes or 'blocks' surrounding a central open area that includes a small mosque, tombs and a walled cemetery (Wynne-Jones and Fleisher 2010, 2). The stratigraphy represents around 200 years of continuous occupation between the 14th and 16th centuries, currently dated using diagnostic ceramics but carbon samples have been collected for analysis. As part of the current project at Songo Mnara led by Wynne-Jones and Fleisher, I have undertaken the analysis of fish remains recovered from the on-going excavations across the settlement. The case study presented here represents the results of the material excavated in 2009 and is supplemented by my analysis of the other (non-fish) animal remains from the same contexts in order to get a complete picture of the diet and the relative importance of fish. Future analysis will continue to shape our understanding of fishing and food subsistence at Songo Mnara.

The 2009 excavation season at Songo Mnara focused on eight trenches from within domestic structures and another seven in select open areas (Wynne-Jones and Fleisher 2010; Fleisher and Wynne-Jones 2010) (refer to Figure 6.5 and Figure 6.11). A complete domestic structure, House 44, was excavated by placing a trench in each of the rooms (SM001, SM003, SM004, SM008, SM009, SM010). Another structure, House 23, was sampled in one room and the courtyard (SM014, SM015). In the realm of public space, two trenches were excavated outside the front entrance of each of the houses (SM002 by House 44, SM013 by House 23). Another three trenches investigated geophysical anomalies on the western (SM007, SM011) and central (SM005) areas of the town. Two other trenches were placed around coral-stone features in open areas: a tomb (SM012) and a well (SM006). Overall, these trenches represent more than just spatial variation across the site from their varied geographical positions, but also differences in private/public spaces and coral-stone/mud-thatch areas. These contextual differences provide the background for exploring differences in fish consumption, fishing and diet in significantly variable spaces throughout the town.

The excavations thus far have revealed interesting patterns in the use of private and public spaces. Artefacts associated with different activities, such as spindle whorls and cooking debris, were recovered from the interior rooms of Houses 44 and 23. House 44, which was fully excavated, showed concentrations of artifacts to the right of the doors in several rooms, indicating a particular practice of object disposal or storage (Fleisher and Wynne-Jones 2012). Excavations in open spaces showed evidence of stratified cultural deposits that may be associated with mud-thatch houses inside the town and cultural activities taking place around the well and by a tomb. Trench SM005, identified through high magnetometry readings, contained evidence of iron smithing in the central open space (Wynne-Jones and Fleisher 2010). Overall, the ratio of imported to local pottery sherds (<1%) excavated in 2009 at Songo Mnara was small compared to other Swahili towns; however, coins and beads were numerous probably as a result of the use of fine mesh-size to recover artefacts (2010, 7).

Recovery and identification of faunal remains

Animal remains, mainly in the form of bone fragments, were recovered from all contexts during excavation using 2 mm mesh sieves. The bones were separated and stored in labelled plastic bags according to Trench and Context. These bags were transported to the United Kingdom, where I separated the material into two main taxonomic groups: fish and tetrapods. I identified the fish remains with the aid of a comparative reference collection of Indian Ocean fish at the Muséum national d'Histoire naturelle (MNHN), Paris. I identified the tetrapod remains at the University of York using a basic collection of comparative skeletons of domesticated animals and wild birds. I took some unidentified elements, in particular the reptile remains, to the MNHN for further identification. The methods of analysis are those outlined in Chapter 2.

6.4 Summary of zooarchaeological analysis

A total of 6.2 kg of faunal material was collected during the 2009 excavations at Songo Mnara. The relative quantity of fish and other animals can be compared by weight for all trenches (Table 6.1).

Table 6.1: Comparison of non-fish and fish masses at Songo Mnara
~m^3=approximate volume of excavated trenches, T(g)/m^3=approximate density of finds
(analysed samples of non-fish remains marked in grey)

	Songo Mnara Weight (g) Comparison					
~m^3	Trench	Non-Fish	Fish	Total	%Total	T(g)/m^3
1.0	SM001	30.98	37.47	68.45	1.1%	68.5
2.0	SM002	22.22	65.46	87.68	1.4%	43.8
9.0	SM003	2.36	1.91	4.27	0.1%	0.5
10.6	SM004	18.73	6.98	25.71	0.4%	2.4
3.0	SM005	33.91	71.84	105.75	1.7%	35.3
5.3	SM006	280.38	278.36	558.74	9.0%	106.4
2.0	SM007	55.84	68.83	124.67	2.0%	62.3
10.6	SM008	38.87	39.06	77.93	1.3%	7.3
10.9	SM010	2128.58	1740.56	3869.14	62.4%	355.8
.8	SM011	27.19	43.93	71.12	1.1%	88.9
3.6	SM012	99.83	42.73	142.56	2.3%	39.6
.8	SM013	236.57	237.49	474.06	7.6%	592.6
2.0	SM014	2.59	2.98	5.57	0.1%	2.8
6.0	SM015	266.84	305.31	572.15	9.2%	95.4
	SM00x	11.45	0	11.45	0.2%	
	Total	3256.34	2942.91	6199.25	100.0%	
	%Total	52.5%	47.5%	100.0%		

Fish (T=2943 g; 47.5%) and non-fish (T=3256 g, 52.5%) remains share almost equal proportions of the total weight of faunal material. However, the remains are unequally distributed across the site, with over half of the weight coming from Trench SM010 (62%), followed by SM015, SM006 (both 9%), and then SM013 (8%). All other trenches have less than three percent each of the total weight of remains, which amounts to less than 12 percent overall. When size of the excavated trenches is considered, SM010 and SM013 have particulary high densities of faunal remains (Table 6.1). Furthermore, the relative percentage of fish to non-fish remains in each trench varies significantly. This pattern is explored further in a following section comparing spatial patterns of subsistence. I analysed the groups of fish and non-fish remains in more detail within their own categories. Analysis of fish remains included all fish cranial elements and a sample of vertebrae. Non-fish remains were further divided into groups of birds, mammals, reptiles, and unidentified fragments. The following paragraphs summarize the results in their respective categories.

Non-fish remains: tetrapods

The sample of non-fish material that I analysed beyond preliminary weight counts of fish and non-fish remains includes trenches SM010, SM011, SM013, SM014, SM015 (in grey in Table 6.1). This sample represents over 80 percent (T=2662 g) of the total non-fish weight and includes material from different categories of contextual space across the town. Tetrapod remains include all four-legged vertebrates; they make up 75 percent (T=1998 g) of the non-fish animal weight from the sample described above. Other non-fish animal remains include two fragments of crab exoskeleton and a large amount of unidentified fragments. The unidentified fragments are summarized in a section that follows.

Overall the tetrapod remains are composed primarily of domesticated animals such as chicken, sheep/goat, and cattle, but also include wild animals such as large lizards (*Varanus sp*.), wild birds, turtle and possibly dugong. A comparison of the total number of remains found in each taxonomic group shows that chicken (80 NISP) and sheep/goat (77 NISP) each make up around a quarter of the identified tetrapod remains (Table 6.2). They are followed by significant amounts of cattle (39 NISP) and rat (30 NISP) remains and smaller numbers of cat (7 NISP), monitor lizard (6 NISP), wild birds (5 NISP), and pig (2 NISP). A large amount of sea turtle remains (656 NISP) was found mostly in Trench SM010, where a sea turtle shell was recorded as a special find (Context 10036; Turtle= 520 NISP), and in the surrounding rich midden deposit (Context 10035) (Fleisher and Wynne-Jones 2010: 9). The turtle remains are not included in Table 6.2 so as not to skew the relative percentages of the other taxonomic groups. The following tables summarize the categories of tetrapod remains.

Table 6.2: Summary of tetrapod remains at Songo Mnara (excluding turtle remains), NISP=number of identified specimens

Taxonomic Group	NISP	%NISP
Chicken	80	26%
Sheep/goat	77	25%
Cattle	39	13%
Rat	30	10%
Large ungulate	21	7%
Med ungulate	11	4%
Med-large ungulate	10	3%
Dugong?	9	3%
Cat	7	2%
Monitor lizard	6	2%
Possible sheep/goat	4	1%
Wader bird	3	1%
Duck	2	1%
Small mammal	2	1%
Pig	2	1%
Small bovid	1	0%
Grand Total	**304**	**100%**

Table 6.3: Comparison of species richness of tetrapods at Songo Mnara (excluding turtle remains)

	SM010	SM011	SM013	SM014	SM015	Total
Total NISP	199	4	49	3	49	304
% of Total	65%	1%	16%	1%	16%	100%
Species richness	14	3	9	3	9	16

Table 6.4: Distribution of tetrapod remains (NISP) across Songo Mnara (the remains marked in grey are not included in totals of the tables above)

Class	Taxonomic ID	SM010	SM011	SM013	SM014	SM015	Total
Bird	Duck	2					2
	Wader bird			3			3
	Chicken	69	1	3	1	6	80
	Unid bird	52		17	1		70
Bird Total		123	1	23	2	6	155
Mammal	Cattle	32	2			5	39
	Sheep/goat	27		28		22	77
	Possible sheep/goat		1	2		1	4
	Small bovid	1					1
	Dugong?	9					9
	Cat	6		1			7
	Rat	23		1	1	5	30
	Pig	2					2
	Large ungulate	13		6		2	21
	Med ungulate	5		5		1	11
	Med-large ungulate	3				7	10
	Small mammal	2					2
	Unid mammal	26	12	34		13	85
Mammal Total		149	15	77	1	56	298
Reptile	Turtle	647		3		6	656
	Monitor lizard	5			1		6
Reptile Total		652		3	1	6	662

Trench SM010 has the highest abundance and species richness of tetrapod remains (Table 6.3). Most likely, these two factors are related; the number of taxa represented increases as the sample size increases (Bartosiewicz and Gál 2007). What is particularly interesting about SM010 is the high number of chicken (69 NISP) compared to the total of the analysed trenches (Total=80 NISP). Chicken is followed by cattle, sheep/goat and rat in relatively high proportions in trench SM010. Trench SM015 most closely resembles the pattern in SM010, with high proportions of chicken, cattle, sheep/goat and rat. However, the sheep/goat remains are much more dominantly represented than chicken. The relatively high number of large to medium sized ungulates could represent even higher percentages of sheep/goat and cattle. SM013 reflects this high proportion of sheep/goat and medium to large ungulates, but with lower proportions of chicken and rat. However, there is a larger number of bird remains in SM013 (23 NISP) than in SM015 (6 NISP) when unidentified birds are considered (Table 6.4). The numbers of non-fish remains in both SM011 and SM014 are too low to describe in detail, but they can be considered in relation to the patterns of fish remains (Table 6.1). SM014 in particular, has a very low number of faunal remains in general: 0.1% of the total mass of the faunal remains from all units. Although the amount of faunal remains in SM011 is relatively low, it shows a larger amount of fish remains mass than other fauna that could indicate a diet dominated by fish.

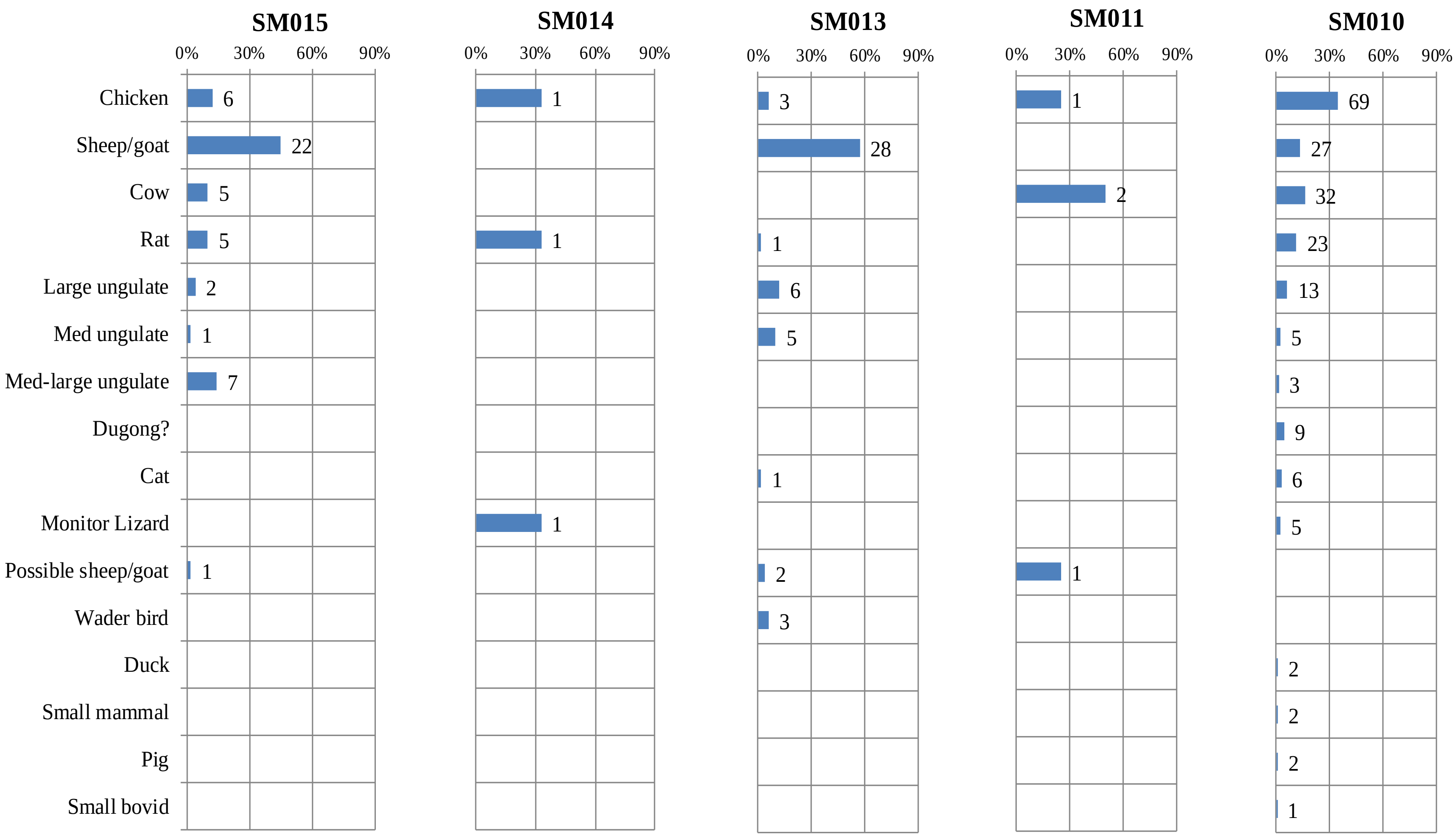


Figure 6.2: Relative proportions of tetrapods in SM010, SM013, and SM015 (excluding turtle). Number of identified specimens at end of bars

The actual spatial relationships among the trenches considered above reveals some interesting patterns. SM010, the back room of House 44, and SM015, the central room of House 23, share similar proportions in the composition of tetrapod remains that reflect a diet composed mainly of domesticated animals. Both trenches associated with House 23, SM015 and SM013 (the monumental steps outside House 23), share a similar pattern of high numbers of domesticated bovid remains. The percentage of rat remains is particularly high in areas associated with domestic space, inside Houses 44 and 23. Most likely these rat bones represent the remains of house pests rather than a tasty snack. SM014, the courtyard in House 23, contained very low numbers of faunal remains, a pattern that holds true for all other finds and seems to indicate that this space was kept clean (Fleisher and Wynne-Jones 2010: 29). Finally, SM011 shows a different pattern of food consumption with a heavier reliance on fish, which could be related to its position outside the area of coral-stone houses. SM011 was excavated in an open area in the western half of Songo Mnara that has been associated with mud-thatch houses (Fleisher, pers. comm.). The differences between these various types of spaces are investigated further in the analysis of fish remains.

<u>Fish remains: overview</u>

In total, the fish remains compose around half of the total mass of faunal remains (Table 6.1). This material was divided into four groups and weighed per context: nonvertebrae, vertebrae, unidentified spines, and unidentified fragments (UFR). Unidentified spines and fragments were not counted but can be compared by mass to the other categories of remains (Figure 6.3, Table 6.5).

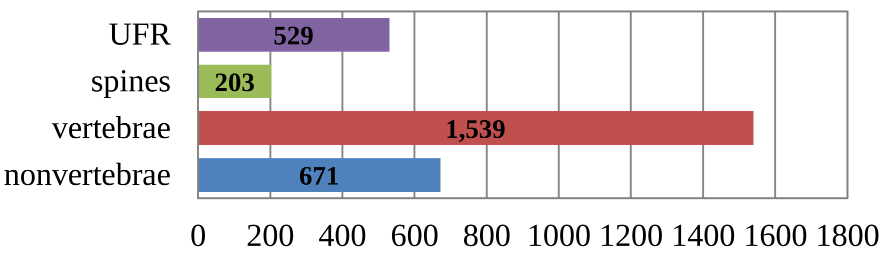


Figure 6.3: Fish remains categories from Songo Mnara (grams) UFR=unidentified fragments

Table 6.5: Fish remains categories from Songo Mnara (grams)
UFR=unidentified fragments
(analysed samples in grey)

Trench	nonvertebrae	vertebrae	spines	UFR	Total
SM001	3.77	14.49	3.79	15.42	37.47
SM002	4.90	28.51	2.59	29.46	65.46
SM003		0.89		1.02	1.91
SM004	1.65	2.94		2.39	6.98
SM005	2.01	65.19		4.64	71.84
SM006	46.70	157.37	1.68	72.61	278.361
SM007	13.95	34.01	0.83	20.04	68.83
SM008	2.68	29.91		6.47	39.06
SM010	435.50	843.44	174.08	287.53	1740.56
SM011	5.74	37.20	0.72	0.27	43.93
SM012	2.24	37.65	1.55	1.29	42.73
SM013	63.53	136.49	14.18	23.29	237.491
SM014	1.22	0.47	0.11	1.18	2.98
SM015	87.60	150.36	3.48	63.87	305.31
Total	671.49	1538.92	203.01	529.48	2942.91

The identified material included mainly cranial and appendicular bones, as well as other special diagnostic bones from other parts of the fish skeleton. I analysed this category of material from all the contexts, which made up around 23 percent of the total mass of fish remains (Figure 6.3). The vertebrae, spines and other unidentified elements were weighed for each context. I analysed all of the vertebrae from Trench SM010, which made up around 55 percent of the total mass of vertebrae. Overall, I analysed over half of the total mass of fish remains (marked in grey in Table 6.5). Additionally, I counted all of the shark and ray vertebrae from all contexts.

Overall there was little evidence of modifications on fish remains, such as traces of cutting and burning (Figure 6.4). Only 5 fish remains had cutmarks, and 201 fish remains showed traces of burning. Burned remains consisted mostly of vertebrae found in contexts associated with cooking debris. Additionaly 14 bones showed signs of hyperostosis, but I was not able to identify which fish taxa or elements they represented.

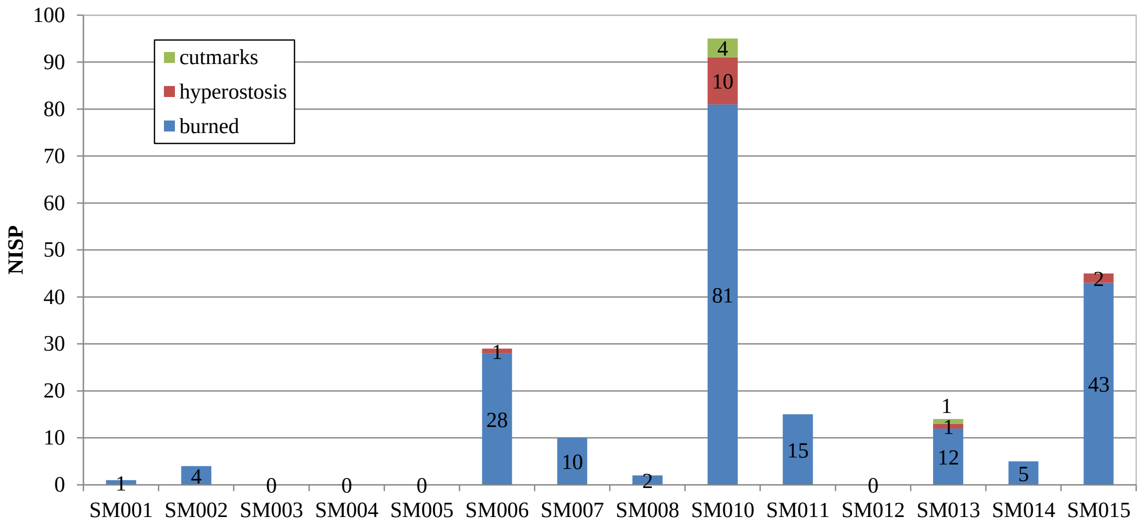


Figure 6.4: Summary of fish remains modifications from Songo Mnara (numbers indicate NISP per category)

Fish remains: nonvertebrae

The category of nonvertebrae fish bones includes cranial and appendicular elements as well as other diagnostic bones, such as the dorsal spines of the Balistidae fishes. The majority of spines were not identified because they did not have particularly diagnostic features and were included in the category of unidentified spines described above. At least 24 fish families are represented in the 987 fish remains in the category of nonvertebrae. They can be ranked in order of importance by the number of remains represented (Table 6.6). In the first order, Lethrinidae, Serranidae and Carangidae each makeup close to 20 percent of the total remains. The second order of fish families includes Sparidae, Lutjanidae, Haemulidae and Scaridae, all together representing 33 percent of the total. The final order includes 17 fish families that comprise 10 percent of all the remains. The data show a wide range of exploited fish but also predominance of certain fish families.

Table 6.6: Fish families represented in Songo Mnara by nonvertebral elements

Family	NISP	%Total
Lethrinidae	198	20.1%
Serranidae	187	18.9%
Carangidae	173	17.5%
Sparidae	92	9.3%
Lutjanidae	85	8.6%
Haemulidae	79	8.0%
Scaridae	70	7.1%
Balistidae	25	2.5%
Sphyraenidae	17	1.7%
Acanthuridae	12	1.2%
Gerreidae	8	0.8%
Tetraodontidae	7	0.7%
Platycephalidae	6	0.6%
Chirocentridae	5	0.5%
Scombridae	5	0.5%
Terapontidae	5	0.5%
Diodontidae	3	0.3%
Muraenidae	2	0.2%
Siganidae	2	0.2%
Carcharhinidae	2	0.2%
Ariidae	1	0.1%
Belonidae	1	0.1%
Labridae	1	0.1%
Mugilidae	1	0.1%
Total	987	100.0%

Of the 987 fish remains in this category, 232 (24%) were identified to species level. It was possible to identify the remains at this precise level because I was able to compare among a large array of species from various families represented in the reference collection at the Muséum national d'Histoire naturelle (MNHN), Paris. The list of 42 identified fish species is topped by *Carangoides fulvoguttatus* (19%), followed by *Lethrinus lentjan* (10%), *Cephalopholis argus* (7%), and *Lethrinus nebulosus* (5%) (Refer to Appendix G for full list of species). The identification of such a wide range of fish species is not uncommon in other examples of analysed fish remains from the Swahili coast (e.g., Chwaka=31species in Fleisher 2003; Shanga=46 species in Horton and Mudida 1993). The large number of identified species reflects the rich biodiversity of the marine habitats along the East African coastline and the fishers' ability to exploit these. This section is only an outline of the major fish family groups found at Songo Mnara. Fish species can be used to infer which habitats were exploited around the island and what fishing methods were used. Differences in fishing consumption and subsistence strategies are used to show social organization at Songo Mnara. The distribution of the identified fish species is explored in a section that follows.

Fish remains: vertebrae

The sample of analysed vertebrae included all vertebrae from Trench SM010. This sample was chosen because of its large sample size in order to investigate which fish taxa were underrepresented in the nonvertebrae category of cranial and appendicular elements. A total of 1981 vertebrae were identified to at least family level, of which 194 (10%) were identified to species level. Six families that were not identified in the nonvertebrae category were represented in the vertebrae: Elopidae, Dasyatidae, Monodactylidae, Albulidae, Chanidae, and Mullidae. Similarly, four families represented in the nonvertebrae category were not represented in vertebrae: Tetraodontidae, Terapontidae, Diodontidae, and Ariidae. I identified 11 additional fish species from the vertebrae analysis (Table 6.7). This level of precision was possible by carefully comparing the all species within each family represented in the reference collection. Taking into account the sample of vertebrae, there are at least 30 fish families and 53 fish species represented at Songo Mnara.

Table 6.7: Fish species identified in sample of vertebrae from Songo Mnara (SM010) (species identified from vertebrae only marked in grey)

Family	Genus	Species	NISP
Carangidae	*Scomberoides*	*tol*	40
Scombridae	*Euthynnus*	*affinis*	39
Carangidae	*Carangoides*	*fulvoguttatus*	21
Platycephalidae	*Papillo*	*longiceps*	18
Carangidae	*Selar*	*crumenophthalmus*	15
Siganidae	*Siganus*	*sutor*	15
Gerrreidae	*Gerres*	*longirostris*	14
cf. Monodactylidae	*Monodactylus*	*argenteus*	7
Mugilidae	*Mugil*	*cephalus*	5
Chanidae	*Chanos*	*chanos*	4
Chirocentridae	*Chirocentrus*	*nudus*	4
Siganidae	*Siganus*	*stellatus*	3
Serranidae	*Variola*	*louti*	2
Monodactylidae	*Monodactylus*	*argenteus*	1
Lutjanidae	*Lutjanus*	*sanguineus*	1
Lutjanidae	*Lutjanus*	*sebae*	1
Scaridae	*Calotomus*	*carolinus*	1
Grand Total			191

The additional families and species identified in the vertebrae sample highlight the value of analysing vertebrae in addition to cranial elements. These results can also be used to predict which fish are under/over-represented in the sample of cranial and appendicular elements (Figure 6.5). The families represented in each category of data, vertebrae and nonvertebrae, were put in order according to the highest number of remains and ordered accordingly. Families with the same number of remains received the same ranking number. The orders were compared by obtaining the difference between the two ordered categories. This way a fish family that is ranked similarly in both categories has a score close to zero and a family that is ranked highly in one category and not in the other has a larger score. The graph expresses these differences in order from smallest to largest. The category that best represents that family is signalled by its negative or positive score. Families that were unique to one of the categories, a total of six, were given a rank number of 60. This number allows us to compare these families by differences in ranking while setting them apart from the rest of the family groups that are represented in both categories. The six 'uniquely represented' families are marked on the graph with a yellow dot instead of a blue dot.

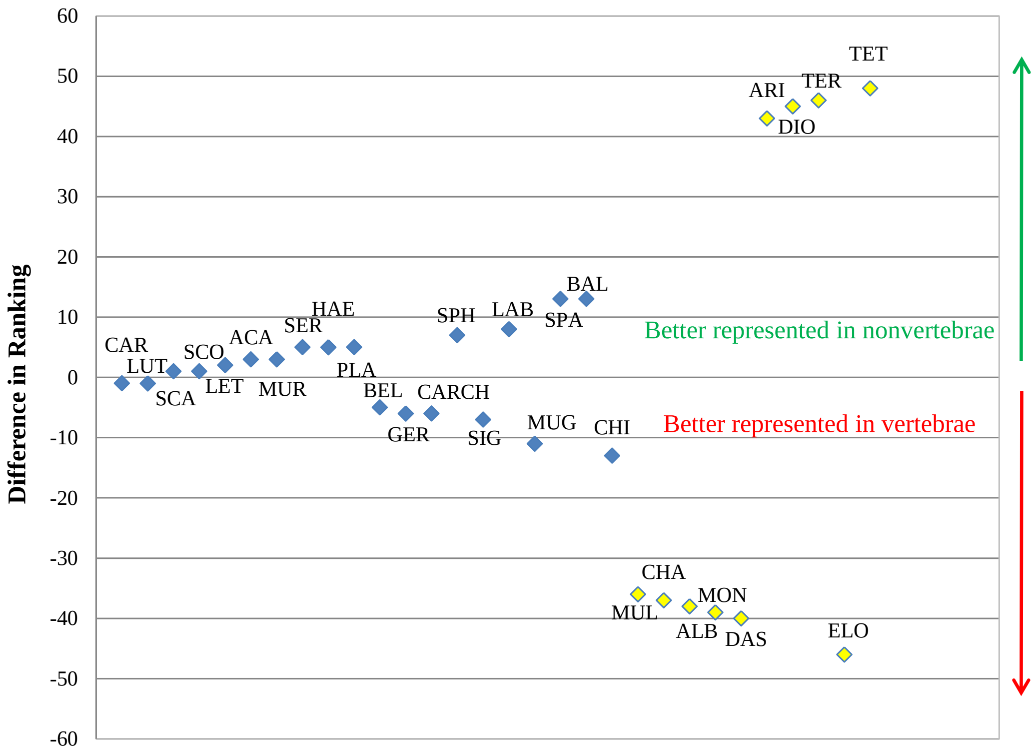


Figure 6.5: Rank difference analysis for identified fish families from Songo Mnara
The graph compares differences in the representation of fish families (ranked from most to least common) in two categories of identified fish remains: vertebrae vs. nonvertebrae. The families closest to zero are most equally represented in both sample categories while those represented by yellow dots were identified only within their own category.

The results of the rank difference analysis show 16 families that are well represented by both vertebrae and nonvertebrae elements. These include the three most common families in the nonvertebrae category described above: Lethrinidae, Carangidae and Serranidae (Table 6.6). It is important to note that the analysis does not show *where* a fish family is ranked in either category. Carangidae, for example, has a score of one, indicating that it is closely ranked in both categories of data, but the graph does not show whether it is very prevalent in both cases or not. Four families fall within the 10 to 20 range in rank difference. Of these, Mugilidae and Chirocentridae are better represented in vertebrae and Sparidae and Balistidae are better represented in the nonvertebrae category. This pattern is not surprising given that Sparidae (breams) and Balistidae (triggerfish) have more robust cranial elements and less identifiable vertebrae. Chirocentridae (wolf herrings) have very elongated bodies that contain a larger sum than average of vertebrae. Mugilidae (mullets) have easily distinguishable vertebrae but relatively small and fragile cranial bones. On the extreme end of fish identified only by vertebrae, Elopidae (ladyfish) has an elongated body with many vertebrae (around 80 per individual). Other fish in this extreme also have characteristically elongate bodies: Albulidae (bonefish), Chanidae (milkfish), and Mullidae (goatfish). At the other extreme, Tetraodontidae (puffers) and Diodontidae (porcupinefish) have easily identifiable unique and robust cranial elements.

Vertebrae are also important in identifying the consumption of cartilaginous fishes such as shark and ray. Because most of their skeletal elements made of cartilage decompose easily, these fishes are represented in the archaeological record mainly by teeth and vertebrae. Shark and ray vertebrae are easily distinguished from bony fish vertebrae by their form, but they are also very difficult to identify more specifically. I did not attempt to identify the shark and ray remains beyond family level. A total of 349 shark vertebrae and 66 ray vertebrae where found at Songo Mnara. These are generally believed to represent members of the Carcharhinidae (requiem shark) and Dasyatidae (whiptail stingray) families. Otherwise, only two shark teeth provide evidence for the presence of these cartilaginous fishes at Songo Mnara. I discuss the distribution of shark and ray vertebrae across Songo Mnara in a section below.

Although vertebrae are seldom analysed because they are notoriously more abundant and difficult to analyse, they provide important information about the types of fish represented in the assemblage. In Songo Mnara, the analysed vertebrae sample added fish taxa that were not identified in the analysis of non-vertebral elements (see Table 6.8 for a full list of fish families identified from all elements in trench SM010). A comparison of fish family representation between analysed vertebral and non-vertebral elements demonstrates which families were better identified in each category. The results can be used to predict which fish might be underrepresented in other contexts where only non-vertebral elements were analysed.

Table 6.8: List of fish families represented in all identified elements from SM010

Family	NISP
Carangidae	321
Lethrinidae	313
Serranidae	274
Chirocentridae	265
Lutjanidae	232
Scaridae	155
Gerrreidae	148
Haemulidae	144
Mugilidae	130
Siganidae	97
Carcharhinidae	94
Sparidae	94
Belonidae	85
Acanthuridae	57
Sphyraenidae	52
Scombridae	46
Elopidae	44
Platycephalidae	38
Muraenidae	26
Balistidae	21
Dasyatidae	20
Monodactylidae	10
Albulidae	9
Chanidae	4
Terapontidae	4
Labridae	2
Mullidae	2
Tetraodontidae	2
Ariidae	1
Diodontidae	1
TOTAL	2691

Non-fish remains: unidentified fragments

Of the 2662 g of non-fish remains sampled for more detailed analysis, approximately 25 percent of the mass was composed of unidentified fragments (651 g). This mass of fragments was divided into size groups that show a high level of fragmentation (Table 6.9).

Table 6.9: Summary of size classes of unidentified fragments (UFR) from Songo Mnara (grey text represents samples with insufficient data for analysis)

Trench	≤3cm		>3cm		Total UFR
	(g)	%	(g)	%	
SM010	356	72%	136	28%	492
SM011	8	100%	0	0%	8
SM013	48	68%	22	32%	70
SM014	0	0%	<1	100%	<1
SM015	61	76%	20	24%	81
Total	473	73%	178	27%	651

Over 70 percent of all the unidentified fragments (UFR) have a maximum dimension that is less than 3 cm. This pattern is seen across all analysed samples with sufficient data. Even rates of fragmentation indicate comparable levels of preservation in the analysed trenches at Songo Mnara.

6.5 Comparison of spatial patterns of subsistence

This section explores spatial differences in exploited marine habitats around the island and links them to social patterns visible in the organization of Songo Mnara. I investigate subsistence patterns across the town by organizing the 15 trench locations into significant social spaces (Figure 6.6). The areas of excavation include domestic structures and open spaces across the town. House 44 and House 23 represent the areas associated with two coral-stone structures. Trenches SM007 and SM011 are located on the western side of the town, which has been associated with mud-thatch houses. Trenches in open spaces are located in a central open area (SM005), around a tomb (SM012), and around a well (SM006). These excavation units represent differences in private/public spaces and coral-stone/mud-thatch areas, which provide the background for exploring fish consumption trends. In the following subsections, I analyse spatial patterns of subsistence by comparing fish and non-fish remains, fish size and exploited marine habitats around Songo Mnara.

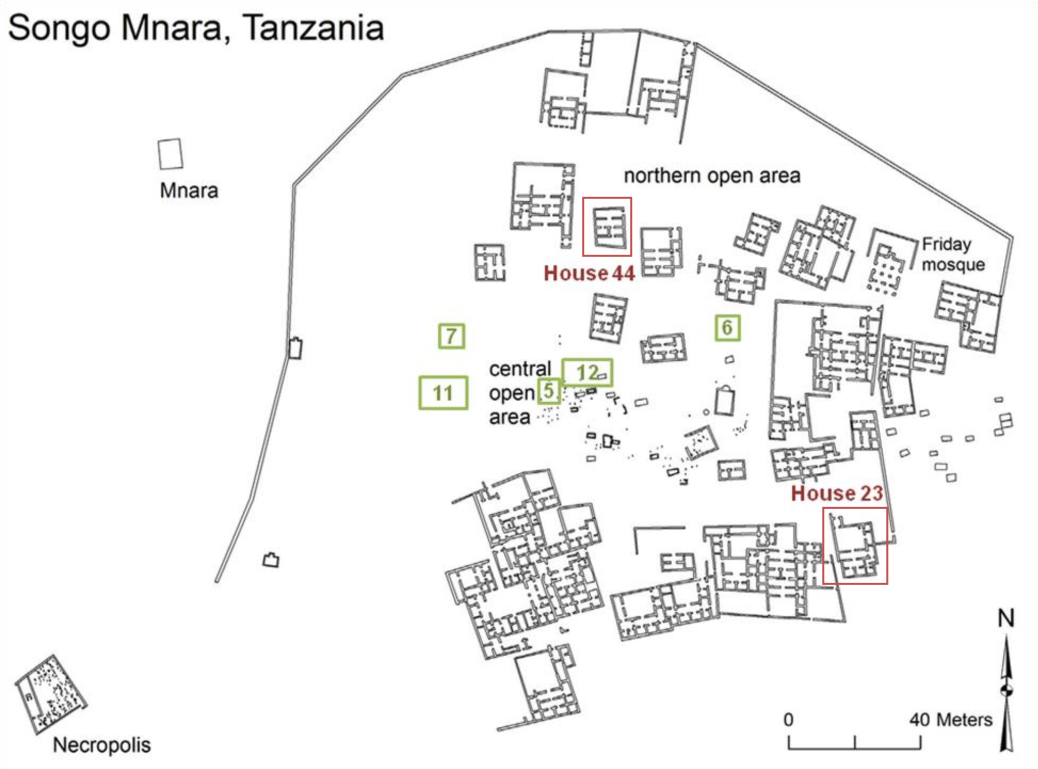


Figure 6.6: Excavated areas around Songo Mnara
Enclosed areas marked in red and open areas marked in green.

Fish to non-fish comparison

I use weights to compare the representation of fish and non-fish remains in all of the excavated areas. This measure (g) was chosen because it includes all the faunal material excavated in 2009: fish (T=2943 g; 47.5%) and non-fish (T=3256 g, 52.5%). Although the total fish and non-fish material is almost equally divided, their relative proportions vary significantly in different areas of the town. The relative importance of fishing over other subsistence strategies is evident in the proportions of fish to non-fish weight per trench, which ranges from 30 to 70 percent (Figure 6.7). It appears that the areas with the highest proportion of non-fish remains are associated with coral-stone structures. The area around a tomb, SM012, has the highest percentage of non-fish weight, followed by House 44 and the area around the well, SM006. Among the areas where fish weight dominates, the central open area, SM005, has the highest percentage of fish, followed by the two areas associated with mud-thatch dwellings, SM007 and SM011. House 23, the other coral-stone dwelling, has only a slightly higher percentage of non-fish weight than the mud-thatch area represented by SM007. This comparative analysis is used to show the relative representation of fish to non-fish remains across the town.

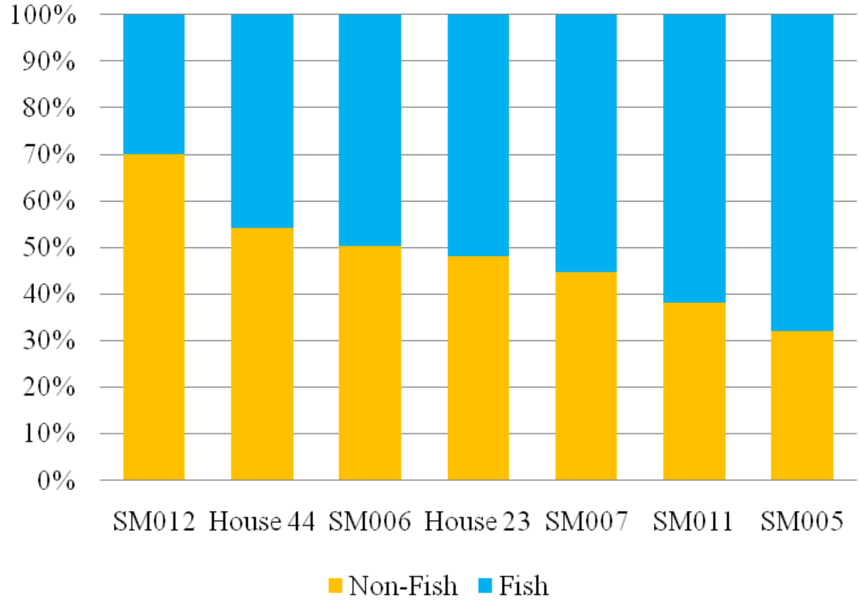


Figure 6.7: Comparison of fish and non-fish weights per trench at Songo Mnara

Fish size

I estimated the size (kg) of the fish represented by each element during the process of identification using a comparative reference collection of Indian Ocean fish. Reference specimens have associated lengths and weights for the whole fish. I used the known total weight of the reference specimens to make a rough estimate of the size of the fish represented by each archaeological element. This estimation was carried out for 675 elements identified to near species level (identified to species or closely resembled an identified species). These were divided into size categories based on weight. I plotted the distribution of sizes represented in each excavated area to compare fish size variation across Songo Mnara. House 44, Trench SM006, and House 23 have higher percentages of large-sized fish, particularly House 23 (Figure 6.8). The largest fish represented were found in House 23. Two elements, a vomer and quadrate, represent a large snapper of the genus *Lutjanus* with an estimated weight of 15 kg. At least two species of snappers that reach this size are found in the Western Indian Ocean: *Lutjanus sebae* with a maximum published weight of 32.7 kg, and *Lutjanus sanguineus* with a maximum published weight of 23.0 kg (Froese and Pauly

2012). *Carangoides fulvoguttatus* fills the range of all 7 to 12 kg-sized fish represented at Songo Mnara. This fish has a maximum published weight of 18.0 kg and is present in the Indian Ocean waters along the East African coast (Froese and Pauly 2012). Other families represented with weights over 5 kg include Serranidae, Scaridae, Sphyraenidae and Ariidae. The grand majority (82%) of fish families were less than 4 kg. The smallest size interval (<1 kg) was dominated by Lethrinidae (36%) and Serranidae (22%) species. These results do not include the cartilaginous fishes, such as shark, which also tend to be large in size. These are represented by vertebrae and are described below.

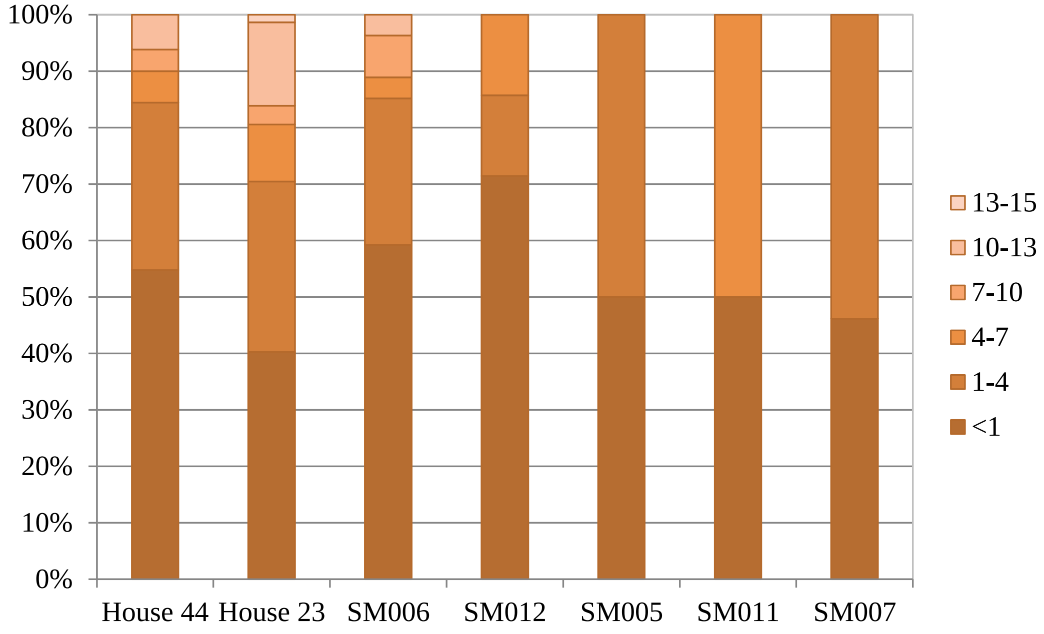


Figure 6.8: Distribution of fish size groups (kg) across Songo Mnara

<u>Shark and ray</u>

A total of 349 shark vertebrae and 66 ray vertebrae were analysed for spatial distribution at Songo Mnara. The number of vertebrae in each excavated area was plotted, showing large sums of shark and ray vertebrae associated with House 44, the well (SM006), and House 23 (Figure 6.9). These vertebrae are particularly well represented in certain areas within the coral-stone structures: the back room of House 44 and the monumental steps in front of House 23. The other trenches have considerably fewer numbers of shark and ray vertebrae. The concentrations of shark and ray vertebrae in these areas could have formed part of food waste middens or could be related to processing. During my ethnoarchaeological research at Vanga (Chapter 4), I noted that shark and ray meat were often salted and dried to preserve the large quantities of flesh that came from these often hefty animals.

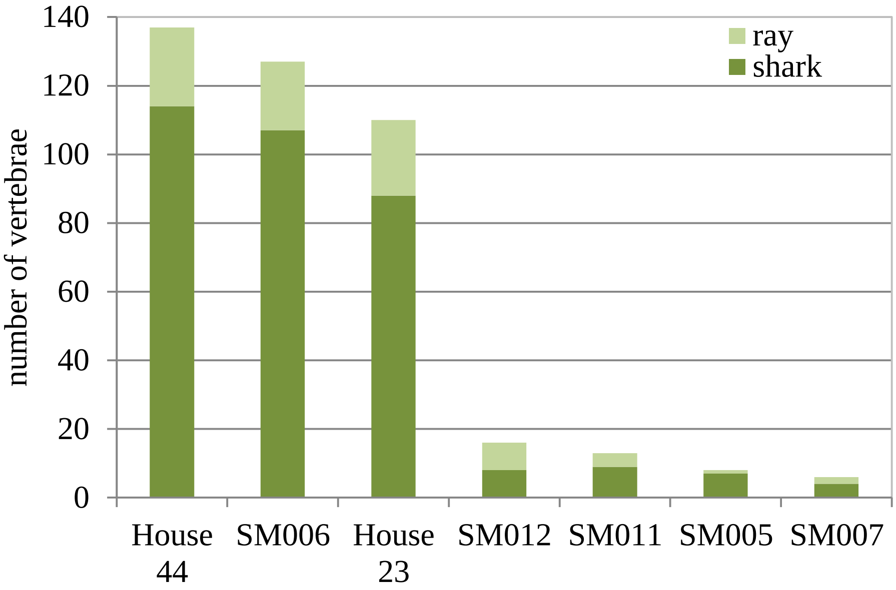


Figure 6.9: Distribution of shark and ray vertebrae across Songo Mnara

The majority of shark and ray vertebrae were <1 cm (78%) or 1-2 cm (21%) in diameter. Only one percent (5 NISP) had a 2-4 cm diameter. These were found in the central open area (SM005), the front room of House 44 (SM008), the mud-thatch area (SM011), and the central room of House 23 (SM015). Unlike bony fish, the vertebrae in an individual shark or ray are smaller when they are closer to the tail. Thus, it is not surprising that small vertebrae are so abundant. Additionally, this makes it harder to estimate the size of these cartilaginous fishes. However, the five vertebrae recovered measuring 2-4 cm in diameter indicate that large individuals were captured. Interestingly, the large vertebrae were not recovered from the areas with large quantities of smaller shark and ray vertebrae. Perhaps these large vertebrae had a value beyond their association with food. For example, some vertebrae, both large and small, show wear through the middle of the centrum, creating an orifice that could be used to string them on thread like beads (Figure 6.10). The inhabitants of Songo Mnara may have purposefully separated the large vertebrae from the bulk of smaller ones, endowing them with a different social meaning.

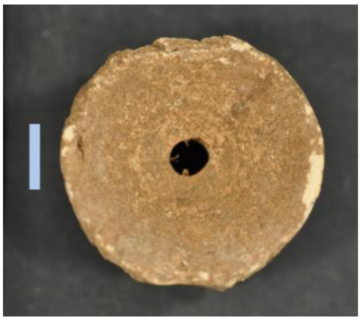


Figure 6.10: Large shark vertebrae with hole through centrum
Context SM011001; 36.56 mm diameter

For the archaeologist, shark could represent more specialized fishing methods because of their large size and offshore habitat. The presence of these fish is often indicative of offshore fishing with large sized boats. At the town of Shanga, in the northern Kenyan coast, evidence for shark first appears around the 12th century (Horton and Mudida 1996, 380). Significant quantities of shark vertebrae at Songo Mnara indicate that 14th to 16th century fishers in this area participated in offshore fishing.

Fish habitat

Spatial analysis of fish habitat exploitation included all cranial and appendicular fish elements identified to near species level. The analysis included the same set of 675 fish remains that formed part of the size group analysis above. I categorized the 65 near species according to the main environmental zone they inhabit (refer to Chapter 3 on fish ecology). Fish species that inhabit several zones fell in the 'various' category. The general pattern of fish habitat analysis shows that the inhabitants of Songo Mnara exploited the range of environmental areas around the island (Figure 6.11). There is a high abundance of fish that are mainly found in coral areas (48%), followed by mixed (23%), sand and mud (13%), mangrove (10%) and estuary (5%) habitats. Only one percent of the bony fish species represented were mainly found in the open sea. These were two species retrieved from House 44: *Katsuwonus pelamis*, and *Euthynnus affinis*. These two Scombridae (tunas) are ocean migratory species.

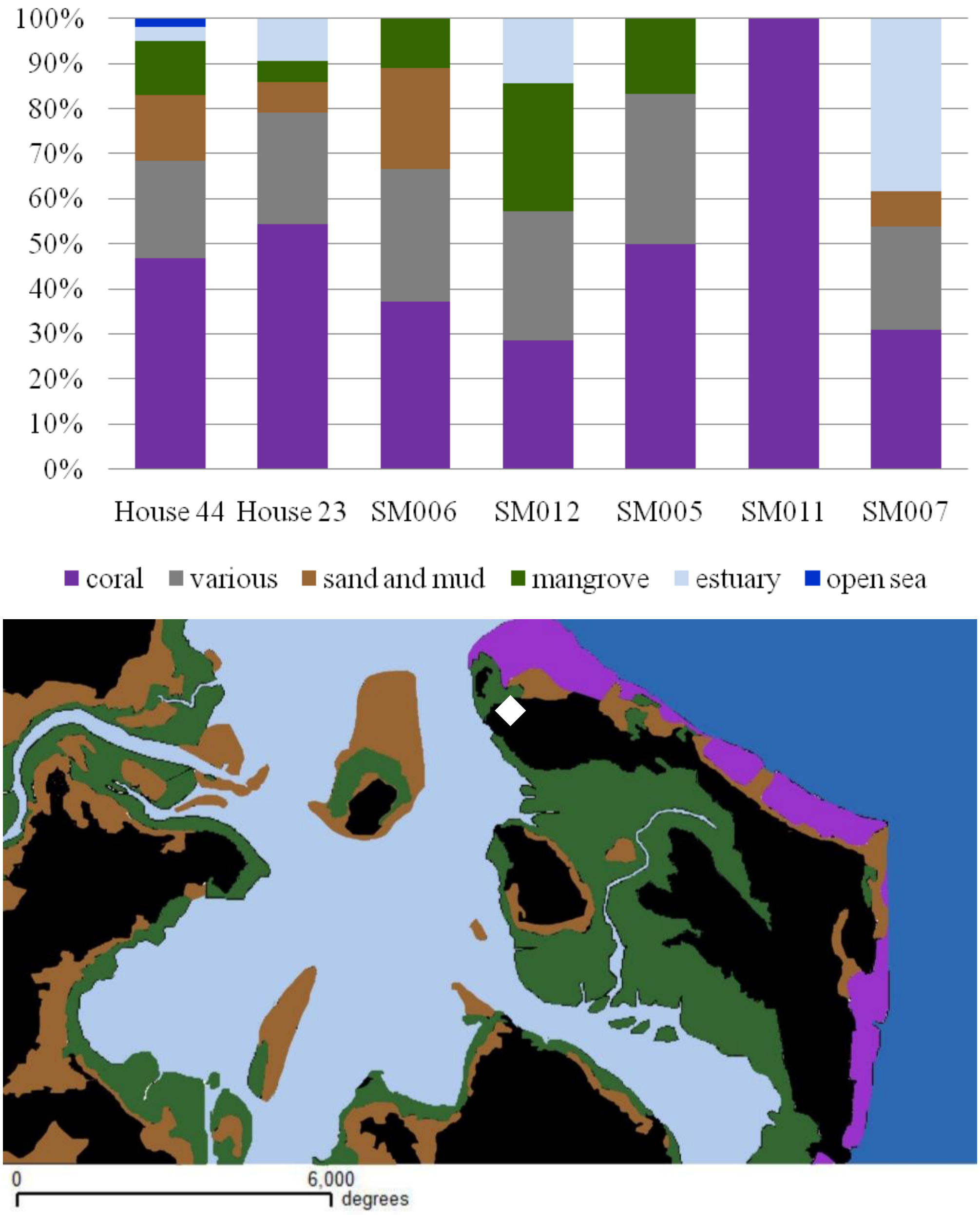


Figure 6.11: Distribution of exploited marine habitats around Songo Mnara Island (the white diamond marks the location of Songo Mnara town)

The results of these analyses suggest that fish from the diverse near-shore habitats around the island were consumed across Songo Mnara. It is likely that the nearby coral reef on the eastern side of the island was an important fishing resource. The diversity of these marine environments is reflected in the variety of fish families identified, 30 at the least. While it appears that inhabitants across town had access to these various resources, I have identified differences in consumption patterns between mud-thatch and coral-stone house areas of Songo

Mnara. The mud-thatch house area (SM007 and SM0011) is characterized by larger percentages of fish than non-fish. The fish in this area tend to be smaller, less than 5 kg. Fewer shark and ray vertebrae were recovered in this area. In contrast, the coral-stone house area (House 44, House 23, SM006, SM012) has higher percentages of non-fish remains compared to fish. The fish that are found have a larger range in size, with significant numbers of 10 to 15 kg fish. Larger fish are also represented by higher numbers of shark and ray vertebrae in this area. Additionally, two oceanic species of tuna are represented in House 44.

Consumption patterns within Houses 44 and 23

Two excavated houses at Songo Mnara provide comparative data about the distribution of food consumption activities within households. House 44 is a small house with a simple layout that is representative of the northern area of town, while House 23 is a more complex domestic structure typical of the southern part of Songo Mnara (Wynne-Jones and Fleisher 2010, 4). Faunal remains were retrieved from contexts representing various spaces around House 44 and House 23, showing that food debris is concentrated in particular areas of the houses (Figure 6.12). Around 90 percent of the total mass of faunal remains from House 44 (4.6 kg) was found in a midden in the back room. The total mass of excavated animal remains was smaller at House 23 (1.2 kg), where the excavations were less extensive. Three samples from House 23 revealed that 45 percent of animal remains came from the front monumental steps and 55 percent from an interior room of the house; the remaining 5 percent came from a central courtyard. The distribution of shark and ray vertebrae also shows an interesting pattern, with higher concentrations found in the back room of House 44 (114 NISP) and the front steps of House 23 (85 NISP) (Figure 6.13).

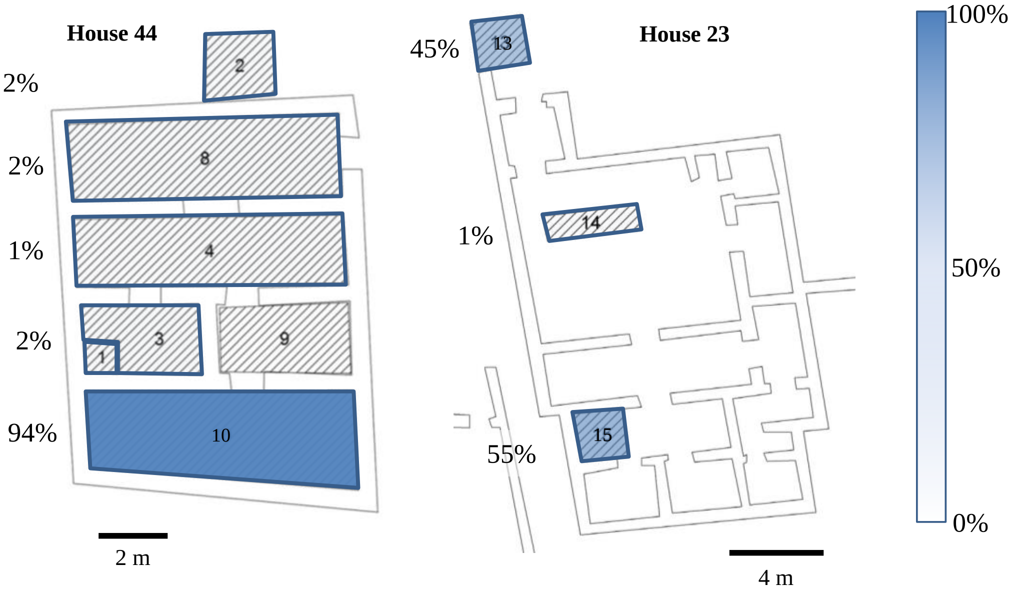


Figure 6.12: Concentration of mass of faunal remains around Houses 44 and 23

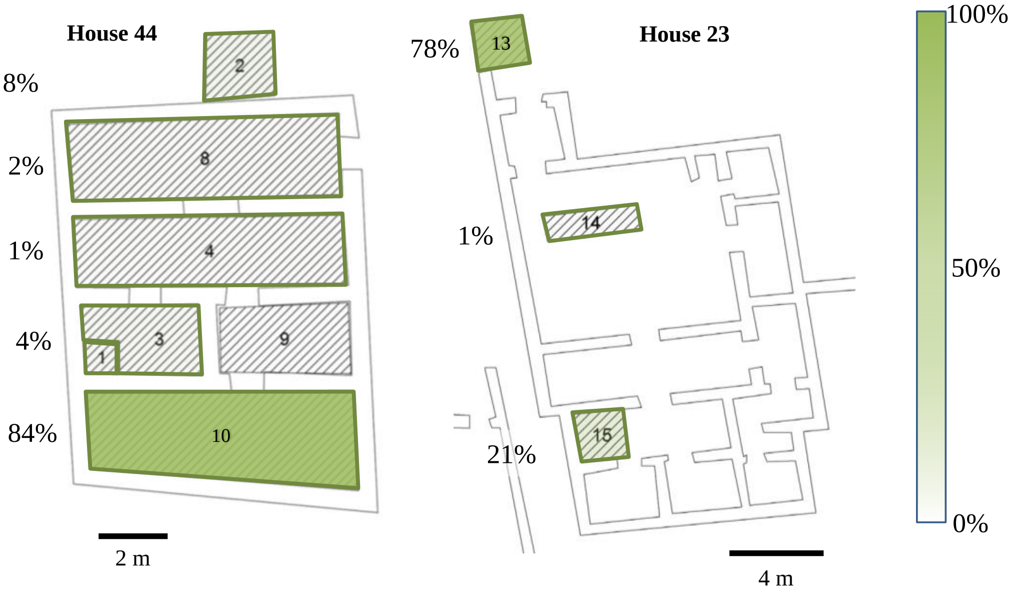


Figure 6.13: Concentration of number of shark/ray vertebrae around Houses 44 and 23

These results indicate that food debris was concentrated in particular areas within and around the houses: in the back room, interior room, and just outside the front entrance. The back room of House 44 likely had a *makuti* (thatch) roof rather than a plaster ceiling, which would be better suited for cooking activities (Fleisher and Wynne-Jones 2010, 18). High concentrations of shark/ray vertebrae in the back room of House 44 and front steps of House 23 indicate that shark meat was processed (dried or cooked), eaten, and/or discarded in these areas.

6.6 Discussion

Faunal analyses indicate that the inhabitants of Songo Mnara had a diet consisting mainly of fish and domesticated animals. Chicken and small domesticated bovids (sheep/goat) each make up a quarter of the tetrapod remains. Cattle remains were also present but less common. This diet was complemented with a few examples of hunted wild animals, such as monitor lizards, water birds and sea turtle. Animals associated with urban areas, particularly rats and cats to a lesser extent, were present in the domestic spaces at Songo Mnara. I noted some differences between the two coral-stone houses. While both had similar proportions of cattle remains, House 44 had higher numbers of chicken and House 23 higher numbers of sheep/goat. The sample from the mud-thatch house area (SM011) contained few tetrapod remains.

The distribution of fish and non-fish faunal material indicates that inhabitants in the mud-thatch area relied more heavily on the consumption of fish than domesticated and other wild animals. However, inhabitants in the coral-stone house area consumed larger fish and more oceanic fish compared to their mud-thatch house neighbours. These types of fish are more accessible using larger boats and could be related to other measures of wealth and status.

<u>Materiality in Context</u>

Previous research on the Swahili coast has shown that owning and maintaining a large fishing boat requires a significant amount of wealth (Nakamura 2011). Boat owners, in turn, have better access to prized food items. Apart from having access to larger fish, as the fish remains suggest at Songo Mnara, boat owners are able to realize other benefits. In the present fishing communities around Vanga, boat owners gain a higher profit, oftentimes without participating in fishing activities, compared to fishers who do not own boats. This advantage gives them the time and money to join other profitable pursuits and obtain domesticated animal meat—sheep/goat and cattle meat is favoured over the abundant fishes. Consumption trends at Songo Mnara indicate that a similar social dynamic could have been at play during the 14^{th} to 16^{th} centuries. Larger quantities of chicken, sheep/goat, and cattle remains occur in the coral-stone house area, indicating that these potential 'boat owners' consumed more domesticated animal meat than the mud-thatch 'inshore' fishers. The coral-stone house area also had higher percentages of imported wares compared to local pottery (Fleisher and Wynne-Jones 2010). These artefacts and the coral-stone architecture signal that the inhabitants of this area enjoyed greater wealth and higher status than the inhabitants of the mud-thatch houses. The relationship between meat consumption, boat ownership and wealth/status provides a plausible explanation for the food consumption trends observed at Songo Mnara.

These conclusions are somewhat in line with the limited historical references to diet in this area. Dorman (1938: 64) refers to Portuguese sources describing a diet of millet, rice, cattle, and honey at Kilwa, while the "native slaves living in wooden or mud houses" had a diet of millet, rice, roots and wild fruit. These statements, lined with colonial attitudes, disregard the importance of fishing to these communities that is evident in the archaeology. However, they accurately observe that cattle were a less accessible food item for mud-house inhabitants.

6.7 Summary

Understanding the different types of animal food that formed part of the diet at Songo Mnara helps us reconstruct the subsistence activities used to obtain these animals. Because there are limited examples of systematic faunal analyses of other Swahili sites in this region, the research at Songo Mnara contributes largely to our understanding of how the inhabitants of Swahili towns interacted with their surrounding environment and how diet and subsistence shaped their way of life in the pre-colonial period. This chapter contributes to the study of Swahili societies by exploring patterns of social organization and food consumption at Songo Mnara in connection to its environmental setting. I have discussed the results of the faunal analysis by combining marine ecological models summarized in Chapter 3 and social patterns observed in my ethnoarchaeological research summarized in Chapter 4. In the following chapter, I use a similar structure to discuss the contemporaneous town of Vumba Kuu within its own social and environmental setting.

Chapter 7: Vumba Kuu Case Study

"On the day appointed for the enthronement, the Diwan proceeds to Vumba Kuu, a road having been previously cut through the thick, tangled wood... [in] the sacred precincts of the ruined city... [at] the grave of Mwana Chambi Chandi Ivor, the most powerful of the Sultans of Vumba."

-A.C. Hollis, 1900 (p. 279)

7.1 Introduction

At the same time that a society of fishers and farmers was thriving on the island of Songo Mnara, another coastal community called Vumba Kuu existed on the mainland coast at the present-day border between Kenya and Tanzania. Its unique geographical and historical setting provides an opportunity to explore differences in diet and subsistence strategies compared to those at Songo Mnara.

Although there is an extensive oral/written record on the history of Vumba Kuu, the archaeological record provides an additional lens through which we can view the lives of the inhabitants of this area. This chapter discusses archaeological evidence of life at this Swahili town in light of its recorded history. Large amounts of excavated fish remains from Vumba Kuu illustrate the importance of fishing as a form of subsistence—an aspect of this town that is not recognized in its historical records. I address this gap through a summary of the faunal analysis of excavated material from Vumba Kuu.

7.2 Vumba Kuu in context

Excavations at Vumba Kuu show evidence of occupation between the 14th and 16th centuries, a time considered as "the height of Swahili wealth and influence" (LaViolette 2008, 31). Songo Mnara was a contemporaneous Swahili town roughly 500 km south along the coastline. However, some key differences between these two Swahili towns make them interesting case studies for comparison. Vumba Kuu lacks the well preserved coral-stone architecture that defines the town plan of Songo Mnara. Instead, Vumba Kuu contains few examples of preserved coral architecture limited to the remains of a town wall and a mosque. Nonetheless, aspects of Vumba Kuu history are preserved through recorded oral traditions surrounding the *Chronicle of Vumba Kuu*, a written document of the history of the area. Inhabitants of both Vumba Kuu and Songo Mnara had access to similar tropical coastal marine habitats, yet Vumba Kuu fishers lived on the mainland rather than an island. These differences are explored in detail below.

Environment

Vumba Kuu lies by a creek on the mainland coast surrounding the Umba River Delta (Figure 7.1). The Umba River discharges approximately 16 million cubic m of freshwater annually into the bay (Tychsen 2006, 13). This estuarine environment creates a rich ecosystem of mangrove forest that lines the coast. Less than 5 km from the shoreline, the continental shelf supports coral reefs up to a depth of 45 m. Thus, the area around Vumba Kuu is rich in marine environments available for exploitation: from the extensive expanse of mangrove forest to the nearby coral reefs. Additionally, mud flats and seagrass beds can be found around these habitats.

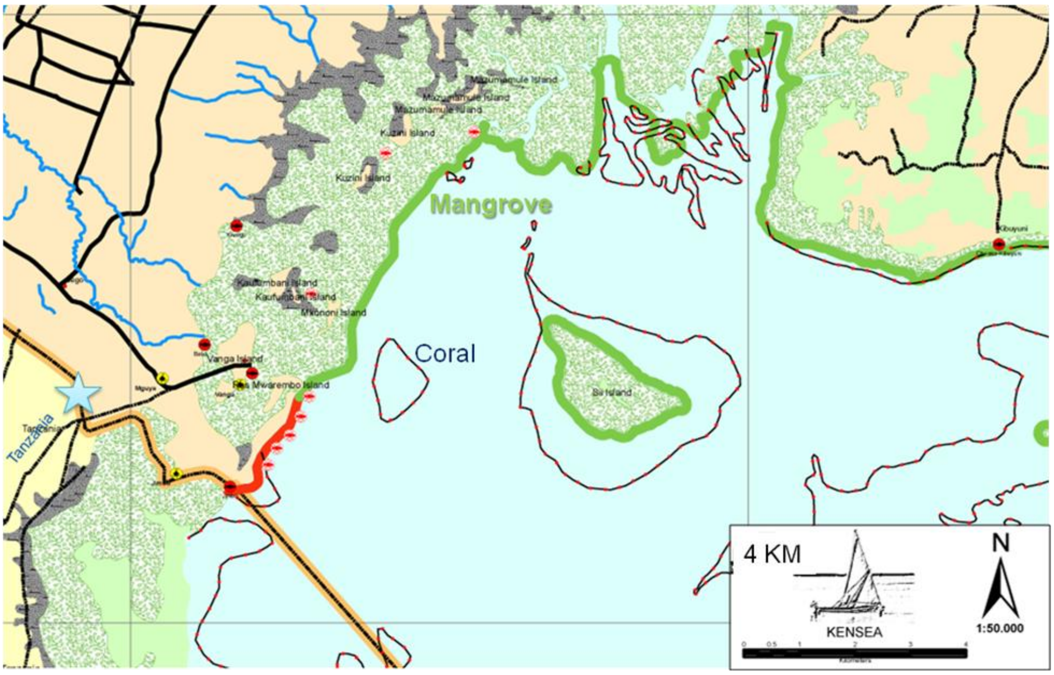


Figure 7.1: Environmental habitats around Vumba Kuu
Vumba Kuu is marked with a blue star, green area=mangrove, grey area=sand or mud, black with red dots=coral, red line=sheltered sand (Tychsen 2006)

These various ecological zones have provided rich resources for fishers, past and present. I recorded traditional fisheries currently practiced in this area as part of the ethnoarchaeology research summarized in Chapter 4. The fishing strategies observed aid the interpretation of analysed fish remains from excavations at Vumba Kuu, allowing us to explore past marine resource exploitation in this area.

Historical background

Two slightly conflicting sources form the history of Vumba Kuu: oral/written traditions and archaeological evidence. In 1900, Hollis, a British colonial officer, took on the task of recovering the *Chronicle of Vumba Kuu*, a volume recording the history of Vumba Kuu that was destroyed during the sack of Vanga in the late 19th century (1900). Hollis never found an actual document, so he set out to record oral accounts from the region and compared notes with other historical documents in order to recreate its history. What resulted was an exercise in "the use of Vumba's past to serve the needs of the present" (Wynne-Jones 2010, 410). In effect, the histories related by the Vumba informants recorded by Hollis were a process of identity negotiation that accentuated foreign ancestry and nobility. Nonetheless, these accounts show important aspects of Vumba history and society, even as idealized versions.

According to these oral histories, Vumba country was founded as early as AD 1204. The history describes a series of succeeding sultans beginning with a sultan called Zumbura, meaning to find a hidden place or thing (Hollis 1900, 279). More historical details are recorded for the early 17th century onwards; for example, Diwan Ruga, the first sultan to use the title 'Diwan', led his people to move to the nearby island of Wasini in the early 18th century under fear of attack by Mombasa (Hollis 1900, 284). The history then describes the following leaders of the Wavumba (Vumba people) and their rituals of succession, up until the date of publication.

Hollis' account does not clearly define the period of occupation at the town of Vumba Kuu. Instead, the oral/written history shows that there is an important reverence to the place; the ruined remains of Vumba Kuu continue to be the setting for important Vumba rituals until the last diwan was enthroned there in the 19th century. Vumba Kuu is first mentioned as the place of burial of the founding sultan of Vumba, Zumbura (Hollis 1900, 281). The last sultan to be buried there was Mwana Chambi Chandi Ivor (reigning around 1630), who is remembered for defeating dissident groups in the area, such as the Wakifundi

(Shirazi), with the aid of the Wakilio (Segeju) and Wadigo (Hollis 1900, 282–3). Shortly after his death, the Vumba people relocated to surrounding fishing villages like Jimbo under fear of attack from Mombasa. From this point on, the Vumba people separated into various groups at different times and relocated to other towns in the area, many of which continue to exist today: Jimbo, Vanga, Jasini, and Wasini among these. However, the two main lines of Wavumba, at Vanga and Wasini, continued to follow rituals of enthronement at Vumba Kuu until the 19th century:

> *On the day appointed for the enthronement, the Diwan proceeds to Vumba Kuu, a road having been previously cut through the thick, tangled wood... [in] the sacred precincts of the ruined city... [at] the grave of Mwana Chambi Chandi Ivor, the most powerful of the Sultans of Vumba. (Hollis 1900, 279)*

According to Hollis (1900, 294), the Diwan of Wasin and the Diwan of Vanga were enthroned together at Vumba Kuu in 1864. The last Diwan of Wasin, Diwan Ukungu, died in 1878 before he was enthroned, but we can assume that the last Diwan of Vanga, Diwan Marithia who died in 1897, was also enthroned at Vumba Kuu (Hollis 1900, 294–5).

Hollis' reconstruction of oral and written traditions around Vumba Kuu formed the basis of future work by Robinson (1939) and McKay (1975). The vivid descriptions of the rituals and successions of Vumba rulers in the *Chronicle* have become an example of Swahili power structures (e.g., Allen 1993; Horton and Middleton 2000; see Wynne-Jones 2010). Vumba history has also been interpreted through a linguistic lens (Nurse and Walsh 1992) that traces the languages associated with the different groups living in this area. The long list of sultans and descriptions of elaborate ritual practices render Vumba Kuu as an important and influential cultural centre along the East African coast. However, the visible remnants of Vumba Kuu's past are the meagre architectural remains of a collapsed mosque, traces of a town wall and coral mounds.

The archaeology of Vumba Kuu

Despite its allusion to a prominent past, the humble ruins of Vumba Kuu had received little attention by the archaeological community until recently. Past archaeological projects at Vumba Kuu had been limited to surveys and test pits.

Wilson (1980) reports a 15th century occupation at Vumba Kuu, which is included in his regional survey report for National Museums of Kenya.

More recently, archaeological excavations directed by Wynne Jones from 2007 to 2009 have shown evidence for occupation at Vumba Kuu, from the 14th to 16th centuries (Wynne-Jones 2009; Wynne-Jones 2010). This project investigated evidence of material culture associated with the "performance of power and authority" that is described in the oral/written historical sources of Vumba Kuu and how this material was distributed throughout the layout of the town (Wynne-Jones 2009). To address these aims, the research team used a series of archaeological methods including shovel test pits, geophysical survey and excavation, supplemented with laboratory analyses of botanical and faunal remains (Wynne-Jones 2009). The combined results from the array of research techniques provide insights into the lives of the past residents of Vumba Kuu, complementing our knowledge from the oral/written records.

Food subsistence and consumption in the Vumba region

The oral/written traditions surrounding the *Chronicle of Vumba Kuu* revolve around the elite, with little to no information about other members of Vumba society. The same is true in the realm of food. Hollis describes certain customs during succession ceremonies that involve feasting and ritual use of animals: before becoming diwan, the candidate had to marry a suitable woman, and if oxen were slaughtered at his wedding, he received special honour (Hollis 1900, 278). Further feasting took place on several other occasions, including the birth of a candidate's son, the official presentation of the diwan candidate, a reunion with chiefs of neighbouring groups, and after enthronement (Hollis 1900, 278–9). Relatives of a deceased sultan of Vumba also gave a funeral feast at which the largest possible ox was named and slaughtered (Hollis 1900, 291). It appears that cattle and feasting were integral parts of the Wavumba display and negotiation of social power (Fleisher 2010). Fishing activities and fish consumption do not play a role in the history of Vumba Kuu according to the *Chronicle,* nor do the majority of residents who lived outside the elite sphere. Archaeology becomes an important tool for investigating these aspects of Swahili life.

7.3 Methodology

Excavation summary

The stratigraphy excavated at Vumba Kuu was composed of mostly sandy silts over a sterile coralline substrate and contained evidence of occupation between the 14th and 16th centuries (Wynne-Jones 2012). Geophysical survey was used to identify the extent of the site and areas of activity within it, which were explored archaeologically (Wynne-Jones 2012; Wynne-Jones 2010). Vumba Kuu is surrounded by a coral wall, except along its border by a creek. There is no evidence of activity immediately outside the wall, but the space within it was likely covered with mud-thatch houses. Linear features identified in the magnetometry readings were excavated and found to represent accumulated debris between mud-thatch houses in the eastern area of town. An area of iron working (possibly smithing) was identified in the western area of the town among mud-thatch houses. The majority of finds are locally-made ceramic vessels, and the few decorated vessels are found in the excavated areas by the mosque. Very small quantities of imported ceramics (63 sherds) were found across the site, indicating that Vumba Kuu had limited connections to external trade. Thus, Vumba Kuu lacks some of the characteristics of other known sites of the 14th to 16th centuries that show evidence of strong trade connections and elaborate coral-stone architecture—Songo Mnara included.

Large excavation units were placed around the town to investigate the variable use of space and forms of materiality. Because of the lack of standing architecture, it was not possible to organize excavation units around domestic and public spaces at Vumba Kuu in the same way this was achieved at Songo Mnara. The general layout of the town consists of a mosque by a creek on the northeastern (NE) side and remains of the town wall in the southwest (SW) (Figure 7.2). Three units were excavated on the SW side of the town: two units (VMB011 and VMB012) were opened to investigate strong geophysical anomalies that resulted from large quantities of iron slag, and another unit (VMB007) investigated a concentration of ceramics that was identified during the shovel test pits (Wynne-Jones 2009; Wynne-Jones 2012). The patterns of use visible on the surface are different in the NE part of town, which contains coral mounds and a mosque. Two units were opened in this area: one (VMB008) next to the remains of the mosque and the other (VMB010) bisecting a linear feature identified during geophysical survey later identified as midden debris between mud-thatch houses (Wynne-Jones 2012). These areas represent variable uses of space in the composition of artefacts recovered and their position within the town and association with other features.

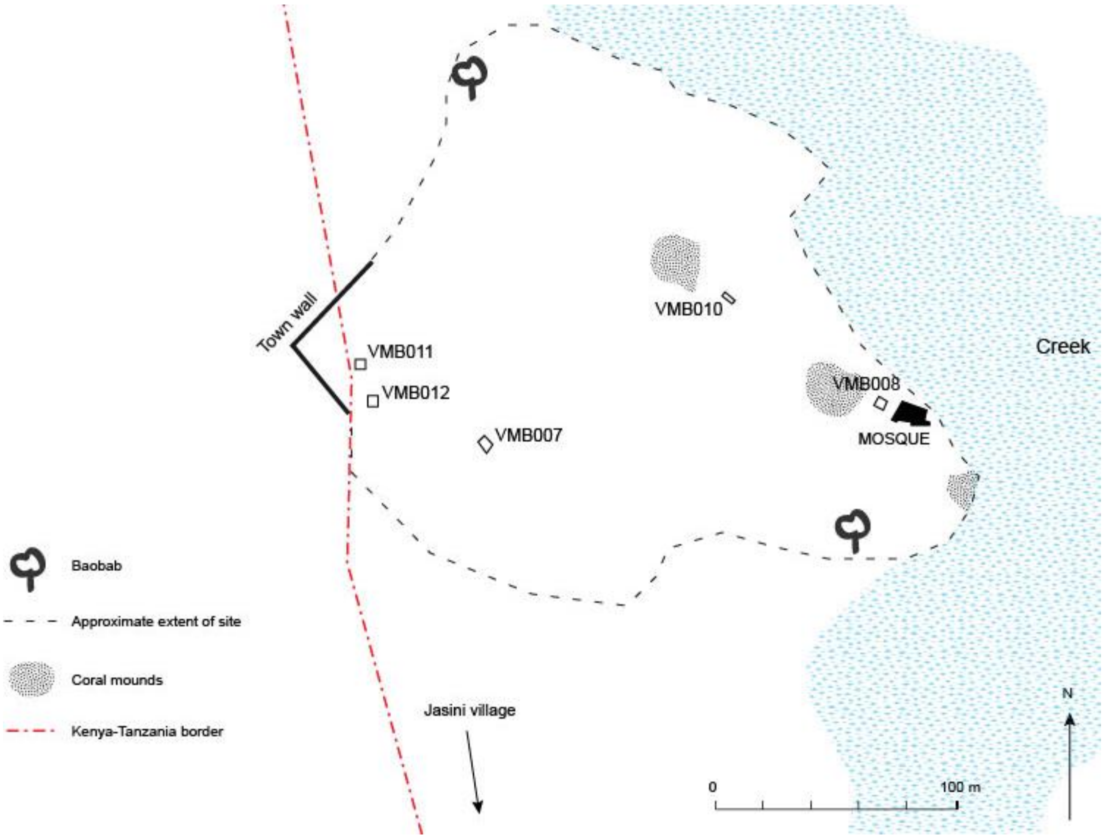


Figure 7.2: Layout of excavation units at Vumba Kuu

I explore food consumption activities around Vumba Kuu using zooarchaeological data that provide evidence of the variability in diet and subsistence strategies undertaken by Vumba Kuu residents. I analysed the faunal remains excavated from Vumba Kuu as part of a larger project led by Stephanie Wynne-Jones. Most of the artefacts recovered from the excavations come from the units excavated in June 2007 and February 2009: Trenches 7-12. In this chapter, I will be referring mainly to the research associated with these excavations.

Recovery and identification of faunal remains

Material remains from all excavation units were recovered using 5 mm mesh sieves and recorded according to context within the excavation unit (Wynne-Jones 2009). Faunal remains were separated and stored in labelled plastic bags according to Trench and Context. The faunal material excavated during the January 2008 season (VMB007 and VMB008) was stored at National Museums of Kenya, Nairobi. I analysed this faunal material with the aid of the comparative reference collection in the Osteology Department in Nairobi. The faunal material from the February 2009 excavations (VMB010, VMB011, and VMB012) was transported to the University of Bristol, UK, where I separated the material into two main taxonomic groups: fish and tetrapods. I identified the fish remains with the aid of a comparative reference collection of Indian Ocean fish at the Muséum national d'Histoire naturelle (MNHN), Paris. I identified the tetrapod remains at the University of York using a basic collection of comparative skeletons of domesticated animals and wild birds. I took some unidentified elements, in particular the reptile remains, to the MNHN for further identification. The methods of analysis are those outlined in Chapter 2.

7.4 Summary of zooarchaeological analysis

A total of 7.2 kg of faunal material was collected during the 2007 and 2009 excavations at Vumba Kuu. The relative quantity of fish and other animals can be compared by weight for all trenches (Table 7.1).

Table 7.1: Comparison of non-fish and fish masses at Vumba Kuu
~m^3=approximate volume of excavated trenches, T(g)/m^3=approximate density of finds (numbers in italics mark indefinite volume and density values)

	Vumba Kuu Weight (g) Comparison					
~m^3	Site	Non-Fish	Fish	Total	%Total	T(g)/m^3
8.0	VMB007	2141.85	185.02	2326.87	32.1%	290.9
7.2	VMB008	1797.31	1220.89	3018.20	41.6%	419.2
3.0	VMB010	570.06	249.30	819.36	11.3%	*273.1*
2.0	VMB011	678.03	108.93	786.96	10.9%	393.5
4.0	VMB012	268.88	28.64	297.52	4.1%	74.4
	Total	5456.13	1792.78	7248.91	100.0%	
	%Total	75.3%	24.7%	100.0%		

Non-fish remains (Total=5456 g; 75.3%) outweigh fish (Total=1793 g; 24.7%) three fold. Additionally, the faunal material is unequally distributed across the town. The majority of remains come from Trench VMB008 (41.6%) and VMB007 (32.1%), followed by VMB010 (11.3%) and VMB011 (10.9%), and finally VMB012 (4.1%). When considering the volume of the excavated trenches, most have a density of faunal remains between 290 and 420 g/m3, except VMB 012 that has a low density of 74.4 g/m3 (Table 7.1). The following sections describe the types of animals represented in each unit and the relative abundance of fish and non-fish remains.

Non-fish remains: tetrapods

Non-fish remains were further divided into groups of birds, mammals, reptiles, and unidentified fragments. Tetrapods—four-legged vertebrates—make up approximately 77% (4210 g) of the total weight of non-fish remains. Unidentified fragments (17%; 933 g) and crab (6%; 313 g) compose the remaining portion of non-fish remains. Crab remains were distributed across the trenches in small numbers. It is not clear if crabs were eaten or were carried into the town as fishing bycatch. The town lies far enough from the shoreline that crabs would not have travelled into the settlement on their own. I describe unidentified fragments in their own sub-section.

Domesticated animals top the list of tetrapod taxa identified at Vumba Kuu, together representing 78% of the total number of identified tetrapod remains (NISP=number of identified specimens) (Table 7.2). Among these, cattle (192 NISP) and chicken (171 NISP) were most abundant, followed by sheep/goat (68 NISP). Rat (18 NISP) and cat (4 NISP) were also represented. Wild animals consisted mainly of dugong (27 NISP). Other types of wild birds, mammals and reptiles are less represented.

Table 7.2: Summary of tetrapod remains at Vumba Kuu (excluding turtle remains), NISP=number of identified specimens

Taxonomic Group	NISP	%NISP
Cattle	192	35.0%
Chicken	171	31.2%
Sheep/goat	68	12.4%
Dugong	27	4.9%
Rat	18	3.3%
Small bovid	16	2.9%
Large ungulate	8	1.5%
Possible chicken	7	1.3%
Spurfowl	6	1.1%
Medium ungulate	5	0.9%
Cat	4	0.7%
Francolin	4	0.7%
Possible cattle	4	0.7%
Guinea fowl	3	0.5%
Mongoose	2	0.4%
Large bovid	2	0.4%
Duiker	1	0.2%
Monkey	1	0.2%
Warbler	1	0.2%
Cormorant	1	0.2%
Crocodile	1	0.2%
Elephant shrew	1	0.2%
Large mammal	1	0.2%
Medium mammal	1	0.2%
Possible frog	1	0.2%
Possible sheep/goat	1	0.2%
Pig	1	0.2%
Grand Total	**548**	**100.0%**

Table 7.3: Comparison of species richness of tetrapods at Vumba Kuu (excluding turtle remains)

	VMB007	VMB008	VMB010	VMB011	VMB012	Total
Total NISP	174	264	37	40	33	548
% of Total	32%	48%	7%	7%	6%	100%
Species richness	8	18	6	6	9	28

Table 7.4: Distribution of tetrapod remains (NISP) across Vumba Kuu (the remains marked in grey are not included in totals of the tables above)

Class	Taxonomic ID	VMB007	VMB008	VMB010	VMB011	VMB012	Total
Bird	African warbler		1				1
	Helmeted guinea fowl		3				3
	Great cormorant		1				1
	Possible chicken		7				7
	Francolin		4				4
	Chicken	16	128	5	12	10	171
	Spurfowl		6				6
	Unid bird	6	52	14	11	4	87
Bird Total		22	202	19	23	14	280
Amphibian	Possible frog		1				1
Amphibian Total			1				1
Mammal	Cattle	135	36	8	11	2	192
	Sheep/goat	15	33	10	4	6	68
	Duiker		1				1
	Possible cattle				4		4
	Possible sheep/goat			1			1
	Large bovid					2	2
	Small bovid	1		12		3	16
	Old World monkey		1				1
	Dugong	4	23				27
	Cat	1	3				4
	Mongoose		2				2
	Elephant shrew		1				1
	Rat		13			5	18
	Pig					1	1
	Large ungulate				6	2	8
	Med ungulate				3	2	5
	Large mammal			1			1
	Med mammal	1					1
	Unid mammal	44	78	9	27	6	164
Mammal Total		201	191	41	55	29	517
Reptile	Turtle	15	29	17		5	66
	Crocodile	1					1
Reptile Total		16	30	17		5	68

Species richness—the total number of different taxa represented—provides a measure for comparison among the excavated trenches (Table 7.3). Trench VMB008 contained almost half (48%) of the total number of identified tetrapods and also has the highest species richness (18). Surprisingly, VMB007, which has the next highest number of remains (32%), has low species richness, with only 8 taxa represented by 174 total remains. In fact, VMB012, which has the lowest number of identified remains (6%), has higher species richness (9). This suggests that the deposition of tetrapod remains in the areas represented by VMB007 and VMB012 were different than the rest of the excavated areas. Excavations show that these two deposits resulted from different types of activities: VM007 contained a domestic midden, and VM012 included large quantities of iron slag linked to ironworking with mixed-in food debris.

The proportions of 548 identified tetrapod remains from the excavated areas reveal variation in the consumption patterns across town (Figure 7.3). The most striking trend is the high proportion of cattle remains (78%) represented in VMB007. This trench is dominated by the principal domesticated species—cattle, sheep/goat, and chicken—which together make up the majority (96%) of the identified tetrapod remains in this trench. Another strong pattern occurs in VMB008, where chicken (48%) makes up almost half of the tetrapod remains. The proportions of cattle (14%) and sheep/goat (13%) remains are almost equal and significantly smaller than chicken. Fragments of dugong rib, mandible, skull, and vertebra make up a smaller portion (9 %) of the assemblage. Rat remains (5%) are also present. Trench VMB011 contains high levels of chicken (30%) and cattle (28%) remains. Of the domesticated animals, sheep/goat was significantly less represented (10%). In contrast, half of the VMB010 assemblage is roughly divided between sheep/goat (27%) and cattle (22%) remains, with chicken trailing behind (14%). The high proportion of small bovid remains in this trench corresponds to 12 vertebra fragments of a small immature bovid, likely representing one individual. VMB012 has the lowest percentage of domesticated species among the five trenches (55%). Five rat remains (15%) were also found in this trench, but it is not clear if they were eaten. Turtle remains were present in all units except VMB011, mostly as shell fragments.

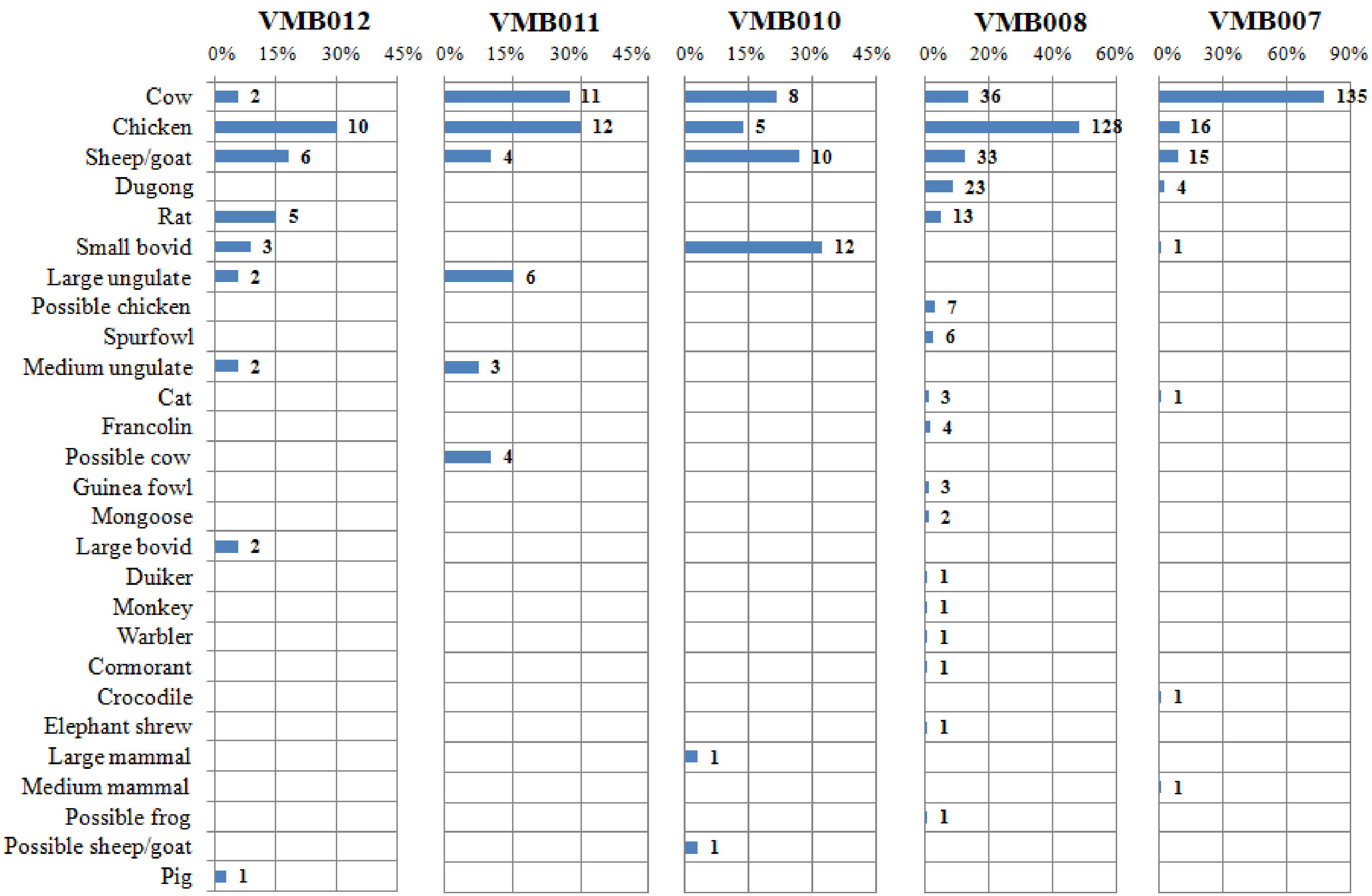


Figure 7.3: Relative proportions of tetrapods in Vumba Kuu Trenches (excluding turtle). Number of identified specimens at end of bars.

It is clear that the faunal remains excavated from Vumba Kuu are related to human consumption because in addition to their contextual association with artifacts, such as pottery, in concentrated middens, a portion of the bones show evidence of human modification: burning and cutmarks (Figure 7.4). Bones can be charred by certain forms of cooking, such as roasting. The process of cutting or slicing meat off the bone leaves marks on the bone surface.

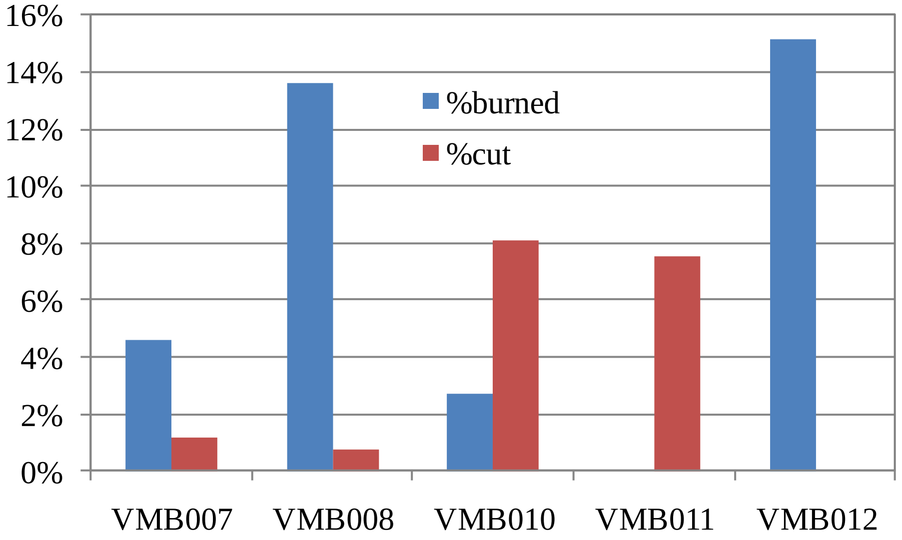


Figure 7.4: Percentages of remains with burning and cutmarks in each trench Total number of remains=548

The distribution of elements can also offer clues as to the nature of deposition of the faunal remains. For example, the faunal assemblage in VMB007 has particularly high numbers of cattle remains. One possibility is that this trench represents the remains of a cattle butchering area. If that were the case, one would expect a high percentage of head and feet elements—parts of the cattle that have low meat value (Klippel 2001). The Food Utility Index (FUI) developed by Metcalfe and Jones (1988) provides a scale for the meat value of specific bones within one animal (Table 7.5). According to this measure, cattle remains from both VMB007 and VMB008 (for comparison) consist of elements with meat values of all categories: low, medium and high (Figure 7.5). Less than 40% of cattle elements in VMB007 are of low meat value. The wide range of meat values represented by the cattle elements in these trenches could result from the deposition of both processing and consumption waste in a single area.

Table 7.5: Food Utility Index (FUI) values for VMB007 and VMB008 cattle remains (FUI values based on Metcalfe and Jones 1988)
Categories: Low=<1000 FUI; Medium=1000-3000 FUI; High=>3000 FUI
(Categories adapted from Purdue, Styles, and Masulis 1989)

Anatomical Region	Element	FUI	Category	VMB007 NISP	VMB008 NISP
Cranial	horns	1	Low	0	0
	skull	235	Low	35	5
	atlas-axis	524	Low	1	0
	mandible	590	Low	8	0
Axial skeleton	vertebrae*	2015	Medium	15	2
	lumbar vertebrae	1706	Medium	2	1
	cervical vertebrae	1905	Medium	6	0
	thoracic vertebrae	2433	Medium	3	1
	pelvis-sacrum	2531	Medium	2	0
	ribs	2650	Medium	26	16
	sternum	3422	High	0	0
Forelimb	metacarpal+carpals	795	Low	3	3
	radio-cubitus	1323	Medium	6	1
	humerus	1891	Medium	0	0
	scapula	2295	Medium	0	1
Hindlimb	phalanges	998	Low	6	2
	metatarsals	1903	Medium	4	0
	tibia+tarsals	3225	High	1	2
	femur	5139	High	15	1
	patella*	4182	High	1	0
Limb	metapodial*	1349	Medium	1	0
Total cattle remains				135	36

***elements not included in original FUI measures have been calculated by averaging the associated elements**

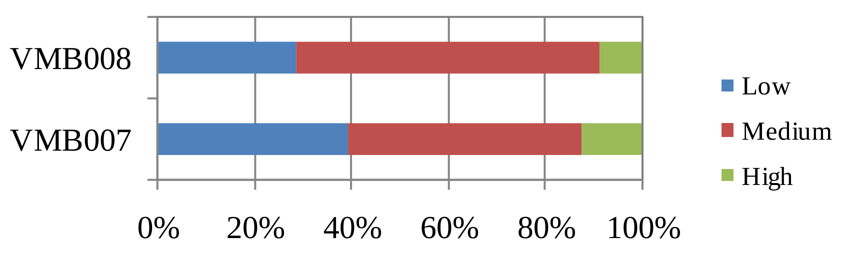


Figure 7.5: Meat value comparison of cattle remains from VMB007 and VMB008

The locations of the excavation areas reveal general patterns of tetrapod consumption across Vumba Kuu. VMB007, VMB011 and VMB012 are located in the SW part of the town. VMB007 and VMB011 are associated with domestic deposits with a high level of cattle consumption, particularly in VMB007. Trench VMB012 is a bit of an anomaly as it has a large variety of animal types in a sample of only 58 remains. This trench is associated with iron working rather than domestic activities (Wynne-Jones 2009; Wynne-Jones 2012). The other two trenches are found close to the creek that serves as the NE limit of Vumba Kuu. A series of coral-stone mounds and a mosque point to a tendency for more coral-stone architecture in this part of town. VMB010 is interpreted as a small domestic midden between mud-thatch houses in this area. The tetrapod remains from VMB010 indicate a more balanced consumption of sheep/goat, cattle and chicken. VMB008 is a much larger midden by the mosque with the highest abundance of artefacts per trench size. In addition to abundant artefacts, more decorated ceramic bowls, mostly of smaller size than the town average along with the largest vessels, and several unique artefacts (an incense burner and a lamp) were recovered in this space, that indicate its association with high status public consumption practices (Wynne-Jones 2010). The tetrapod consumption pattern associated with this area shows a high proportion of chicken remains, while all three domesticated animals are represented in small quantities. There is also a significant amount of dugong. The analysis of tetrapod remains begins to illuminate differences in the distribution of faunal remains between the NE and SW sections of Vumba Kuu. I continue to explore this variability across town in the analysis of fish remains.

Fish remains: overview

Fish remains make up 25 percent of the total mass of faunal remains. They were sorted and weighed in three groups: nonvertebrae, vertebrae, and unidentified fragments (UFR) plus spines (Figure 7.6; Table 7.6).

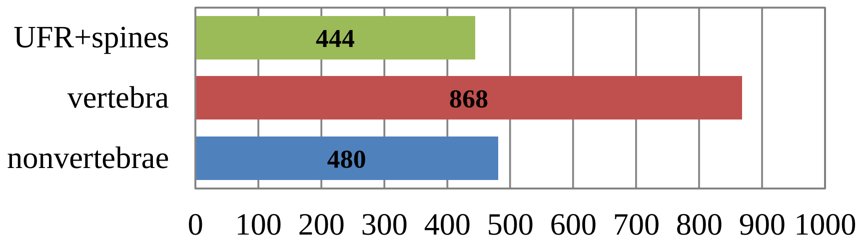


Figure 7.6: Fish remains categories from Vumba Kuu (grams)

Table 7.6: Fish remains categories from Vumba Kuu (grams)
UFR=unidentified fragments
(analysed samples in grey)

Trench	nonvertebrae	vertebra	UFR+spines	Total(g)
VMB007	48.44	111.50	25.08	185.02
VMB008	299.07	645.49	276.33	1220.89
VMB010	109.58	62.11	77.61	249.30
VMB011	15.06	37.99	55.88	108.93
VMB012	8.26	11.02	9.36	28.64
Total	480.41	868.11	444.26	1792.78

Overall, 33 percent of fish material from Vumba Kuu was analysed (marked in grey in Table 7.6). I analysed all cranial and appendicular bones, including special diagnostic bones such as the first dorsal spine of triggerfishes (Balistidae). This category of identified nonvertebral material makes up roughly 27 percent of the total mass of fish remains (Figure 7.6). Fish vertebrae from trenches VMB010, VMB011 and VMB012 were fully analysed. This sample includes material from both NE and SW parts of Vumba Kuu. Additionally, I counted shark and ray vertebrae from these contexts. The material that was not fully analysed, including some vertebrae and all spines and other unidentified fragments, was weighed for each context.

Overall there was little evidence of modifications on fish remains, such as traces of cutting and burning (Figure 7.7). Only three caudal vertebrae had cutmarks, which could be a result of the practice of cutting slits across the length of the fish as I observed during the ethnoarchaeology research, but the evidence is too limited to indicate any kind of preparation technique. Additionaly, seventy fish remains showed traces of burning, mostly of the colour black, which were found in contexts associated with cooking debris.

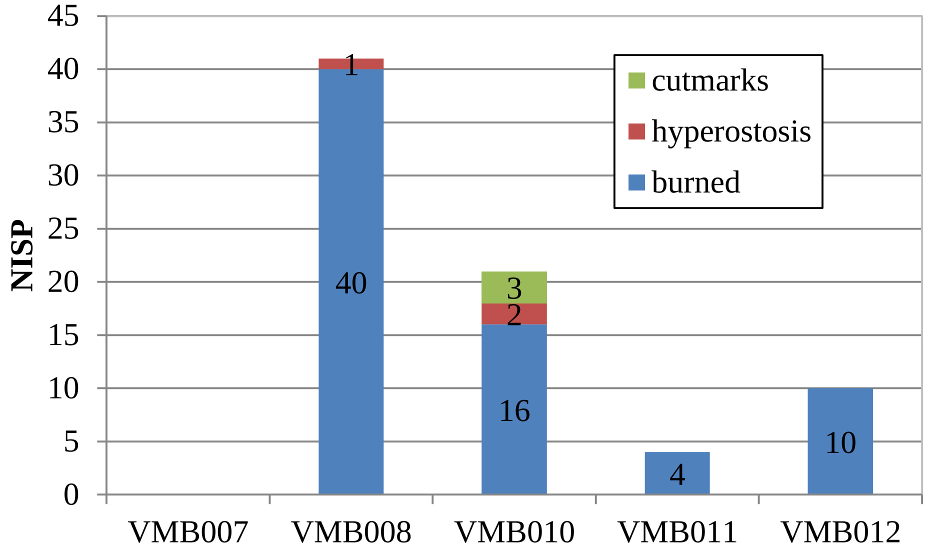


Figure 7.7: Summary of fish remains modifications from Vumba Kuu (numbers indicate NISP per category)

Fish remains: nonvertebrae

I identified 13 fish families from analysis of a total of 872 cranial, appendicular, and special diagnostic bones (Table 7.7). The top four families, Lethrinidae (emperors), Scaridae (parrotfish), Haemulidae (grunts), and Serranidae (groupers), together represent 84 percent of the total assemblage. Within this group, the family Lethrinidae alone makes up one third of the total fish remains. Five other families each represent between one and five percent of the total, and another four families each represent less than one percent. These results indicate that past fishers at Vumba Kuu exploited a diverse set of fishes—although not as diverse as at Songo Mnara—while predominantly catching particular types of fish.

Table 7.7: Fish families represented in Vumba Kuu by nonvertebral elements NISP=number of identified specimens

Family	NISP	%Total
Lethrinidae	303	34.7%
Scaridae	192	22.0%
Haemulidae	164	18.8%
Serranidae	75	8.6%
Acanthuridae	35	4.0%
Lutjanidae	32	3.7%
Carangidae	25	2.9%
Siganidae	23	2.6%
Sparidae	11	1.3%
Sphyraenidae	7	0.8%
Balistidae	2	0.2%
Platycephalidae	2	0.2%
Tetraodontidae	1	0.1%
Total NISP	872	100%

In this category of 872 mostly cranial elements, I identified 223 remains (26%) to species level, resulting in a minimum of 28 fish species represented at Vumba Kuu (a complete list can be found in Appendix G). The most commonly identified species were *Scarus ghobban* (28%) and *Pomadasys multimaculatus* (20%), followed by two members of the Lethrinidae family: *Lethrinus nebulosus* (10%) and *Lethrinus mahsena* (9%). These are followed by a member of the Serranidae family, *Epinephelus malabaricus* (7%). These top five species are representative of the four most common fish families at Vumba Kuu. Although Lethrinidae is the best represented family, species from the family do not top the list of most commonly identified species because fish in the Lethrinidae family are notoriously difficult to identify to species level. Different fish species, even within the same family, inhabit different parts of the marine environment. Thus, precise identification of fish remains allows us to accurately detect which marine habitats were exploited by past Vumba fishers.

<u>Fish remains: vertebrae</u>

Due to the limited amount of time I had to analyse the faunal remains at National Museums of Kenya, I was not able to identify the fish vertebrae from trenches VMB007 and VMB008. However, I analysed all vertebrae from the other three trenches: VMB010, VMB011 and VMB012. This sample, composed of a total of 471 vertebrae, serves to predict which fish are under and over-represented in the analysis of cranial, appendicular and special diagnostic bones. Of the 471 vertebrae, 310 were identified to family level, representing 15 fish families including three that were not found in the analysis of nonvertebrae remains: Carcharhinidae (requiem sharks), Chirocentridae (wolf herring), and Mugilidae (mullets). Only one family was found exclusively in the nonvertebrae category and not in the vertebra sample: Tetraodontidae (puffers). I identified eight fish species in the vertebra sample, seven of which were not found in the analysis of cranial, appendicular and special diagnostic bones (Table 7.8). The additional taxa identified in the analysis of vertebra make a total of 16 families and 35 species of fish found at Vumba Kuu.

Table 7.8: Fish species identified in sample of vertebrae from Vumba Kuu (species identified from vertebrae only marked in grey)

Family	Genus	Species	NISP
Mugilidae	*Liza*	*macrolepis*	1
Platycephalidae	*Papilloculiceps*	*longiceps*	2
Scaridae	*Scarus*	*ghobban*	2
Carangidae	*Selar*	*crumenophthalmus*	4
Siganidae	*Siganus*	*luridus*	9
Siganidae	*Siganus*	*stellatus*	25
Siganidae	*Siganus*	*sutor*	17
Sphyraenidae	*Sphyraena*	*flavicauda*	3
Grand Total			63

A comparison of fish represented in the categories of analysed fish vertebrae and nonvertebrae remains from Songo Mnara (Chapter 6) showed that certain fish families were better represented in one category or the other. Fish families were ranked in order from highest to lowest number of remains in each category. These rankings were then compared between the two categories to see which families were better represented in either vertebrae or nonvertebrae remains. The same rank comparison analysis was applied to the data from Vumba Kuu (Figure 7.8). The results show that six families are ranked in equal order in both categories. Five families have a rank difference of less than five. Siganidae (rabbitfish) was the only family represented in both categories that was significantly better represented in one group: vertebrae. This and the three families found exclusively in the vertebra category— Mugilidae, Chirocentridae and Carcharhinidae—were also better identified in the vertebra remains at Songo Mnara. It was observed that these fish tended to have more recognizable vertebrae, longer bodies with more vertebrae, or more fragile cranial elements. At the other extreme, Tetraodontidae was found only in the nonvertebrae remains at both Songo Mnara and Vumba Kuu. Again, this family has distinctive robust cranial elements that are more likely to be found in the category of nonvertebrae remains and a low number of vertebrae.

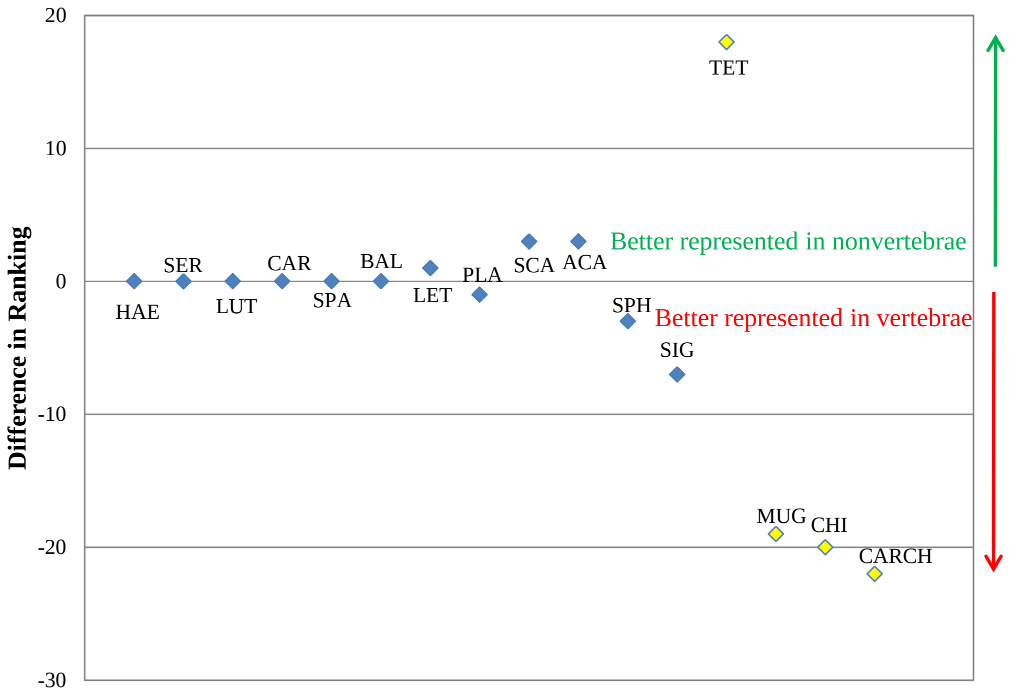


Figure 7.8: Rank difference analysis for identified fish families from Vumba Kuu
The graph compares differences in the representation of fish families (ranked from most to least common) in two categories of identified fish remains: vertebrae vs. nonvertebrae. The families closest to zero are most equally represented in both sample categories while those represented by yellow dots were identified only within their own category.

Analysis of fish vertebrae is important to detect the presence of cartilaginous species, such as shark and ray. Seven shark vertebrae were found in the analysis of the vertebra sample from Vumba Kuu, indicating that sharks were consumed in the town. The richest deposits, VMB007 and VMB008, were not included in the sample. Thus, it is difficult to determine the extent to which the inhabitants of Vumba Kuu consumed sharks.

The analysis of vertebrae outlined above highlights its value in determining the representation of certain fish families. At Vumba Kuu, vertebrae analysis revealed shark as well as three additional fish families, which included seven additional fish species.

Non-fish remains: unidentified fragments

Approximately 17 percent of the 5454 g of non-fish remains was composed of unidentified fragments (934 g). Fragments were divided into two size groups based on the length of their maximum dimension (Table 7.9).

Table 7.9: Summary of size classes of unidentified fragments (UFR) from Vumba Kuu

	≤3cm		>3cm		Total
Trench	(g)	%	(g)	%	UFR
VMB007	286	67%	140	33%	426
VMB008	155	84%	29	16%	184
VMB010	184	86%	31	14%	215
VMB011	76	81%	18	19%	94
VMB012	7	44%	8	56%	15
Total	708	76%	226	24%	934

Around 76 percent of all the unidentified fragments (UFR) have a maximum dimension ≤3 cm. However, some trenches contained higher fragmentation rates than others. Trenches VMB008, VMB010, and VMB011 have similarly high levels of fragmentation, with over 80 percent of unidentified fragments ≤3 cm. In VMB007, the percentage of ≤3 cm unidentified remains is slightly less than 70 percent. This trench also contains almost half the total mass of unidentified fragments. The particularly large sum of fragments >3cm could be related to the high number of cattle remains it contained, which produce heavier fragments from thicker bone. VMB012 has the lowest level of fragmentation and a very small amount of unidentified bone fragments (10 NISP). The approximately 95.5 kg of iron slag (Wynne-Jones 2009, 29: Table 10) excavated in this trench provides strong evidence that it was an ironworking area. The amount of faunal remains, on the other hand, is a meager 0.3 kg (Table 7.1). The nature of this small sample size is difficult to determine but it does not appear to be associated with domestic activity.

7.5 Comparison of spatial patterns of subsistence

In this section, I analyse the variability of diet and subsistence strategies across Vumba Kuu. I consider the spatial context of the results of the faunal analysis summarized above. Five trenches excavated within the town limits represent various locations around Vumba Kuu (Figure 7.9). As described before, the town can be divided into two sections: the NE section and the SW section, based on different above-surface characteristics. The NE side is an area with coral-stone mounds and the remains of a mosque along a creek. Two trenches were excavated in this section: VMB008 and VMB010. Trench VMB010 contained a small midden built up along the edge of a mud-thatch house (Wynne-Jones 2009, 22). In contrast, VMB008—a very rich midden deposit next to the mosque that was unique in the sheer quantity and types of remains—likely represents a form of public consumption (Wynne-Jones 2009, 17). The existence of coral mounds and proximity to the mosque indicate that people living in this section of Vumba Kuu may have enjoyed higher social status. These superficial features are not present on the western end of town by the remains of the town wall. Of the units excavated in this area, two represent domestic deposits (VMB007 and VMB011) and one an ironworking site (VMB012). Trench VMB007 contained a midden between mud-thatch houses (Wynne-Jones 2009, 15). Another domestic midden deposit was evident in VMB011 (Wynne-Jones 2009, 26). Nearby, an ironworking area was identified from a concentration of slag in trench VMB012 (Wynne-Jones 2009, 28).

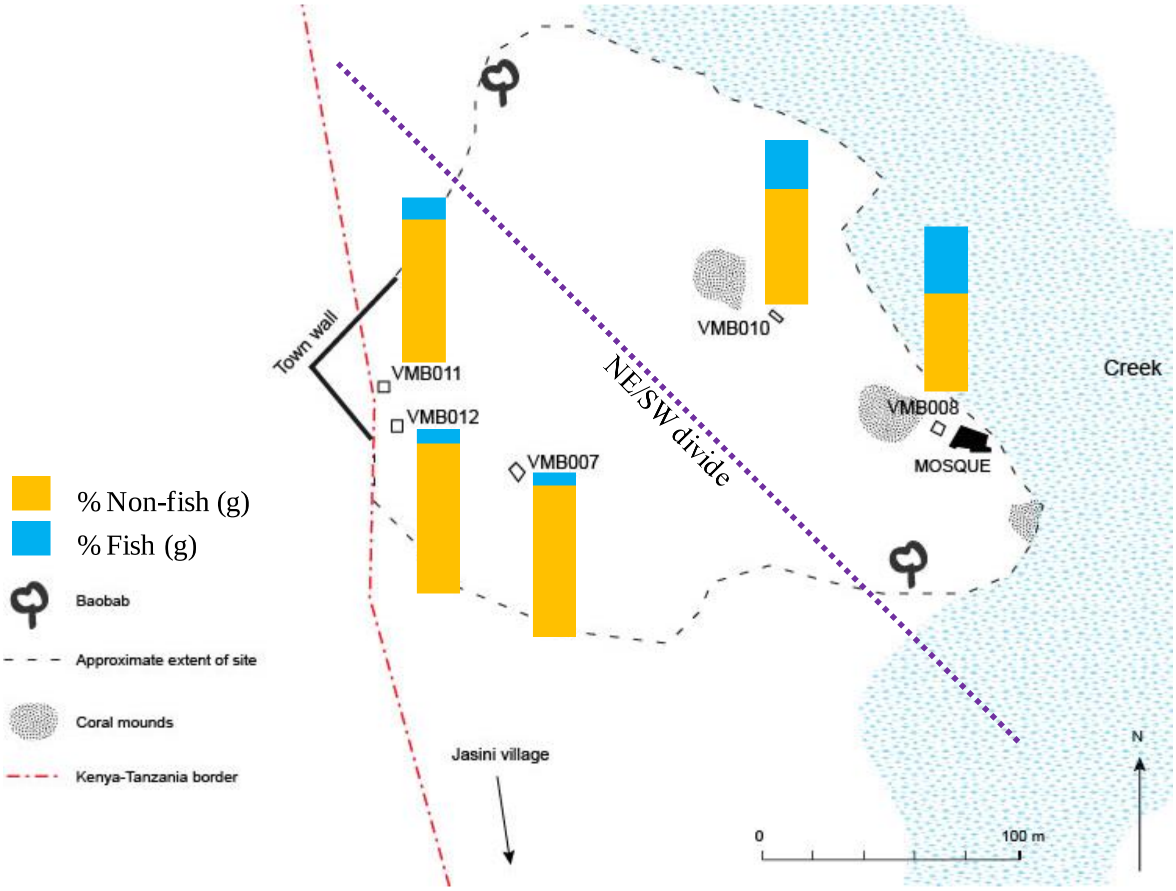


Figure 7.9: Relative mass of fish and non-fish remains across Vumba Kuu (the dotted line loosely divides the town into a NE and a SW section)

In summary, among the five excavated units, four represent midden deposits and one represents an iron-working site. Three of the midden units show food consumption patterns on a domestic level and the fourth on a larger scale. These midden deposits are divided between two characteristically different sections of Vumba Kuu. The following paragraphs compare the types of faunal remains found in each of these deposits.

Fish to non-fish comparison

The distribution of fish to non-fish weights reveals the relative importance of fish consumption across Vumba Kuu. Overall, non-fish remains outweigh fish 3 to 1—fish make up 25 percent of the total weight of faunal remains (7249 g). However, the percentage of fish to non-fish weight varies among the different excavation units, ranging from 8 to 40 percent (Figure 7.10). The difference is especially marked between the two sections of Vumba Kuu. In the SW side of town, percentages of fish mass range from 8 to 14 percent (in VMB007, VMB012, and VMB011). The trenches on the NE end near the mosque and creek show a higher reliance on fish consumption, with a range of fish mass percentage from 30 to 40 of the total mass of faunal remains. The NE and SW areas of Vumba Kuu are associated with different types of activities and material signatures—ironworking in the NE as opposed to feasting and coral mounds in the SW. Similarly, the proportion of fish to tetrapod remains point to different consumption practices in the two areas of town.

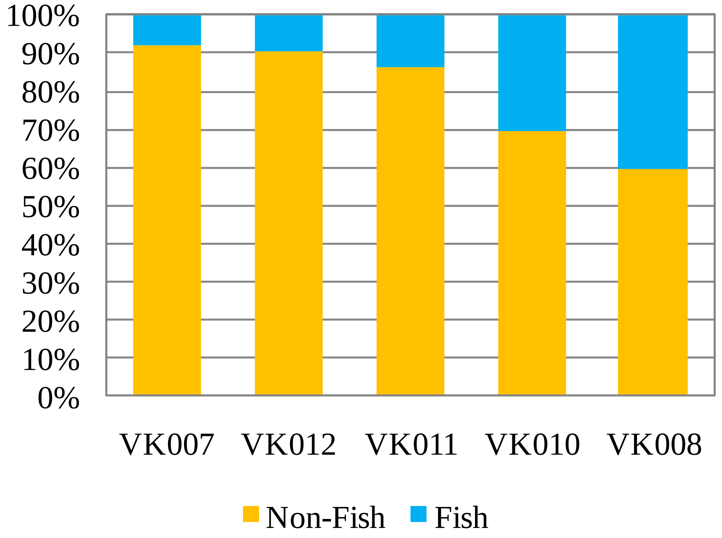


Figure 7.10: Comparison of fish and non-fish weights per trench at Vumba Kuu

Fish size

Size estimation was possible for 509 elements identified to near species level (identified to species or closely resembled an identified species). Methods for estimating the size (kg) of excavated fish remains are outlined in Chapter 6 for Songo Mnara. I divided these elements into size categories based on weight and plotted the distribution of sizes represented in each excavated area to compare variation across the town (Figure 7.11). The largest estimated fish sizes at Vumba Kuu reach up to 6 kg, much smaller than at Songo Mnara where fish up to 15 kg were caught. Like at Songo Mnara, *Carangoides fulvoguttatus* and *Lutjanus* cf. *sanguinueus* are among the largest identified fish at Vumba Kuu. In addition, a large parrotfish, *Cetoscarus bicolor* (identified from a left dentary), was estimated to weigh 5 kg. Other fish weighing around 4 kg were identified as likely the serranid species *Epinephelus multinotatus*. This species reaches up to 9 kg and inhabits coastal reefs (Froese and Pauly 2012). The majority of fish (98% of the total) weigh less than 4 kg. Fish from the family Haemulidae make up 43% of the category of fish with an estimated size of 1 to 3 kg. The smallest fish, <1 kg, are mostly from the Lethrinidae (39%) and Scaridae (32%) families. Overall, the lack of very large fish, over 6 kg, is striking compared to Songo Mnara. This pattern could reflect the types of fishing strategies employed around Vumba Kuu. The limited gear selectivity studies along the Swahili coast indicate that nets, small hooks, and small basket traps are mostly associated with smaller-sized fish catch (refer to Chapter 3). It is possible that Vumba Kuu fishers used fishing strategies such as these to target smaller fish.

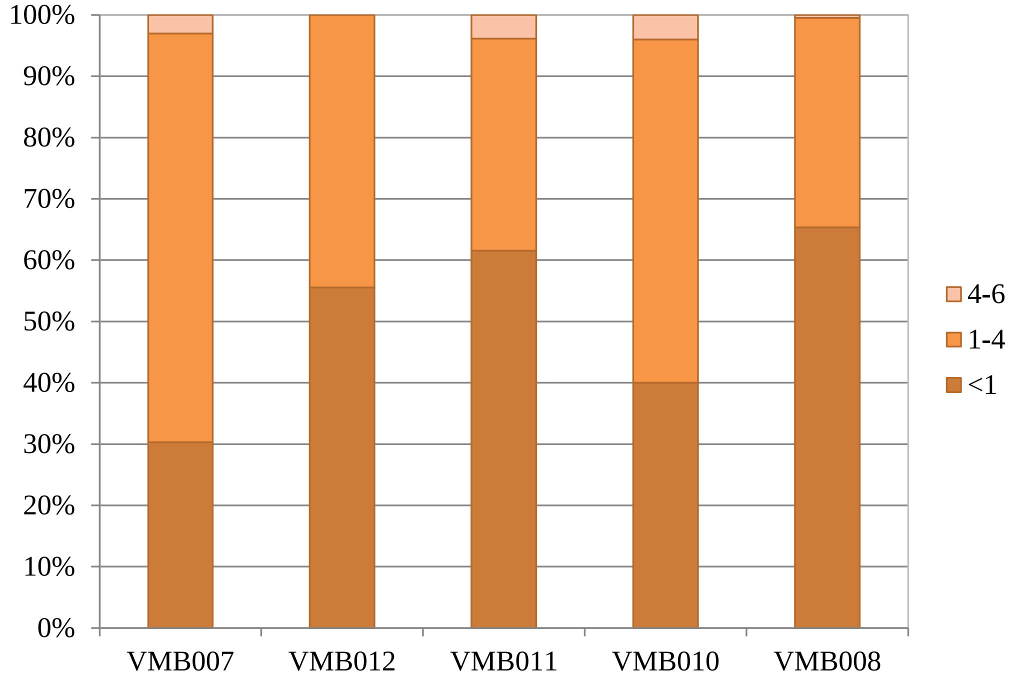
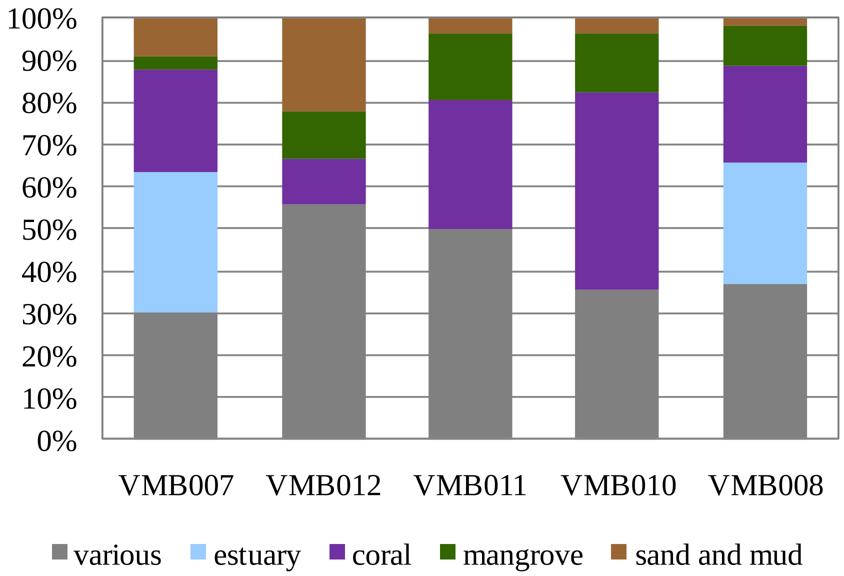


Figure 7.11: Distribution of fish size groups (kg) across Vumba Kuu

<u>Fish habitat</u>

I analysed the variation of exploited fish habitats from the same set of 509 fish remains—cranial, appendicular and special diagnostic elements identified to near species level—that formed part of the size group analysis above. This sample included 45 species categorized according to their principal habitat (refer to Chapter 3 on fish ecology). A large portion of these fish species (38%) inhabit several environmental zones and thus fall into the 'various' category. The remaining species can be associated with particular marine habitats found around Vumba Kuu. The two most exploited environments, estuary and coral reef, are almost equally represented, each making up 25% of the total (Figure 7.12). These habitats are followed by mangrove (10%) and sand and mud (3%) areas. No open sea species were identified at Vumba Kuu.



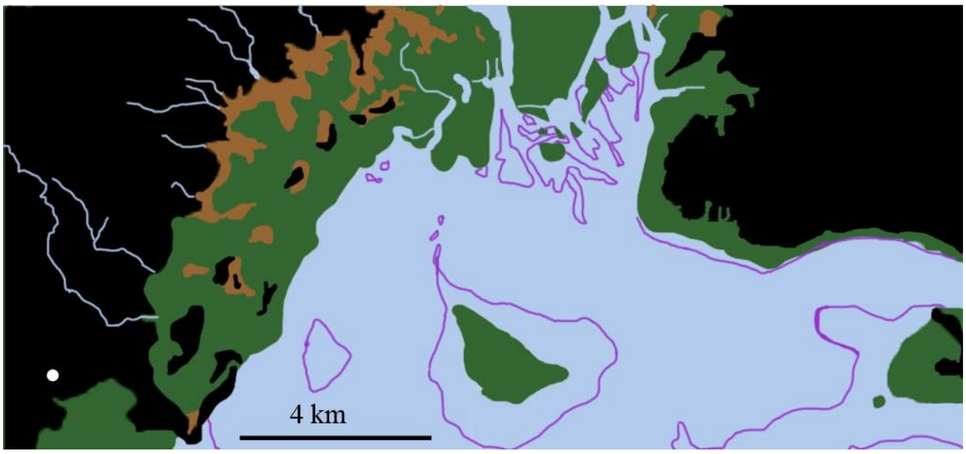


Figure 7.12: Distribution of exploited marine habitats around Vumba Kuu (the white circle marks the location of Vumba Kuu)

Like at Songo Mnara, fishers from Vumba Kuu exploited the range of nearby marine habitats. Fish remains from the various ecological zones are distributed around the town. Nonetheless, the layout of surrounding marine habitats differs between the two towns. A fringing coral reef lined one side of Songo Mnara island, allowing easy access to the rich resource. In contrast, Vumba Kuu fishers had to navigate creeks and channels through the mangroves into the estuarine bay to reach the offshore coral reefs. The fish habitat analysis shows that these reefs were nevertheless an important resource to exploit, but in equal standing with the more easily accessible estuary habitat. The higher representation of Haemulidae fish at Vumba Kuu results from greater exploitation of the estuary zone.

The spatial analysis of fish consumption around Vumba Kuu suggests that the contrast between the two principal areas of the town, NE and SW, is not as clear cut as at Songo Mnara. The largest contrast in fish consumption patterns between these two areas is in the relative contribution of fish to the diet. The reliance on fish consumption is significantly greater on the eastern end of town close to the mosque and the creek (Figure 7.9). Interestingly, the largest fish, >4 kg, are found in the domestic assemblages (VMB007, VMB011, and VMB010). The area associated with large scale food consumption (VMB008) contains the largest percentage of small, <1 kg, fish. Overall, there is little evidence for open sea fishing. No oceanic bony fish species were identified, although a total of seven shark vertebrae were found in VMB010 and VMB011. However, a sample of vertebrae from VMB007 and VMB008 was not analysed. Nonetheless, the lack of very large fish and oceanic species indicate that open sea fishing was probably not as common as at Songo Mnara. Instead, Vumba Kuu fishers mostly exploited the rich resources available inshore.

7.6 Discussion

On the surface, food consumption at Vumba Kuu is in line with the diet found at Songo Mnara; both are based on fish and domesticated animals supplemented with a few hunted animals. However, there are key differences between the two towns in the consumption of tetrapods and fish. Chicken and sheep/goat made up the majority of domesticated animals represented at Songo Mnara. In contrast, at Vumba Kuu, domesticated animals consist mainly of cattle and chicken remains. At Songo Mnara, rat remains were found exclusively in enclosed domestic spaces. At Vumba Kuu, rat and cat remains are also present, albeit mainly in the non-domestic deposits (VMB008 and VMB012). There is also a wider range of hunted animals found at Vumba Kuu. These are composed mainly of dugong remains in addition to various wild birds, mammals and reptiles. Dugongs could have been caught in shallow estuarine waters where they feed on sea grass beds (Macdonald 2011). Size and habitat analyses of fish remains at Vumba Kuu show a greater reliance on the nearby estuarine and coral habitats with very limited evidence for offshore fishing. The majority of fish were less than 4 kg at both Vumba Kuu (98%) and Songo Mnara (82%). However, there was a much wider range of fish sizes at Songo Mnara, up to 15 kg, than at Vumba Kuu, up to 6 kg. Additionally, no oceanic bony fish species were identified at Vumba Kuu. Overall, it appears that Vumba Kuu residents took advantage of locally available resources. The location of the town on the mainland would have allowed access to a wider array of wild animals and perhaps more grazing land required to maintain larger cattle herds than those found on an island. Vumba Kuu fishers exploited the estuary habitat they had to transverse en route to the coral reefs.

Dietary differences across the town were also detected, although they were not as marked as in Songo Mnara. The town is divided into two sections: the SW section exhibits high levels of iron slag, especially in an iron working area (VMB012); the NE section of town lies close to the mosque, the creek and a series of coral mounds. The SW end of town is characterized by higher consumption of cattle in the domestic deposits (VMB011 and VMB007). In contrast, a domestic deposit in the NE section (VMB010) shows a more balanced consumption of domesticated animals. Overall, fish consumption was more prevalent in this area. Especially high numbers of fish remains were found in a rich midden near the mosque (VMB008), which represents evidence of public consumption.

In comparing Vumba Kuu and Songo Mnara, one might also consider the different mesh sizes used to recover the faunal remains at each site. The quantity of fish at Vumba Kuu may be underestimated because of the use of 5 mm mesh—as opposed to the 2 mm mesh used at Songo Mnara—which would limit the retrieval of very small fish. During my ethnoarchaeological work in this area, I observed the use of small fish species, such as sardines (called *dagaa*). However, these species have not been identified in the archaeological material, possibly due to the collection methods. Future excavations at Vumba Kuu could include experimental work with different mesh sizes to determine the types of fish that are missing from the archaeological record.

Materiality in Context

Analysis of faunal remains from Vumba Kuu can be used to examine previously held assumptions about Swahili life. The *Chronicle of Vumba Kuu* portrays a link between elite, feasting, and cattle consumption. The connection between elite and cattle is noted in other historical sources and in ethnoarchaeological observations. The NE section of town can be interpreted as an area inhabited by higher status residents; proximity to the mosque and coral mounds (which could represent remains of coral-stone structures) are indicators visible on the surface. Excavations have revealed higher numbers of beads and imported ceramics in this area (Wynne-Jones 2009; Wynne-Jones 2010).

Additionally, there is evidence of feasting in the rich midden deposit excavated near the mosque (VMB008). The form of the ceramics as well as some special finds, such as a lamp and an incense burner, indicate that the materials in this trench are different from the other deposits (Wynne-Jones 2010). In light of the connection between high status and cattle consumption, one would expect this section of town, particularly the deposit associated with feasting, to have large quantities of cattle remains. However, the results from this analysis are not consistent with those expectations. The archaeological evidence of feasting at Vumba Kuu, represented by VMB008, shows consumption of mostly small fish, and larger quantities of chicken than cattle—although a high concentration of cattle remains occurs on the other end of town, near the ironworking area. A possible explanation is that cattle were slaughtered and processed in the SW area, and then the meat carried across town for the feast. Comparison of the proportion of high and low quality meat associated with cattle bones shows evidence that both butchering and consumption took place in both sections of town. The domestic deposits around Vumba Kuu indicate more cattle consumption in the SW area and a higher reliance on fish in the NE area; thus, although there is evidence of cattle consumption in the town, fish is more abundant in the areas associated with higher status.

The zooarchaeological evidence at Vumba Kuu reveals that perhaps fish was the preferred food in this community, indicating a break from other Swahili towns, such as Songo Mnara, where higher proportions of sheep/goat and cattle are found in elite areas. However, the consumption of mostly fish during feasting evident at Vumba Kuu can be interpreted as a local form of feasting that connects it to Swahili practices (Wynne-Jones 2010; Wynne-Jones). Furthermore, the zooarchaeological evidence indicates that food consumption and subsistence practices at Vumba Kuu are tied to its local environmental and social conditions. Different proportions of fish to other food items around the town reflect different consumption practices between the NE and SW areas of Vumba Kuu, which are also linked to different types of activities—ironworking in the SW and feasting and religious activities in the NE. The absence of very large fish and offshore species indicate that these types of resources were either not available or not exploited by Vumba Kuu fishers. One possible explanation is that the lack of large fish and oceanic species was an effect of overfishing, but there is no current data to support this hypothesis. Alternatively, fishers may have lacked the necessary tools, such as large boats and nets, to fish larger specimens farther offshore. Unlike many of the towns during the 14th to 16th centuries, Vumba Kuu shows little evidence of material wealth and trade connections. Higher numbers and variety of terrestrial animals and an abundance of estuarine fish can be linked to the types of resources available in Vumba Kuu's surrounding environment—its location on the mainland next to an estuary bay.

7.7 Summary

In this chapter, I used the results of faunal analyses to enrich the limited picture of Vumba Kuu portrayed in the *Chronicle*. This oral/written account outlines the succession of leaders and describes rituals surrounding the inheritance of power at Vumba Kuu that may have more to do with the present than the past. On the other hand, the faunal remains analysed here speak to the daily lives of the 14th to 16th century inhabitants of Vumba Kuu. The types of fish consumed in the town reveal how fishers primarily exploited the surrounding estuarine and coral habitats, with little evidence of fishing in the open sea. The faunal analysis shows that fish consumption was not only a part of the daily subsistence of the community at Vumba Kuu, but also played an important role as one of the main foods offered at feasting events—mainly small fish composed the faunal assemblage associated with public consumption next to the mosque.

Chapter 8: Research Themes in Swahili Ichthyoarchaeology

8.1 Overview

Researchers working in the Swahili coast recognize fishing as an important part of coastal subsistence because of its abundance in the faunal record and mention in historical accounts, but its role in coastal communities is not well understood. I addressed this gap through my analyses of fish remains at different scales of research. I used a multidisciplinary approach, including ethnoarchaeology and fish ecology, to understand the cultural and environmental processes that lead to the composition of fish bone samples from which I made interpretations about the role of fishing and fish consumption in Swahili societies. I summarize my results in an outline of Swahili ichthyoarchaeology at different scales of research and an overview of the main research themes that recur throughout the chapters in this thesis.

8.2 Beyond the midden: food consumption at different scales

Faunal remains, often found in deposits of ancient food debris around Swahili settlements, represent activities related to subsistence strategies and food consumption at different scales. Analyses of faunal assemblages from a variety of contexts show that distributions of food items and consumption activities vary within a house, around a town, and across the region. Within and across these spheres, food serves a variety of functions beyond the fulfilment of nutritional needs. I have described zooarchaeological evidence of food consumption at various scales in the contexts of two Swahili towns, Songo Mnara and Vumba Kuu, and in a regional analysis.

Household distribution

Although coral-stone structures have been a main focus of attention in the history of Swahili archaeology, the activities that took place within these houses have been reconstructed more with ethnographic than archaeological evidence. Ethnographic models have shaped our understanding of Swahili houses in relation to the roles of their inhabitants as elite members of societies and brokers in trade networks (reviewed in Fleisher and Wynne-Jones 2012). Thus, there are few examples in archaeological sources from which to draw comparisons of distributions of faunal remains at the household level. Donley-Reid's (1987) excavations of three 18th century houses in the Lamu Archipelago focused on the symbolic meaning of spatial organization within Swahili houses. Using ethnoarchaeological evidence, she interpreted the archaeological remains of a buried goat or sheep as the remains of *kafara*, the burial of a sacrificed animal in the centre of the *ndani* (back room) to protect the house, and a set of chicken bones in the same room as a type of love charm (1987, 184-5). These animal finds emphasize the ritual importance of the back room of the house, but animal remains associated with daily food consumption activities are not considered.

House 44 and House 23 at Songo Mnara provide data about the distribution of food consumption activities within households. Similar comparative data were not available from Vumba Kuu because it lacks the well-defined architectural remains found at Songo Mnara. The results indicate that food debris was concentrated in the back room of House 44, the interior room of House 23, and the monumental steps in the front entrance of House 23. The back room of House 44 and the front steps of House 23 contained large quantities of shark remains, which indicate that shark processing and/or consumption occurred in these areas. The concentration of food debris in a back room and an interior room at Songo Mnara challenge the notion of space in Swahili houses described by Donley-Reid (1987), which postulates that spaces towards the back of the house are more private and of higher ritual value.

This notion is also challenged by the patterning of other artefacts around the houses. There is a general pattern of deposition of refuse to the west of the doorways in all the rooms of House 44, which indicates that patterns of activities within a house are more complex than previously thought; there are differences among rooms but also within rooms (Fleisher and Wynne-Jones 2012, 197). Coins and spindle whorls were found in the various rooms of House 44, especially concentrated in the back room—evidence that craft production activities took place within the household (Fleisher and Wynne-Jones 2010, 26). The courtyard of House 23 had very few remains of all types indicating that this space was kept clean, and the interior room had evidence of cooking and craft production (Wynne-Jones and Fleisher 2010, 5).

In contrast to Donley-Reid's ethnoarchaeological work that focused on symbolic associations between materials and spaces, a component of my ethnoarchaeological research around Vanga studied the spatial layout of food-related activities—such as fish preparation, consumption and disposal--within a house. A survey of 30 participants who described the location of these activities around their house showed that cooking occurred most often in the back room—especially when this area lacked a permanent roof, eating in a room or a hallway, and disposing refuse outside of the house. This patterning of activities is a more flexible model for activities around a house and better reflects the trends observed in the archaeological layout of food debris at Songo Mnara.

Intrasite analysis

In their review of the use and meaning of space in Swahili towns, Fleisher and Wynne-Jones (2012, 175) point out an increasing emphasis on the study of town layouts as part of the process of social structure and not just a reflection of it. The distribution of faunal remains has been used to show intra-site differences at a few Swahili towns. Radimilahy (1998) notes evidence for the use of more domesticated animals and a more selective range of wild animals in assemblages from the fort at Mahilaka than in samples from the surrounding area of town. Horton and Mudida (1993; 1996) attribute the variation in the faunal assemblages from three trenches around Shanga to dietary preferences of different ethnic groups.

Analysis of the distribution of fish remains at Songo Mnara and Vumba Kuu provide two other cases of intra-site variability, which are possible because of extensive excavations across each site. The general picture at Songo Mnara showed that inhabitants of the mud-thatch area ate smaller fish (<5 kg) and higher proportions of fish than domesticated animals, while coral-stone dwellers consumed more domesticated animals than fish. Additionally, larger fish (5-15 kg) and higher numbers of shark and ray vertebrae were found in the coral stone area. There were also differences between areas of coral-stone structures; chicken was more abundant at House 44 while sheep/goat and cattle were more common in House 23.

The proportions of food items varied across Vumba Kuu. Numbers of domesticated animals, especially cattle, were higher in the southwestern area of Vumba Kuu, where there is also evidence of ironworking. In this area fish comprised <15% of the total weight of faunal remains. In contrast, fish comprised >30% of the mass of faunal remains in samples from the northeastern area. In the northeastern area, a small domestic midden showed a more balanced proportion of the three main domesticated animals—goat, chicken, and cattle—and a large midden near the mosque contained mostly remains of small fish, chicken, and dugong. The large quantity of remains and certain types of artefacts found in the midden next to the mosque—a lamp and an incense burner—indicate that this deposit resulted from public consumption (Wynne-Jones 2010).

Intra-site zooarchaeological analysis at Songo Mnara and Vumba Kuu reveals different patterns of consumption among different social groups (coral-stone house vs. mud-thatch house dwellers) and in different settings (domestic vs. public consumption). Moreover, these two settlements appear to represent different patterns of value associated with particular food items on the Swahili coast. At Songo Mnara, larger quantities of domesticated animal remains are found within coral-stone houses; these contexts are generally associated with higher socio-economic status, which could be extended to the remains of domesticated animals found within them. The high value of domesticated animal meat is corroborated in historical sources that describe the use of sheep, goat, and cattle in feasting rituals and offerings. However, the context representing public consumption at Vumba Kuu contained a majority of small fish. This provides evidence for a localized re-enactment of the regional custom of feasting, where fish instead of cattle are the main food item (Wynne-Jones n.d.).

Regional trends and variation

To understand the role of fish in Swahili life at a regional level, I compiled all available sources of faunal data from the coast. I used regional analysis to identify spatial and historical trends in the data as well as portray the variability of subsistence strategies across the region. In order to gain a fuller understanding of Swahili food consumption at a regional level, it is important to consider other sources, such as linguistic, historical, and other material evidence. Innovations in fish vocabulary were introduced as a group of Proto-Sabaki speaking people of mixed economy settled along the coast, and this vocabulary widened as the language developed into Proto-Swahili at the beginning of the sixth century. Historical sources as early as the first century AD describe hunting and fishing on the coast, and later sixteenth century descriptions mention rice and domesticated animals as important food items. The later historical references also describe the use of sheep and cattle for food offerings and in ritual feasting. The archaeological record shows that after the 11th century there is an increased use of large, open, decorated bowls and an increased consumption of rice. During this time, the coast was experiencing a period of growth in which many of the defining features of Swahili culture—coral-stone architecture, urban centres, and Islam—developed.

Important changes are evident in the zooarchaeological record during post-11th century period of development on the coast. Offshore fishing, deduced from the presence of mostly shark remains, begins at Shanga around the 12th century and increases thereafter (Horton and Mudida 1993). This pattern holds true across the region; only settlements occupied after this date contain evidence of offshore fishing, but not all later settlements participate in this new fishing strategy. At Shanga and Chwaka, which have comparable chronological data, there is an increase in the proportions of domesticated animals over fish around this time. In the middle of the 13th century, there is a sudden shift between dry and wet conditions in the regional climate visible in lake cores, which may have had an effect on coastal environments and played a role in subsistence changes, such as an increasing reliance on domesticated animals and offshore fishing.

Zooarchaeological evidence reveals that habitats are exploited differently at each settlement although a similar set of coastal habitats exist around much of the coastline. Overall, coral reefs are the most exploited habitat, and the proportion of coral species represented in each settlement ranges from 25 to 90 percent. There are also differences in the types of species that dominate samples from various settlements: Vumba Kuu, Kizimkazi, Shanga, and Tumbatu assemblages are dominated by remains of emperor fish (*Lethrinus* spp.), which are normally caught with handlines or nets. Chwaka, Mduuni, Kaliwa, Unguja

Ukuu, and Fukuchani have mostly remains of parrotfish (*Scarus ghobban*), which is caught mainly with traps.

8.3 Themes in Swahili ichthyoarchaeology

The socio-natural landscape of the Swahili coast

The term socio-natural is used to emphasize the interrelated roles of culture and environment in fishing and fish consumption on the Swahili coast. Eaten fish, as with other food, are closely linked to both natural and cultural processes: fish have adapted to living in a variety of marine environments and they enter the social realm at the hands of fishers. I use a combination of ethnoarchaeology, ecology and archaeology to show that culture and environment do not act in isolation, but are in fact tightly linked in the practices of fishing and fish consumption. For example, fishers make decisions about how and when to fish by considering environmental factors (e.g., monsoon currents, tides, and fish habitats) as well as cultural factors (e.g., age, skill, and socioeconomic status). Because the archaeological record of fish remains is a result of the effects of these factors, ichthyoarchaeological analysis allows us to reconstruct both social and environmental aspects of life on the Swahili coast.

The Swahili coastline has been classified into regions with distinct cultural and environmental characteristics. I used a systematic analysis of subsistence strategies and exploited fish habitats at various Swahili settlements to show how culture and environment are interrelated. Five main habitats are found along the Swahili coastline although in different proportions around each settlement: coral, estuary, sandy-muddy, mangrove, and open sea. Overall, the exploitation of marine habitats reflects the proximity of these habitats to the settlements. For example, around offshore islands, where coral reefs are more abundant and accessible, fishers exploited more coral species. However, the types of exploited fish species within habitat groups varied among settlements; this could reflect a combination of variability in fish species distributions and the use of different fishing strategies or tools to exploit similar environments. Furthermore, open sea fishing occurred in settlements with more capital, attested by higher numbers of coral-stone architecture, imported ceramics, and higher proportions of domesticated animal meat. I propose that the wealth and position of elite members of society allowed them to invest in the more expensive boats and gear needed for offshore fishing. These patterns show that fishing strategies are determined not just by the configuration of marine habitats, but also by cultural conditions.

The cultural life of fish

Numerous fish remains found in settlements along the coast attest to the economic importance of fish in Swahili communities, but how did fish fit into the cultural fabric of Swahili life? Related to this question is an investigation into the trajectory of fish within the social realm, from the moment they are captured out at sea, through different stages of use and transformation, to the disposal of their bones. This series of taphonomic processes, which I refer to as the cultural life of fish, has been left out of previous discussions of Swahili fishing and fish consumption. Ethnographic sources of the Swahili coast (Prins, Ingrams, Grottanelli) have described in great detail the cultural and material aspects of fishing strategies on the coast, but little is mentioned about what happens next. Similarly, in the limited archaeological sources of fish remains, the focus is on inferring the types of technology used to capture the species represented, and there is little discussion about processing, consumption, or disposal practices associated with these remains. I argue that in order to understand the role of fish in Swahili society, we need to decipher the processes involved in creating the accumulations of fish remains that we find in archaeological contexts.

I used ethnographic tools—interviews and participant observation—to investigate the social and material dimensions in the capture, distribution, use, and disposal of fish at three contemporary fishing settlements in southern Kenya: Vanga, Jimbo, and Jasini. The results demonstrate that different fishing strategies required different levels of skill, number of crew, and capital invested in gear and vessels. Different social categories of people were involved in the various stages of the cultural life of fish; women, for example, had a particularly important role in transforming fish through cooking and redistributing fish within the household and often across the community in cases when they sold dried or cooked fish. I observed four principal ways of preparing fish—boiling, frying, grilling, and drying—and the tools, methods, and spaces used. The open area by the landing beach was the site of important fish-related activities, such as boat maintenance (using fire and shark oil), gear fixing and construction (making basket traps, drying nets), and distribution of landed fish (weighing and selling). These observations bring the archaeological material to life by identifying the social processes behind material traces.

For example, the analysis of fish remains excavated from Vumba Kuu (summarized in detail in Chapter 7) shows some patterns consistent with observations made in the ethnoarchaeology study. Fish was ranked as an important and common food item in food diaries and food rankings recorded around Vanga, which shows the importance of fishing and fish consumption to the current inhabitants of this area. Large quantities of fish remains excavated across the ancient town reveal that fishing was also an important subsistence strategy in the 14th to 16th centuries. Emperors and parrotfish are two of the most common fish families currently fished and also make up half the total number of identified remains at Vumba Kuu. This parallel could be explained by the continuation of similar fishing technologies to exploit the marine resources around the past and present settlements in this area. The abundance of fish cranial elements in the excavated fish remains is a result of both preservation and the consumption of whole fish. Fish processing and consumption patterns that result in the disposal of complete fish skeletons are still visible in the Swahili region today.

It's all in the way you do it: Swahili ichthyoarchaeology

One of the underlying aims of this thesis is to begin to develop a more cohesive approach to Swahili ichthyoarchaeology in an effort to address the disjointed nature of previously published fish remains data. We have come a long way since Chittick's (1984) short report on the hand-collected remains from Manda, but the regional meta-analysis shows that more can be done to create a more cohesive methodology. Explicit consideration of the use of different methods enables the comparison of assemblages to understand not just the particular characteristics of one settlement, but also how an assemblage fits into the regional picture.

In the process of my own analyses, I have tested the effectiveness of a variety of methods in exploring Swahili fish remains data. For example, I compare three principal quantification techniques: Number of Identified Specimens (NISP) and Minimum Number of Individuals (MNI) show similar trends in the relative representation of fish families, while weight (W) shows a slightly different trend that reflects differences in sizes. These results are in line with what is expected from the comparison of these techniques (Reitz and Wing 2008). I compile fish ecological information on habitat preference associated with commonly found species on the Swahili coast and categorize these into five main coastal habitats—I use this index to interpret the exploitation of marine habitats at Songo Mnara and Vumba Kuu, as well as in the regional analysis. This index requires further fine-tuning, but could serve as a useful tool for sorting species by habitat in the analysis of other fish remains assemblages. I have also considered the impact of excavation and sampling methods on the interpretation of the data. For example, a comparison of fish families identified in the analysis of vertebrae versus the analysis of other identified elements (mostly cranial and appendicular) allowed me to identify the types of fish that are underrepresented and overrepresented in each category. Fish mostly or only represented in vertebrae tend to have elongated bodies, fragile cranial bones, vertebra with distinct characteristics or a combination of these. Conversely, fish mostly identified in cranial and appendicular samples tend to have robust cranial elements, shorter bodies, less identifiable vertebra, or a combination of these. The variability of preservation rates evident in the representation of fish elements highlights the importance of analysing all skeletal elements.

8.4 Applications in a wider context

As described in the introductory chapter, the study of subsistence strategies in Africa has focused on large scale changes, such as the introduction and spread of domesticated plants and animals, that emphasize the role of foreign food sources and the dichotomy of culture and environment. In contrast, my research focuses on fish, a locally available resource, and the ways environment and culture intersect to define subsistence strategies at a local and regional level.

Similarly, an overview of published sources in the field of ethnoarchaeology of faunal remains showed gaps in research on fishing communities and complex societies (also discussed in David and Kramer 2001) and cooking and food distribution (Gifford –Gonzalez 1993). My ethnoarchaeology of Vanga area contributes to these areas of ethnoarchaeological research. My research portrays the role of fish in complex coastal communities in East Africa, tracing the entire trajectory of fish from capture to disposal. Furthermore, I demonstrate how these insights apply to the interpretation of archaeological data.

Anthropogenic and climatic impacts on marine habitats are a growing concern in the world today. It is estimated that important natural resources, such as the Great Barrier Reef, are deteriorating rapidly (De'ath et al. 2012). Researchers acknowledge the need for a better understanding of long term trends in order to manage and protect these resources. Fish remains data from the Swahili coast have the potential to contribute to a long term regional record of the changing state of East African marine resources. My work contributes a synthesis of available historical data for the Western Indian Ocean fringe and a look into the ways exploited marine resources relate to societies that can help in developing conservation efforts in this region.

8.5 Limits of thesis

The major challenge in working with zooarchaeological data (which is the case in archaeology in general) has been controlling and identifying taphonomic processes so that their impacts are considered in the interpretation of the data. I distinguished two types of taphonomic processes: first order processes are those that are out of the control of the archaeologist, such as rates of diagenesis; second order process include processes in which archaeologists are directly involved, such as sampling and excavation techniques. These challenges were particularly evident in the regional analysis because I compared faunal data sets from a variety of sources. I addressed these challenges by obtaining as much information as possible about the conditions in which assemblages were excavated and sampled to acknowledge how these may affect the results of my analyses. Future work could involve experimental work in this area, such as testing for differences in a variety of mesh sizes to test the impact of mesh size on the collection of fish remains.

8.6 Future directions

Numerous possibilities for future research emerged in the process of developing this project; here I highlight a few. The ethnoarchaeological study, habitat analysis, and comparison of gears highlighted the various implications of fish size. Although most fish are eaten whole, larger fish are cut into smaller pieces and smaller fish are cooked whole. Fish size, which correlates to fish age within species, also determines where a fish is mostly likely to be captured since juvenile and adult fish of the same species sometimes inhabit different sections of the marine environment. Gears are designed to capture different ranges of fish sizes by changing the mesh size of the net, the opening size of a trap, or the size of the hook. Furthermore, the intrasite analysis of fish remains from two Swahili towns revealed differences in the spatial distribution of fish sizes that could be linked to socio-economic status. However, estimation of fish size is rarely attempted (e.g., Van Neer 2001). More work on fish size estimation promises great potential in revealing meaningful patterns of fishing and fish consumption on the Swahili coast.

There is also potential in the study of seasonality through growth ring analysis visible on fish bones or otoliths to test whether fish assemblages show signs of seasonal consumption practices of particular types of fish. It has been assumed that the fish collected in Swahili samples represent all seasons, but ethnographic and ethnoarchaeological evidence and fisheries reports suggest that the two main monsoon seasons have an impact on the availability of certain fish and the use of different fishing strategies. Testing this approach was not within the scope of this thesis, but future work could provide interesting results that would be applicable to the study of Swahili archaeology and historical ecology.

Ethnoarchaeology has proved to be an effective strategy for deciphering the cultural life of fish and the impacts of taphonomy, and more work can be done in these areas. For example, food diaries could be expanded to record the types of food that are eaten during longer spans of time and at different times of the year. More ethnoarchaeological work in other parts of the coast is needed to evaluate how the processes associated with fishing and fish consumption play out in different settlement types and environmental regions. Experimental approaches could be used to study the impact of different types of cooking methods on the diagenesis of fish bones. In the many paths of future research, it is clear that a multidisciplinary approach is an effective way to produce meaningful information from analysing the remains of fish.

Appendix A: Reference Specimens Donated to NMK

Table A.1: Reference specimens donated to NMK
List and description of fish skeletons collected for donation to the Osteology Department, National Museums of Kenya (NMK).
***Incomplete: missing skulls; TL=total length, SL=standard length, HL=head length, W=weight, FL=fork length**

#	Family	Genus	Species	Date	Locality	TL (mm)	SL (mm)	HL (mm)	W (g)	FL (mm)	Sex
1	Lethrinidae	*Gymnocranius*	*sp.*	11/15/2010	Mombasa	284	219	73	372		F
2	Lutjanidae	*Lutjanus*	*argentimaculatus*	11/18/2010	Jimbo	409	330	118	880		M
3	Labridae	*Coris*	*formosa*	11/18/2010	Jimbo	378	312	89	879		
4	Nemipteridae	*Scolopsis*	*bimaculatus*	11/18/2010	Jimbo	261	206	63	257		
5	Haemulidae	*Plectorhinchus*	*schotaf*	11/18/2010	Jimbo	267	215	64	240		
6	Platycephalidae	*cf. Papilloculiceps*	*longiceps*	11/18/2010	Jimbo	284	227	88	130		
7	Scaridae	*Calotomus*	*carolinus*	11/18/2010	Jimbo	278	224	67	369		
8	Labridae	*Cheilio*	*inermis*	11/20/2010	Vanga	273	236	80	125		
9	Clupeidae	*Sardinella*	*sp.*	11/21/2010	Vanga	195	158	35	64		
10	Acanthuridae	*Naso*	*thynnoides*	11/21/2010	Vanga	310	255	56	395		F
11	Carangidae	*Scomberoides*	*tol*	11/22/2010	Vanga	327	268	57	198	286	
12	Sphyraenidae	*Sphyraena*	*putnamae*	11/22/2010	Vanga	412	340	107	286		M
13	Lutjanidae	*Lutjanus*	*lutjanus*	11/22/2010	Vanga	173	137	48	71		F
14	Lethrinidae	*Lethrinus*	*lentjan*	11/22/2010	Vanga	354	280	94	687		F
15	Lethrinidae	*Lethrinus*	*microdon*	11/22/2010	Vanga	323	254	98	342		
16*	Acanthuridae	*Naso*	*sp.*	11/24/2010	Vanga	458	374	80	943		
17*	Elopidae	*Elops*	*machnata*	11/24/2010	Vanga	1077	870	180	5000		M
18	Carangidae	*Carangoides*	*plagiotaenia*	11/24/2010	Vanga	324	262	70	367	280	F
19	Lethrinidae	*Lethrinus*	*harak*	11/24/2010	Jimbo	247	191	62	220		
20	Carangidae	*Carangoides*	*caeruleopinnatus*	11/25/2010	Vanga	292	227	70	363	247	M
21	Carangidae	*Gymnocranius*	*grandoculis*	11/25/2010	Vanga	283	211	69	325		

Appendix B: Habitat Index

Table B.1: Habitat Index
List of all identified fish species from regional data set and their associated habitat
Data from Shanga (Horton and Mudida 1993); Kaliwa, Chwaka, Mduuni (Fleisher 2003); Mtambwe Mkuu, Ras Mkumbuu, Tumbatu, Fukuchani, Unguja Ukuu (Mudida and Horton n.d.); Kizimkazi (Van Neer 2001)

Family	Genus	Species	Common Name	Habitat
ACA	*Acanthurus*	*cf. mata*	Elongate surgeonfish	coral/rocky
		cf. xanthopterus	Yellow surgeonfish	estuary
		dussumieri	Eyestripe surgeonfish	coral/rocky
		lineatus	Lined surgeonfish	coral/rocky
	Naso	*hexacanthus*	Sleek unicornfish	coral/rocky
ALB	*Albula*	*neoguinaica*	Sharpjaw bonefish	sandy/muddy
		vulpes	Bonefish	sandy/muddy
ARI	*cf. Netuma*	*bilineata*	Bronze catfish	estuary
	Arius	*thalassinus*	Giant catfish	estuary
BAL	*Abalistes*	*stellatus*	Starry triggerfish	sandy/muddy
	Sufflamen	*fraenatum*	Masked triggerfish	coral/rocky
CAR	*Alectis*	*ciliaris*	African pompano	various
		indica	Indian threadfish	coral/rocky
	Atule	*mate*	Yellowtail scad	mangrove
	Carangoides	*chrysophrys*	Longnose trevally	various
		fulvoguttatus	Yellowspotted trevally	coral/rocky
	Caranx	*heberi*	Blacktip trevally	coral/rocky
		ignobilis	Giant trevally	coral/rocky
		melampygus	Bluefin trevally	coral/rocky
		sexfasciatus	Bigeye trevally	coral/rocky
	Gnathodon	*speciosus*	Golden trevally	coral/rocky
	Trachinotus	*blochii*	Snubnose pompano	coral/rocky
CARCH	*Carcharhinus*	*wheeleri & limbatus*	Requiem sharks	open sea
CHA	*Chanos*	*chanos*	Milkfish	estuary
CHI	*Chirocentrus*	*cf. nudus*	Whitefin wolf-herring	open sea
DAS	*Taeniura*	*lymma*	Ribbontail stingray	various
DIO	*Diodon*	*hystrix*	Spot-fin porcupinefish	coral/rocky
EPH	*Tripterodon*	*orbis*	African spadefish	coral/rocky
EPH	*Platax*	*pinnatus*	Dusky batfish	coral/rocky
GER	*Gerres*	*longirostris*	Strongspine silver-biddy	sandy/muddy
HAE	*Diagramma*	*pictum*	Painted sweetlips	sandy/muddy
	Plectorhinchus	*cf. pictus*	Trout sweetlips	various
		flavomaculatus	Lemonfish	various
		gaterinus	Blackspotted rubberlip	various
		plagiodesmus	Barred rubberlip	coral/rocky
		schotaf	Minstrel sweetlips	coral/rocky
		sordidus	Sordid rubberlip	coral/rocky
	Pomadasys	*argenteus*	Silver grunt	various
		cf. commersonnii	Smallspotted grunter	various
		cf. kaakan	Javelin grunter	various
		cf. olivaceus	Olive grunt	various
		multimaculatus	Cock grunter	estuary
LAB	*Cheilinus*	*trilobatus*	Tripletail wrasse	coral/rocky
	Cheilio	*inermis*	Cigar wrasse	various
	Coris	*formosa*	Queen coris	coral/rocky
LAM	*Isurus*	*paucus*	Longfin mako	open sea

(Continued on next page)

Habitat Index (continued)

Family	Genus	Species	Common Name	Habitat
LET	*Lethrinus*	*borbonicus*	Snubnose emperor	coral/rocky
		elongatus	Smalltooth emperor	coral/rocky
		enigmaticus	Blackeye emperor	various
		harak	Thumbprint emperor	various
		lentjan	Pink ear emperor	sandy/muddy
		mahsena	Sky emperor	coral/rocky
		microdon	Smalltooth emperor	coral/rocky
		nebulosus	Spangled emperor	mangrove
		rubrioperculatus	Spotcheek emperor	coral/rocky
		sanguineus	Sky emperor	coral/rocky
	Monotaxis	*grandoculis*	Humpnose big-eye bream	coral/rocky
LOB	*Lobotes*	*surinamensis*	Tripletail	estuary
LUT	*Lutjanus*	*argentimaculatus*	Mangrove red snapper	estuary
		cf. coeruleolineatus	Blueline Snapper	coral/rocky
		cf. ehrenbergii	Blackspot snapper	coral/rocky
		fulviflamma	Dory snapper	various
		gibbus	Humpback red snapper	mangrove
		lutjanus	Bigeye snapper	coral/rocky
		russellii	Russel's snapper	mangrove
		sanguineus	Humphead snapper	coral/rocky
		sebae	Emperor red snapper	mangrove
	Macolor	*niger*	Black and white snapper	coral/rocky
	Pristipomoides	*filamentosus*	Crimson jobfish	coral/rocky
MUG	*Liza*	*macrolepis*	Largescale mullet	estuary
MUR	*Gymnothorax*	*favagineus*	Laced moray	coral/rocky
		undulatus	Undulated moray	coral/rocky
OST	*Lactoria*	*cornuta*	Longhorn cowfish	sandy/muddy
PLA	*Platycephalus*	*indicus*	Bartail flathead	sandy/muddy
	Papilloculiceps	*longiceps*	Tentacled flathead	coral/rocky
PLO	*Plotosus*	*limbatus*	Darkfin eel catfish	estuary
POM	*Pomacanthus*	*chrysurus*	Goldtail angelfish	coral/rocky
		semicirculatus	Semicircle angelfish	coral/rocky
SCA	*Bolbometopon*	*muricatum*	Green humphead parrotfish	coral/rocky
	Calotomus	*carolinus*	Carolines parrotfish	coral/rocky
	Cetoscarus	*bicolor*	Bicolour parrotfish	coral/rocky
	Hipposcarus	*harid*	Candelamoa parrotfish	coral/rocky
	Leptoscarus	*vaigiensis*	Marbled parrotfish	estuary
	Scarus	*cf. arabicus*	Arabian parrotfish	rare
	Scarus	*ghobban*	Blue-barred parrotfish	coral/rocky
	Scarus	*niger*	Dusky parrotfish	coral/rocky
	Scarus	*psittacus*	Common parrotfish	coral/rocky
	Scarus	*rubroviolaceus*	Ember parrotfish	coral/rocky
	Scarus	*russelii*	Eclipse parrotfish	coral/rocky
	Scarus	*sordidus*	Daisy parrotfish	coral/rocky
SCO	*Euthynnus*	*affinis*	Mackerel tuna	open sea
	Katsuwonus	*pelamis*	Skipjack tuna	open sea
	Scomberomorus	*commerson*	Narrow-barred Spanish mackerel	open sea

(Continued on next page)

Habitat Index (continued)

Family	**Genus**	**Species**	**Common Name**	**Habitat**
SCOR	*Synanceia*	*verrucosa*	Stonefish	coral/rocky
SER	*Cephalopholis*	*argus*	Peacock hind	coral/rocky
		aurantia	Golden hind	rare
	Dermatolepis	*striolata*	Smooth grouper	coral/rocky
	Epinephelus	*cf. maculatus*	Highfin grouper	coral/rocky
		cf. multinotatus	White-blotched grouper	various
		chlorostigma	Brownspotted grouper	coral/rocky
		coeruleopunctatus	Whitespotted grouper	coral/rocky
		coiodes	Orange-spotted grouper	coral/rocky
		fasciatus	Blacktip grouper	coral/rocky
		fuscoguttatus	Brown-marbled grouper	coral/rocky
		lanceolatus	Giant grouper	coral/rocky
		malabaricus	Malabar grouper	various
		sexfasciatus	Sixbar grouper	sandy/muddy
	Plectropomus	*cf. leopardus*	Leopard coralgrouper	coral/rocky
		punctatus	Marbled grouper	various
	Variola	*louti*	Yellow-edged lyretail	coral/rocky
SIG	*Siganus*	*cf. argenteus*	Streamlined spinefoot	coral/rocky
		cf. luridus	Dusky spinefoot	coral/rocky
		sutor	Shoemaker spinefoot	various
SPA	*Acanthopagrus*	*berda*	Goldsilk seabream	sandy/muddy
	Acanthopagrus	*cf. bifasciatus*	Twobar seabream	coral/rocky
	Argyrops	*spinifer*	King soldier bream	various
	Rhabdosargus	*haffara*	Haffara seabream	coral/rocky
		sarba	Goldlined seabream	estuary
SPH	*Sphyraena*	*barracuda*	Great barracuda	various
		cf. acutipinnis	Sharpfin barracuda	coral/rocky
		cf. putnamae	Sawtooth barracuda	coral/rocky
		jello	Pickhandle barracuda	coral/rocky
		qenie	Blackfin barracuda	coral/rocky
STE	*Stegostoma*	*fasciatum*	Zebra shark	various
TER	*Terapon*	*jarbua*	Jarbua terapon	various
TET	*cf. Arothron*	*hispidus*	White-spotted puffer	coral/rocky
		stellatus	Stellate puffer	coral/rocky

Appendix C: Ethics Statement

Procedures for Undertaking Archaeology and Ethnographic Fieldwork in Coastal East Africa

During the preparation and development of my PhD research in Kenya, I have taken steps to abide by administrative regulations and ethical standards. Upon review of my research proposal and application, titled *Swahili Fishing Culture and Fish Consumption in Coastal East Africa*, Research Authorization was granted from 20 May 2009 until 30 April 2012 under the Research Permit NCST/5/002/R/363 by the Kenyan National Council for Science and Technology. Affiliation with the National Museums of Kenya was granted for a one year period during which I conducted my ethnoarchaeology research. Subsequently, as advised in the terms of my Research Authorization, I reported to both the District Commissioner and District Education Officer in Msambweni District before undertaking my ethnoarchaeology fieldwork in the concerned district. I met with the respective officers to explain my research.

In addition, I introduced myself and my project to the Administrative Chief of Vanga Location whose office was in Vanga city, the administrative and commercial centre of the area. Upon visiting each surrounding village, I notified the Chairman/Chairlady of my research plans. Following the protocol put forth by the National Museums of Kenya Coastal Archaeology Department, I worked closely with a representative of their institution throughout my field work and deposited a copy of my field notes for their records. In addition, I hired an anthropology student from Moi University who had been assigned to complete her practical experience at the Coastal Archaeology Department. She was able to assist me as a translator during the interviews. Further assistance was provided by a local fisher and resident in Vanga who helped me arrange interviews and navigate the area, assuming the role of a key informant.

Interview participants were selected from the pool of adult members of the public, including men and women, for their involvement in fishing activities, including but not limited to the capture and collection, processing, and consumption of fish and shellfish. Participants were invited to participate in informal interviews with me and my research assistant after explaining the purpose of the research. They were advised that participation was completely voluntary. No formal questionnaire was used during the interviews. However, a carefully prepared series of questions was used to structure the interviews. A copy of the questions outline was included in my original Research Permit Application. Furthermore, although participants' names were recorded at the time of the interview, numbers were assigned to all interviewees to use as a reference during data analysis and publication in order to protect the privacy of individual participants.

Coral stone samples from the archaeological site of Vumba Kuu and fish skeletons from Vanga area were collected with approval from the National Museums of Kenya. These archaeological materials were exported to the University of Bristol for analysis with the following Export Permits: NMK/GVT/2 and NMK/GVT/2/12. Copies of my thesis will be provided to National Museums of Kenya and the National Council for Science and Technology upon completion of my research.

Appendix D: Ethnoarchaeology Interview Data

Table D.1: Summary of 2009 semi-structured interviews

No.	Date	Location	Age	Gender	Birthplace	Kabila	Occupation
1	6/4/2009	Jimbo	60	M	Msambweni	Digo	fisher
2	6/4/2009	Jimbo	50	M	Lunga Lunga	Digo	fisher
3	6/4/2009	Jimbo	42	M	Jego	Druma	fisher, farmer
4	6/4/2009	Jimbo	39	M	Zanzibar	Mtumbatu	fisher
5	6/5/2009	Jimbo	70	M	Ngoa		fisher
6	6/5/2009	Jimbo	32	M	Jimbo	Digo	fisher
7	6/5/2009	Jimbo	65	M	Jimbo	Digo	fisher
8	6/5/2009	Jimbo	75	M	Jimbo		fisher
9	6/5/2009	Jimbo	29	M	Pemba	Mpemba	fisher
10	6/5/2009	Vanga	48	F	Kijiru	Shirazi/Segeju	farmer
11	6/5/2009	Vanga	40	F	Vanga	Arab/Digo	sells cooked octopus
12	6/6/2009	Jimbo	28	M	Jimbo	Digo	fisher
13	6/6/2009	Jimbo	35	F	Tanga	Digo	café
14	6/6/2009	Jimbo	70	F	Jimbo	Segeyu	farmer
15	6/6/2009	Jimbo	44	F	Jimbo	Digo	café
16	6/6/2009	Jimbo	45	M	Jimbo	Shirazi	fisher
17	6/6/2009	Jimbo	35	M	Pemba	Shirazi	fisher
18	6/6/2009	Vanga	37	F	Vanga	Vumba	kiosk
19	6/6/2009	Vanga	45	F	Kiwegu	Digo	kiosk
20	6/7/2009	Vanga	70	F	Vanga		
21	6/7/2009	Jasini	26	F	Tanga	Digo	café
22	6/7/2009	Jasini	48	F	Vanga	Shirazi	daaga
23	6/8/2009	Jimbo	56	F	Moa	Segeyu	sells boabab
24	6/8/2009	Jimbo	26	F	Pemba		duvi fisher and farmer
25	6/8/2009	Jimbo	70	F	Jimbo	Shirazi	businesses, used to be potter
26	6/8/2009	Jimbo	45	F	Jimbo	Shirazi	sells maandazi, thatches
27	6/8/2009	Jimbo	60	F	Name	Segeyu	farmer
28	6/8/2009	Jimbo	48	F	Jimbo	Digo	shop
29	6/8/2009	Jimbo	38	F	Jimbo	Masai	dealer, chair
30	6/8/2009	Jimbo	66	M	Jimbo	Masi	fisher
31	6/9/2009	Jasini	42	M	Pemba	Mazerui	fundi
32	6/9/2009	Jasini	25	F	Mkinga	Digo	café
33	6/9/2009	Jasini	50	F	Kibafuta	Digo	sells coconuts
34	6/9/2009	Jasini	60	F	Duga	Digo	farmer, used to be potter
35	6/9/2009	Jasini		F	Magangani	Digo	sells rice breads
36	6/9/2009	Jasini	35	M	Likoni	Digo	fisher
37	6/9/2009	Jasini	37	M	Jasini	Digo	fisher
38	6/10/2009	Jimbo	65	M	Pemba	Shirazi	fisher
39	6/10/2009	Jimbo	35	M	Jimbo	Digo	fisher

(Continued on next page)

Summary of 2009 semi-structured interviews (continued)

No.	Date	Location	Age	Gender	Birthplace	Kabila	Occupation
40	6/10/2009	Jimbo	29	M	Vanga	Digo	dealer
41	6/10/2009	Jimbo	22	M	Likoni	Digo	tax collector
42	6/10/2009	Vanga	70	F	Vanga	Digo	sells cooked food
43	6/10/2009	Vanga	30	F	Vanga	Digo	sells cooked kome and octopus
44	6/10/2009	Vanga	47	F	Mayayale	Digo	sells sweet ice
45	6/11/2009	Vanga	35	M	Makanjani	Digo	fisher
46	6/11/2009	Vanga	75	M	Shimoni	Wakifundi	fisher
47	6/11/2009	Vanga	80	M	Majoreni	Shirazi	fisher
48	6/11/2009	Vanga	35	M	Boma		fundi
49	6/11/2009	Vanga	60	M	Vanga	Shirazi	fundi and fisher
50	6/11/2009	Vanga	70	M	Sihuu	Gunya	fisher
51	6/16/2009	Vanga	35	M	Chakwa	Digo	fisher
52	6/16/2009	Vanga	58	M	Msambweni	Digo	fisher
53	6/16/2009	Vanga	56	M	Vanga	Digo	fisher
54	6/17/2009	Jasini	54	M	Takaungu	Shirazi	carpenter, sells dagaa (with wife)
55	6/17/2009	Jasini	57	M	Vanga	Digo	farmer, chair
56	6/17/2009	Jasini	34	M	Jasini	Digo	fisher
57	6/17/2009	Vanga	35	M	Vanga	Vumba	Beach Management Unit
58	6/17/2009	Vanga		M	Jego	Digo	chief of Vanga area
59	6/18/2009	Vanga	34	M	Ngoa	Digo	fisher

Table D.2: Summary of 2010 structured interviews

No.	Date	Location	Age	Gender	Quarter (Vanga)	Kabila	Occupation
1	25/11/10	Vanga	50	M	Mkwajuni	Digo	Fisher
2	25/11/10	Vanga	42	F	Mkwajuni	Bajuni	Sells cloth, beads
3	25/11/10	Vanga	43	M	Kiungani	Arabu	Dealer
4	25/11/10	Vanga	50	F	Kiungani	Digo	Farmer
5	25/11/10	Vanga	48	F	Kiungani	Vumba	Homemaker, sells cassava
6	25/11/10	Vanga	22	F	Kiungani	Pemba	Homemaker
7	25/11/10	Vanga	40	F	Kiungani	Digo	Sells fruits and vegetables
8	25/11/10	Vanga	25	F	Gongo la mboto	Digo	Homemaker
9	25/11/10	Vanga	50	F	Gongo la mboto	Digo	Sells cashew nuts and bajia
10	25/11/10	Vanga	31	F	Jitenge	Digo	Sells groundnuts
11	25/11/10	Vanga	70	M	Jitenge	Digo	Fisher (uzio)
12	25/11/10	Vanga	30	M	Mgera	Shirazi	Dealer
13	25/11/10	Vanga	28	F	Mgera	Digo	Mchoraji (henna artist)
14	27/11/10	Jimbo	71	M		Digo	Fisher mshipi
15	27/11/10	Jimbo	52	M		Mtumbatu	Fisher mshipi
16	27/11/10	Jimbo	56	M		Mtumbatu	Fisher (seasonal-jarife)
17	27/11/10	Jimbo	34	F		Digo/Maasai	Dealer, chairlady
18	27/11/10	Jimbo	23	F		Digo	Homemaker
19	27/11/10	Jimbo	34	F		Digo	Homemaker, sells vegetables
20	27/11/10	Jimbo	33	F		Digo	Shares business with sister
21	27/11/10	Jimbo	46	F		Digo	Homemaker
22	27/11/10	Jimbo	23	M		Digo	Recordkeeper at fish market
23	27/11/10	Jimbo	24	M		Digo	Fisher (mshipi)
24	28/11/10	Vanga	26	F	Sheriani	Digo	Homemaker
25	28/11/10	Vanga	35	F	Sheriani	Mpemba	Homemaker
26	28/11/10	Vanga	30	F	Mwakifukua	Digo	Homemaker
27	28/11/10	Vanga	37	M	Mwakifukua	Digo	Fisher (mshipi)
28	28/11/10	Vanga	25	F	Mwakifukua	Digo	Homemaker
29	28/11/10	Vanga	55	M	Ulaya	Giriama	Medical laboratory technologist
30	28/11/10	Vanga	36	M	Magaoni	Digo	Salesperson, sells juice

Appendix E: Vanga Fish Recipe

Ingredients:
1 fish
1 unripe mango
1 small tomato (cubed)
1 small onion
1 lemon

Spices:
1 small piece of ginger
1 pilipili *(chili)*
5 garlic cloves
3 tsp. salt
1 tsp. curry
1 tsp. pepper
1 tsp. cardamom seeds

1) To prepare the fish, first we cut the fins with a knife. We removed the scales by scraping from the tail to the mouth with the knife. To remove the gills and the guts, we cut a line through the bottom of the fish and pulled them out. After cleaning it, we cut it in half, and then cut shallow slices on both sides to absorb the spices. We arranged the sticks at the bottom of the *kikaango* to keep the fish from burning.

2) You peel an unripe mango and slice into small pieces, put in *kikaango*. The rest of the ingredients were cut first, and then put into the *kikaango*. We added 1 small tomato cubed, 1 small onion, and squeezed 1 full lemon over the fish. We added water to the *kikaango* and put it over the charcoal stove.

3) In the meantime, we prepared the spices. We used a grinding stone to mix and grind the following ingredients: small piece of ginger, 1 *pili pili*, and 5 garlic cloves. These were pounded lightly with the grinding stone. We added about 3 teaspoons of salt and grinded. Then we added 1 teaspoon of curry, 1 teaspoon of black pepper, and 1 teaspoon of cardamom seeds → grind until soft. The entire mixture made about 1 heaped tablespoon of spice that was put into the boiling stew and covered.


4) We removed the *kikaango* from the fire when most of the water had evaporated, but not all. The dish was ready (and delicious!). We ate it with *mkate wa mayai*.


Appendix F: Map and Chronology of Sites in Regional Analysis

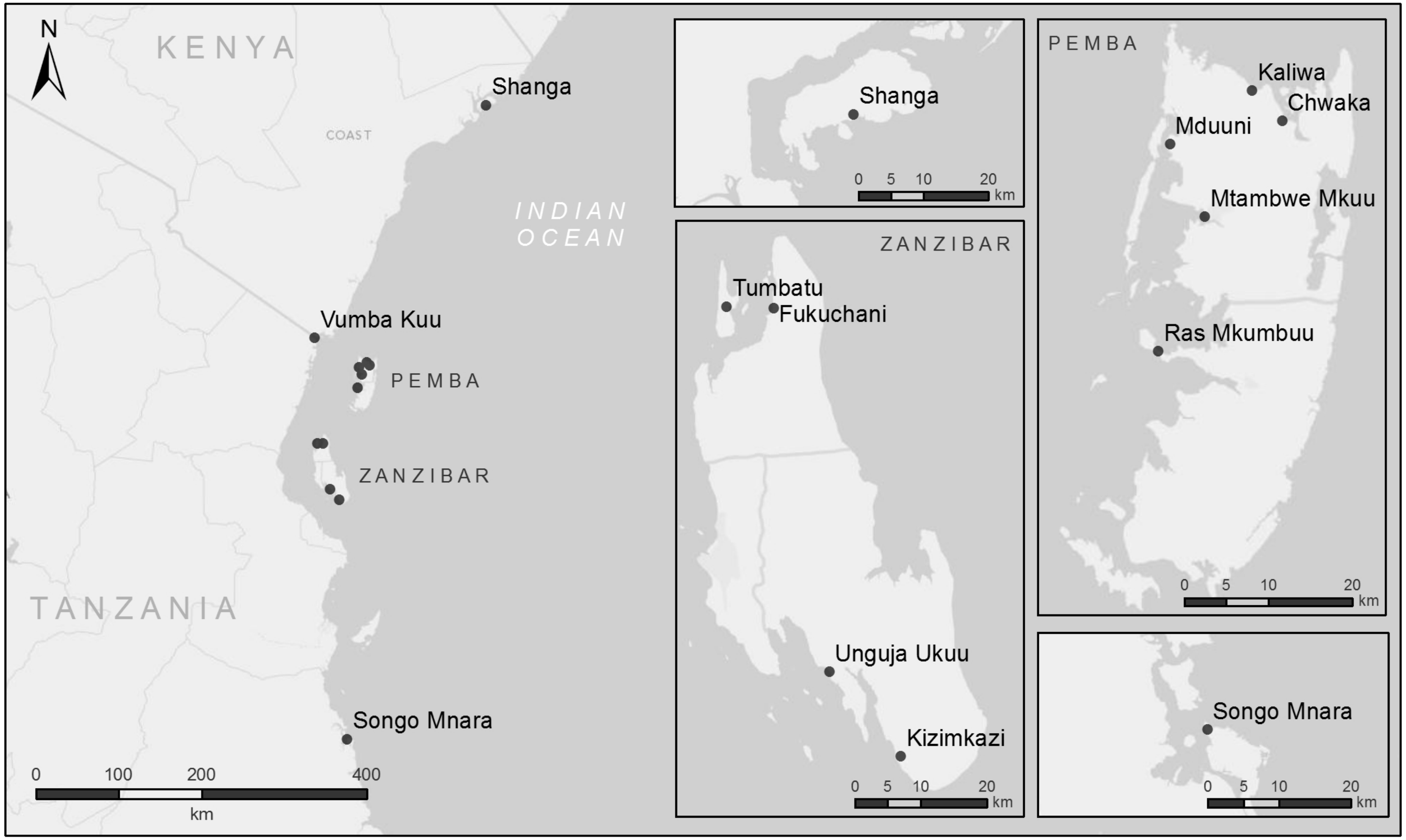


Figure F.1: Map of archaeological sites included in regional analysis

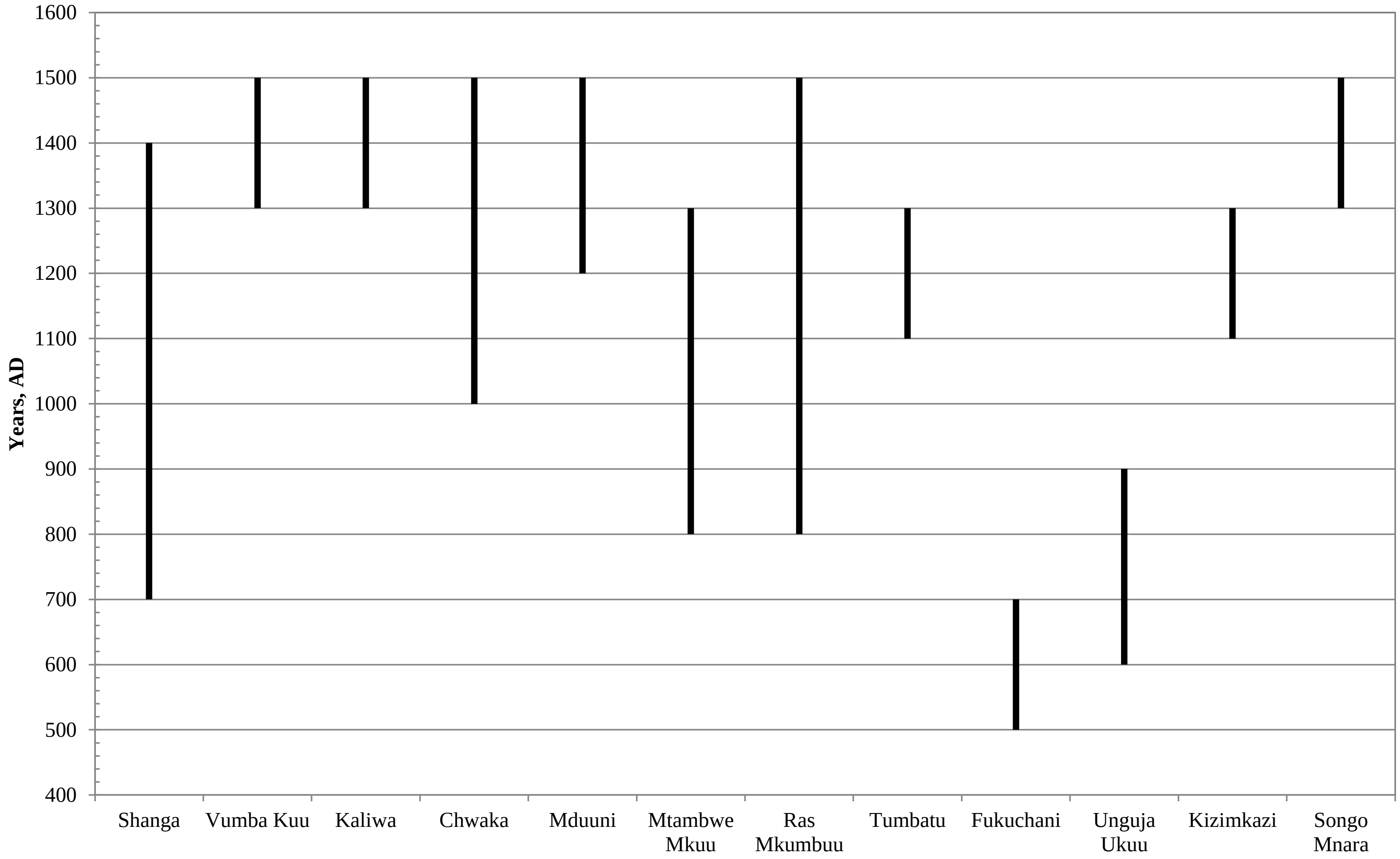


Figure F.2: Plot of occupation spans of archaeological sites included in regional analysis

Appendix G: Faunal Analysis Data

Table G.1: List of identified fish remains from Songo Mnara (nonvertebrae)

Family	Genus	Species	SM001	SM002	SM004	SM005	SM006	SM007	SM008	SM010	SM011	SM012	SM013	SM014	SM015	Total
ACA	*Acanthurus*	cf. *lineatus*							1	3						4
		cf. *mata*								1						1
		cf. *xanthopterus*								3						3
		lineatus								1						1
		spp.								1						1
	Naso	spp.								2						2
ARI	cf. *Netuma*	*bilineata*								1						1
BAL	*Abalistes*	*stellatus*	1													1
	cf. *Abalistes*	*stellatus*								1			1		1	3
	cf. *Canthidermis*	spp.	1							1						2
	cf. *Sufflamen*	*fraenatum*											1		2	3
		spp.					2			6						8
	Sufflamen	cf. *fraenatum*													4	4
		fraenatum								1						1
		spp.								1						1
		spp.					1			1						2
BEL	*Tylosurus*	spp.								1						1
CAR	*Carangoides*	cf. *chrysophrys*					1			2					2	5
		cf. *fulvoguttatus*					3			28			4		4	39
		chrysophrys													2	2
		fulvoguttatus								23			6	1	15	45
		spp.			1					16						17

(Continued on next page)

Songo Mnara nonvertebrae fish remains (continued)

Family	Genus	Species	SM001	SM002	SM004	SM005	SM006	SM007	SM008	SM010	SM011	SM012	SM013	SM014	SM015	Total
CAR	*Caranx*	cf. *heberi*								5					4	9
		cf. *melampygus*								6						6
		cf. *sexfasciatus*					1	2		3					1	7
		heberi	1													1
		melampygus								1						1
		sexfasciatus						1	1	3						5
		spp.					2			10						12
	cf. *Carangoides*	spp.													1	1
	cf. *Caranx*	*sexfasciatus*										1				1
		spp.								4	1					5
	Trachinotus	*blochii*													1	1
		spp.			1			1		12					2	16
CARCH		spp.		1			1									2
CHI	*Chirocentrus*	cf. *nudus*								4						4
		spp.					1									1
DIO	cf. *Diodontidae*	spp.					1									1
		spp.								1					1	2
GER	*Gerres*	cf. *longirostris*								2					1	3
		longirostris								2						2
		spp.		1						2						3
HAE	cf. *Diagramma*	spp.								1						1
	Plectorhinchus	cf. *gaterinus*					1			10			2		5	18
		cf. *pictus*								4			1		1	6

(Continued on next page)

Songo Mnara nonvertebrae fish remains (continued)

Family	Genus	Species	SM001	SM002	SM004	SM005	SM006	SM007	SM008	SM010	SM011	SM012	SM013	SM014	SM015	Total
HAE	*Plectorhinchus*	cf. *sordidus*								1						1
		gaterinus								8			1			9
		spp.					1			6						7
	Pomadasys	*argenteus*		1			1			3					2	7
		cf. *argenteus*			1		2	1		9		1			1	15
		cf. *commersonnii*													1	1
		cf. *kaakan*								1						1
		cf. *olivaceus*								1						1
		spp.					2			10						12
LAB	*Coris*	spp.								1						1
LET	cf. *Gymnocranius*	spp.								1						1
	cf. *Monotaxis*	spp.								1						1
	Lethrinus	*barbonicus*	2							1					4	7
		cf. *barbonicus*				1		1		5					1	8
		cf. *lentjan*					4	1		31			2		4	42
		cf. *mahsena*		1						4		1				6
		cf. *microdon*					2			3	1					6
		cf. *nebulosus*	2				2			19		2	2		3	30
		cf. *rubrioperculatus*					1			8			1		1	11
		lentjan	1				1			21						23
		mahsena								2					1	3
		microdon								3			2			5
		nebulosus		1		1				9						11
		rubrioperculatus								2						2
		spp.		1			4	1		33			1			40
		spp.	1							1						2

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Songo Mnara nonvertebrae fish remains (continued)

Family	**Genus**	**Species**	**SM001**	**SM002**	**SM004**	**SM005**	**SM006**	**SM007**	**SM008**	**SM010**	**SM011**	**SM012**	**SM013**	**SM014**	**SM015**	**Total**
LUT	cf. *Aprion*	spp.		1						2						3
	Lutjanus	cf. *coeruleolineatus*								1						1
		cf. *ehrenbergii*								2						2
		cf. *fulviflamma*					2	1		2						5
		cf. *gibbus*					1			7						8
		cf. *lutjanus*											5		1	6
		cf. *russellii*								5					2	7
		cf. *sanguineus*		1						5						6
		cf. *sebae*								1						1
		fulviflamma								1		1			1	3
		gibbus								6						6
		lutjanus	2	1		1				2					2	8
		russellii								3						3
		sanguineus								4						4
		sebae								1						1
		spp.								21						21
		spp.													1	1
MUG	cf. *Valamugil*	spp.								1						1
MUR	cf. *Gymnothorax*	spp.											1			1
	cf. *Muraena*	spp.										1				1
PLA	cf. *Cymbacephalus*	spp.								5						5
	Platycephalus	*indicus*								1						1

(Continued on next page)

Songo Mnara nonvertebrae fish remains (continued)

Family	Genus	Species	SM001	SM002	SM004	SM005	SM006	SM007	SM008	SM010	SM011	SM012	SM013	SM014	SM015	Total
SCA	*Scarus*	cf. *arabicus*								6						6
		cf. *ghobban*				2	1	1	1	17					5	27
		cf. *psittacus*								1						1
		cf. *rubrioperculatus*								1						1
		cf. *rubroviolaceus*								1						1
		cf. *sordidus*							1	3			1			5
		ghobban								8			2			10
		psittacus											1			1
		rubroviolaceus								2						2
		sordidus								3			1			4
		spp.							1	8						9
		spp.		1			1			1						3
SCO	*Euthynnus*	*affinis*								3						3
	Katsuwonus	*pelamis*								2						2
SER	*Cephalopholis*	*argus*								16						16
		cf. *argus*								13						13
		spp.					1			4						5
	cf. *Cephalopholis*	*argus*								1			1			2
		spp.								7						7
	cf. *Epinephelus*	spp.								4						4
	cf. *Variola*	*louti*					1			1						2
	Epinephelus	cf. *chlorostigma*		1					1	9	1		3		4	19
		cf. *coioides*				1	2			12			2		4	21
		cf. *fasciatus*								9						9
		cf. *maculatus*													1	1

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Songo Mnara nonvertebrae fish remains (continued)

Family	Genus	Species	SM001	SM002	SM004	SM005	SM006	SM007	SM008	SM010	SM011	SM012	SM013	SM014	SM015	Total
SER	*Epinephelus*	cf. *multinotatus*								2						2
		cf. *sexfasciatus*								3						3
		chlorostigma								7					2	9
		coiodes								8					1	9
		fasciatus	2							3						5
		sexfasciatus								2						2
		spp.	1							40					1	42
	Plectropomus	cf. *leopardus*								1						1
		spp.	1							14						15
SIG	*Siganus*	cf. *luridus*								1						1
		spp.								1						1
SPA	*Acanthopagrus*	cf. *berda*		2			1			2			1			6
		cf. *bifasciatus*								2						2
		spp.								1						1
	Argyrops	cf. *spinifer*					1									1
		spinifer								1						1
	cf. *Rhabdosargus*	*sarba*						5		1		1	4		4	15
		spp.								18						18
	cf. *Sparidentex*	spp.								1						1
	Rhabdosargus	cf. *haffara*								2					4	6
		cf. *sarba*							1	7					3	11
		haffara								2						2
		sarba								2					3	5
		spp.								8					1	9
		spp.								13					1	14

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Songo Mnara nonvertebrae fish remains (continued)

Family	**Genus**	**Species**	**SM001**	**SM002**	**SM004**	**SM005**	**SM006**	**SM007**	**SM008**	**SM010**	**SM011**	**SM012**	**SM013**	**SM014**	**SM015**	**Total**
SPH	*Sphyraena*	cf. *acutipinnis*								1						1
		cf. *jello*	1										1		1	3
		cf. *putnamae*								1						1
		cf. *qenie*											1			1
		jello								3						3
		qenie								2						2
		spp.								5						5
		spp.								1						1
TER	*Terapon*	cf. *jarbua*								1						1
		jarbua							1	2						3
		spp.								1						1
TET	*Arothron*	cf. *hispidus*											2			2
	cf. *Arothron*	*hispidus*								1						1
		stellatus											1			1
		spp.		2						1						3
Total			**16**	**15**	**3**	**6**	**44**	**15**	**8**	**710**	**3**	**8**	**51**	**1**	**107**	**987**

Table G.2: List of identified fish remains from Songo Mnara (vertebrae)

Family	Genus	Species	SM001	SM002	SM004	SM005	SM006	SM007	SM008	SM010	SM011	SM012	SM013	SM014	SM015	Total
ACA	*Acanthurus*	spp.								41						41
		cf. *anthopterus*								3						3
	cf. *Acanthurus*	spp.								2						2
ALB	*Albula*	cf. *oligolepis*								5						5
		spp.								4						4
BAL	cf. *Canthidermis*	spp.								1						1
	cf. *Sufflamen*	*fraenatum*								3						3
		spp.								5						5
	Sufflamen	spp.								1						1
BEL	*Tylosurus*	spp.								84						84
CAR	*Alectis*	cf. *indicus*								1						1
	Carangoides	cf. *bajad*								6						6
		cf. *fulvoguttatus*								10						10
		fulvoguttatus								21						21
		spp.								57						57
	Caranx	cf. *sexfasciatus*								3						3
		spp.								31						31
	cf. *Carangoides*	spp.								1						1
	cf. *Caranx*	spp.								3						3
	Scomberoides	*tol*								40						40
		spp.								1						1
	Selar	*crumenophthalmus*								15						15
	Trachinotus	cf. *blochii*								4						4
		spp.								1						1
		spp.								14						14

(Continued on next page)

Songo Mnara fish vertebrae remains (continued)

Family	Genus	Species	SM001	SM002	SM004	SM005	SM006	SM007	SM008	SM010	SM011	SM012	SM013	SM014	SM015	Total
CARCH		spp.	6	8	2	8	112	5	3	94	10	7	78	1	15	349
CHA	*Chanos*	*chanos*								4						4
CHI	*Chirocentrus*	*nudus*								4						4
		spp.								257						257
DASY		spp.		3			15	1		20	4	8	7		8	66
ELO	*Elops*	spp.								44						44
GER	*Gerres*	cf. *longirostris*								37						37
		longirostris								14						14
		spp.								91						91
HAE	cf. *Plectorhinchus*	spp.								1						1
	Plectorhinchus	spp.								20						20
	Pomadasys	spp.								69						69
LAB	*Coris*	spp.								1						1
LET	cf. *Gymnocranius*	spp.								1						1
	Lethrinus	spp.								168						168
LUT	*Lutjanus*	*sanguineus*								1						1
		sebae								1						1
		spp.								167						167
MON	*Monodactylus*	*argenteus*								1						1
		spp.								2						2
cf. MON	*Monodactylus*	*argenteus*								7						7
MUG	cf. *Mugil*	*cephalus*								51						51
		spp.								47						47
	cf. *Valamugil*	spp.								1						1
	Mugil	*cephalus*								5						5

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Songo Mnara fish vertebrae remains (continued)

Family	Genus	Species	SM001	SM002	SM004	SM005	SM006	SM007	SM008	SM010	SM011	SM012	SM013	SM014	SM015	Total
MUG	*Valamugil*	spp.								2						2
		spp.								23						23
MUL	*Parupeneus*	spp.								2						2
MUR	*Gymnothorax*	spp.								26						26
PLA	cf. *Papillo*	*longiceps*								9						9
		spp.								1						1
	cf. *Platycephalus*	spp.								2						2
	Papillo	*longiceps*								18						18
	Platycephalus	spp.								1						1
		spp.								1						1
SCA	*Calotomus*	*carolinus*								1						1
	Scarus	spp.								103						103
SCO	cf. *Euthynnus*	*affinis*								2						2
	Euthynnus	*affinis*								39						39
SER	*Epinephelus*	cf. *coiodes*								1						1
		spp.								113						113
	Variola	*louti*								2						2
		spp.								2						2
SIG	*Siganus*	*stellatus*								3						3
		sutor								15						15
		spp.								77						77
SPA	*Acanthopagrus*	spp.								2						2
	cf. *Rhabdosargus*	spp.								8						8
	Rhabdosargus	cf. *haffara*								1						1
		spp.								16						16
		spp.								7						7
SPH	*Sphyraena*	spp.								39						39
Total			**6**	**11**	**2**	**8**	**127**	**6**	**3**	**1981**	**14**	**15**	**85**	**1**	**23**	**2282**

Table G.3: List of identified tetrapod remains from Songo Mnara

Class	Taxonomic ID	Common name	SM010	SM011	SM013	SM014	SM015	Total
Bird	Anatidae	Duck	2					2
	Charadriidae	Wading bird			3			3
	Gallus gallus	Chicken	69	1	3	1	6	80
Unidentified bird			52		17	1		70
Bird Total			123	1	23	2	6	155
Mammal	*Bos*	Cattle	32	2			5	39
	Caprini	Sheep/goat	27		28		22	77
	cf. *Caprini*	Possible sheep/goat		1	2		1	4
	Small bovid		1					1
	Dugong dugon?	Dugong?	9					9
	Felis sp.	Cat	6		1			7
	Rattus sp.	Rat	23		1	1	5	30
	Suid	Pig	2					2
	Large ungulate		13		6		2	21
	Med ungulate		5		5		1	11
	Med-large ungulate		3				7	10
	Small mammal		2					2
Unidentified mammal			26	12	34		13	85
Mammal Total			149	15	77	1	56	298
Reptile	cf. *Chelonia mydas*	Turtle	647		3		6	656
	Varanus cf. *niloticus*	Monitor lizard	1					1
	Varanus sp.	Monitor lizard	4			1		5
Reptile Total			652		3	1	6	662
Total Identified			**199**	**4**	**49**	**3**	**49**	**304**

Table G.4: List of identified fish remains from Vumba Kuu (nonvertebrae)

Family	Genus	Species	VMB007	VMB008	VMB010	VMB011	VMB012	Total
ACA	*Acanthurus*	cf. *lineatus*		1		2		3
		lineatus		2				2
		spp.		1		1		2
	cf. *Naso*	spp.		2				2
	Naso	cf. *hexacanthus*		8				8
		spp.		1				1
		spp.	1	16				17
BAL		spp.	2					2
CAR	*Carangoides*	cf. *chrysophrys*				1		1
		cf. *fulvoguttatus*			1			1
		fulvoguttatus		2				2
		spp.				1		1
	Caranx	cf. *sexfasciatus*		5				5
		sexfasciatus	2					2
		spp.		5				5
	cf. *Caranx*	spp.		1				1
		spp.		5	2			7
HAE	*Diagramma*	cf. *picta*				1		1
	Plectorhinchus	cf. *gaterinus*		3				3
		cf. *pictus*					1	1
		cf. *plagiodesmus*		1				1
		gaterinus		1				1
		spp.	1	7				8
	Pomadasys	*argenteus*			1			1
		cf. *argenteus*				4		4
		cf. *commersonnii*			6			6
		cf. *kaakan*			2			2
		cf. *multimaculatus*	11	60				71
		multimaculatus		44				44
		spp.		5	5			10
		spp.		4	6			10
LET	*Lethrinus*	*barbonicus*				1		1
		cf. *barbonicus*				1		1
		cf. *elongatus*	1	2				3
		cf. *harak*		9				9
		cf. *lentjan*	1	4			2	7
		cf. *mahsena*		23				23
		cf. *microdon*		1	7	1		9
		cf. *nebulosus*	1	20	2			23
		cf. *rubrioperculatus*			2			2
		cf. *sanguineus*		10				10
		elongatus	1	6				7
		enigmaticus			1			1
		harak		3				3
		lentjan		1	1			2
		mahsena	2	18				20
		nebulosus		17	2	4		23
		spp.	15	129	3	1		148
		spp.			11	1		12

(Continued on next page)

Vumba Kuu nonvertebrae fish remains (continued)

Family	Genus	Species	VMB007	VMB008	VMB010	VMB011	VMB012	Total
LUT	*Lutjanus*	*argentimaculatus*	1	9				10
		cf. *argentimaculatus*		2				2
		cf. *fulviflamma*		3				3
		cf. *russellii*					1	1
		spp.	2	9		1		12
		spp.		4				4
PLA	*Papillo*	spp.		2				2
SCA	*Calotomus*	*carolinus*		3				3
	Cetoscarus	*bicolor*	1					1
	cf. *Cetoscarus*	*bicolor*	1					1
	cf. *Hipposcarus*	*harid*		2				2
	Hipposcarus	*harid*		1				1
	Leptoscarus	*vaigiensis*		7				7
	Scarus	cf. *ghobban*	1	43		7	3	54
		cf. *psittacus*			1			1
		cf. *russelii*		3				3
		cf. *sordidus*		2			1	3
		ghobban	5	57				62
		psittacus		3				3
		rubroviolaceus	3					3
		russelii		2				2
		spp.	3	34	2	3		42
		spp.		2	4			6
SER	*Cephalopholis*	spp.		2				2
	Epinephelus	cf. *coeruleopunctatus*		1				1
		cf. *coioides*				3		3
		cf. *lanceolatus*		1				1
		cf. *malabaricus*		6				6
		cf. *multinotatus*				1		1
		coeruleopunctatus		1				1
		coioides					1	1
		lanceolatus	1					1
		malabaricus	1	14				15
		spp.	1	19		2	1	23
	Variola	*louti*		1				1
		spp.		16	1	1		18
SIG	*Siganus*	cf. *argenteus*		1				1
		cf. *sutor*		7				7
		spp.		15				15
SPA	*Acanthopagrus*	*berda*	2	1				3
		cf. *berda*		1				1
		cf. *bifasciatus*			2			2
		spp.		2				2
		spp.	2	1				3
SPH	*Sphyranea*	cf. *barracuda*		5				5
		spp.		2				2
TET	*Arothron*	spp.				1		1
Total			**62**	**701**	**62**	**38**	**10**	**872**

Table G.5: List of identified fish remains from Vumba Kuu (vertebrae)

Family	**Genus**	**Species**	**VMB010**	**VMB011**	**VMB012**	**Total**
ACA	*Acanthurus*	spp.	1	2	4	7
BAL	cf. *Sufflamen*	spp.			1	1
CAR	*Carangoides*	spp.	1	2		3
	Caranx	spp.	1			1
	Selar	*crumenophthalmus*		2	2	4
	Trachinotus	cf. *rhodopus*		2		2
CARCH		spp.	5	2		7
CHI	*Chirocentrus*	spp.	2			2
HAE	*Plectorhinchus*	spp.	2	2		4
	Pomadasys	cf. *argenteus*			2	2
		cf. *kaakan*	3			3
		cf. *multimaculatus*	16			16
		spp.	11	10	1	22
LET	*Lethrinus*	spp.	18	28	6	52
LUT	*Lutjanus*	cf. *argentimaculatus*		2		2
		cf. *sanguineus*	7			7
		spp.	8	7	1	16
MUG	*Liza*	*macrolepis*		1		1
PLA	*Papillo*	*longiceps*	2			2
SCA	*Scarus*	*ghobban*	1	1		2
		spp.	6	15	12	33
SER	*Epinephelus*	cf. *coioides*	16			16
		cf. *macrospilos*		1		1
		spp.	6	12	1	19
		spp.	3	1		4
SIG	*Siganus*	*luridus*	8		1	9
		stellatus	6	18	1	25
		sutor	5	11	1	17
		spp.	15		1	16
SPA	*Acanthopagrus*	spp.		5		5
SPH	*Sphyranea*	*flavicauda*		3		3
		spp.	3	4		7
Total			**146**	**131**	**34**	**311**

Table G.6: List of identified tetrapod remains from Vumba Kuu

Class	Taxonomic ID	Common name	VMB007	VMB008	VMB010	VMB011	VMB012	Total
Bird	cf. Macrosphenidae	African warbler		1				1
	Numida meleagris	Helmeted guinea fowl		3				3
	cf. *Phalacrocorax carbo*	Great cormorant		1				1
	cf. *Gallus gallus*	Possible chicken		7				7
	Francolinus sp.	Francolin		4				4
	Gallus gallus	Chicken	16	128	5	12	10	171
	Pternistis sp.	Spurfowl		6				6
Unidentified bird			6	52	14	11	4	87
Bird Total			22	202	19	23	14	280
Amphibian	Anura	Possible frog		1				1
Amphibian Total				1				1
Mammal	*Bos*	Cattle	135	36	8	11	2	192
	Caprini	Sheep/goat	15	33	10	4	6	68
	Cephalophus sp.	Duiker		1				1
	cf. *Bos*	Possible cattle				4		4
	cf. *Caprini*	Possible sheep/goat			1			1
	Large bovid						2	2
	Small bovid		1		12		3	16
	Cercopithecus aethiops	Old World monkey		1				1
	Dugong dugon	Dugong	4	23				27
	Felis sp.	Cat	1	3				4
	Herpestes sp.	Mongoose		2				2
	Elephantulus sp.	Elephant shrew		1				1
	Rattus sp.	Rat		13			5	18
	Suid	Pig					1	1
	Large ungulate					6	2	8
	Med ungulate					3	2	5
	Large mammal				1			1
	Med mammal		1					1
Unidentified mammal			44	78	9	27	6	164
Mammal Total			201	191	41	55	29	517
Reptile	cf. *Chelonia mydas*	Sea turtle	15	29	17		5	66
	Crocodylus cf. *niloticus*	Crocodile	1					1
Reptile Total			16	30	17		5	67
Total Identified			**174**	**264**	**37**	**40**	**33**	**548**

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