

Local fishery, global commodity: Conflict, cooperation, and competition in Ghana's coastal fisheries

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Abstract

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A large body of research in recent decades has dramatically increased our understanding of the dynamics, challenges, and management approaches in marine fisheries commons. However, most of this research focuses on specific fisheries in a single subsector, outlining a series of recommendations to improve governance within a particular context. Yet, as most fisheries around the world do not occur within a closed context, but instead are diverse, cross-scale, dynamic, pluralistic, and resource-limited, many of these recommendations are ill-suited to their particular challenges. One of the best examples of these cross-scale resources challenges are the increasingly reported incidents between small-scale and industrial fishers. While small-scale fishers assert that conflict and competition with industrial vessels present some of the most persistent threats to fishing livelihoods, interactions are complex and may also include cooperative and compensatory dynamics. To illuminate these dynamics, I situate my case study in coastal Ghana, analyzing the characteristics, drivers, and consequences of industrial-small-scale incidents at sea. I employ both qualitative and quantitative methodologies, including key informant interviews, cross-sectional surveys, archival work, and spatial modeling. First, I use a historical database of incidents to understand the actors, characteristics, and drivers of incidents, situating them as a form of resource conflict. Further, I ground these incidents in conflict theory, outlining their contingent nature and pathways toward conflict and cooperation. Finally, I empirically assess the consequences of these incidents for small-scale fishing households and communities. Through these analyses, I aim to illuminate one of the least evidenced and theorized conjunctures in fisheries, yet one that profoundly affects the day to day lives of millions of fishers around the world.

Dedication

Dedicated to John and Nancy Wilson, Ann and Max Seto, the past and the future.

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Introduction

In the past several decades, common pool resources have emerged as a substantial and multifaceted field of inquiry, both for their unique challenges and particular management approaches. Marine fisheries are an iconic example of a common pool resource, described as a “resource system that is sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries” (Ostrom 1990). In response to the challenges of managing marine fisheries commons, two primary approaches have been suggested to promote sustainability and equity (Gutiérrez et al. 2011). The first emerges out of classical economic theory, and suggests that private rights are necessary in order to exclude actors, limit exploitation, and avoid the tragedy of the commons (Hardin 1968, Costello et al. 2016). The second emphasizes the ability of comanagement and community-based management approaches to ensure fisheries sustainability (Ostrom 1990, Beddington et al. 2007, Berkes 2007). While both of these themes have contributed substantially to our understanding of marine fisheries dynamics, and led to successful management approaches in some contexts, a great many fisheries throughout the world do not exhibit the “conditions” that facilitate these two solutions to common pool resource challenges. Gutierrez et al. suggest that preconditions for successful comanagement include strong community leadership, strong social cohesion, and community-level management tools (Gutiérrez et al. 2011). Similarly, scholars of rights-based fisheries management have suggested that privatization approaches are best utilized in contexts of strong enforcement, where fisheries are well-resourced, single species, and where stocks lie entirely within the scale of management (Costello et al. 2008, Ban et al. 2009). However many, if not most fisheries do not meet these conditions, and instead are diverse, cross-scale, dynamic, pluralistic, and situated in the developing world, where management resources and technologies are limited. These fisheries represent intersecting and coinciding systems that do not lend themselves to strong central leadership, cohesion, and enforcement. In these contexts, what are the particular challenges and opportunities to sustainably and equitably managing fisheries commons?

A diversity of challenges confront marine fisheries, including but not limited to climate change (Hall 2011, Cinner et al. 2012), biodiversity loss and catch declines (Worm et al. 2006, Srinivasan et al. 2010), coastal erosion and pollution (Shahidul Islam and Tanaka 2004, Garcia and Rosenberg 2010), invasive species (Malpica-Cruz et al. 2016), migration and coastal population growth (Pauly 1990, Garcia and Rosenberg 2010). However, one of the most commonly cited issues by small-scale fishers remains poorly evidenced and poorly explained. Small-scale fishers around the world assert that conflict and competition with industrial vessels present some of the most persistent threats and profound impediments to their day to day fishing livelihoods. From the Central Eastern Atlantic to the South Pacific, industrial fishing vessels are charged with devastating habitat, depleting fish stocks, and destroying small-scale fishers’ nets and boats, reducing overall abundance of traditionally harvested species, as well as small-scale fishers’ ability to access those stocks. However, these conflicts only represent one aspect of these intersectoral interactions at sea. Other interactions reveal complex and layered dynamics, sometimes cooperative, commercial, compensatory, or otherwise. These interactions at sea, both positive and negative, represent a major gap in our understanding of marine fisheries dynamics, and subsequently fisheries ecology, biology, management and governance.

Primary fisheries governance tools (e.g. gear restrictions, catch restrictions, spatial approaches, etc.) are conceived primarily as being implemented through onshore institutions (e.g. co-management, community-based management, state and private actors). However, marine fisheries exploitation activities are almost entirely conducted while at sea, and successful governance requires an improved understanding of activities and interactions that occur in seaspace.

The purpose of this dissertation is to further the very preliminary work that's been done to begin sketching the form and features of these industrial/small-scale fisheries interactions—their characteristics, drivers, and consequences. This dissertation further seeks to theorize the contingent nature of these interactions, emphasizing them as a form of resource conflict, but one deeply shaped by individual and group agency, historical institutions, and broader social and economic contexts. In revealing these interactions as both emerging from and resulting in particular social phenomena, I aim to reveal particular structural and institutional arrangements that may promote positive outcomes of these interactions and prevent and deter negative ones. Finally, this dissertation attempts, for the first time, to empirically assess the consequences of these intersectoral incidents for small-scale fishing households and communities. It is the goal of this work to shed light on one of the least evidenced and theorized conjunctures in fisheries, yet one that profoundly affects the day to day lives of millions of fishers around the world.

Industrial-Small-scale fisheries conflict: A Literature Review

“Less well reported in the North have been the conflicts between inshore fishermen and offshore trawling fleets in the Third World. Over the last thirty years these disputes have cost the lives of several hundred fishermen... A human toll of these proportions in the third world does not attract international press attention. But in an intrinsically good-natured industry it in fact masks a great deal of human suffering and an ecological crisis of severe proportions. Fishing provides a livelihood for over one hundred million people throughout the world. There is a great deal of evidence that the methods of production that are coming to dominate are not only diminishing the resource base of the industry and causing food insecurity for large numbers of people; they are also undermining well-supported traditions for conflict resolution and replacing them with state-managed institutions and mechanisms whose track-record on land, if we judge it by the number of people killed in conflicts over resources, has been lamentable.”

-Simon Fairlie, *Fisheries: Confrontation and Violence in the Management of Marine Resources*

1 Introduction

Since the 1980's, an increasing volume of literature has assessed the relationship between resources and conflict. Most studies have focused on renewable resources in terrestrial systems, such as fertile land, timber, and freshwater, however several facts indicate a significant need to understand of how resource competition *in marine systems* may create the potential for conflict. Since the 1980's, fisheries have experienced a dramatic decline in global catches, despite overwhelming increases in technology and capitalization (Pauly et al. 2005). Furthermore, by 2025, the number of people living within 60 miles of coastlines is projected to increase by 35 percent compared to 1995, with global population reaching 9 billion by 2050 (Population Action International 2006). This disproportionate coastal population growth, combined with the global decline in fisheries, has the potential to significantly exacerbate current food security challenges. While 2.9 billion people worldwide rely on fish for at least 15% of protein consumption, the strongest and earliest effects of these challenges will be felt in the coastal developing countries of the global South, where in some states fish comprise more than 50% of dietary protein (FAO 2016a).

With these issues in mind, this chapter will examine the role of marine capture fisheries as a source of conflict. Since issues pertaining to coastal states in the global South—such as food security and development—are of particular interest, this chapter will closely examine those conflicts that occur between small-scale artisanal fisheries and modern industrial fisheries. In *Fishing for Answers: Making Sense of the Global Fish Crisis*, the World Resources Institute states that, “Small-scale fishing... is by far the dominant form of fishing in the world today, at least in terms of the number of people involved. But small-scale fisheries have been historically marginalized and routinely ignored... Large industrial trawlers that fish the waters close to shore, for example, often degrade the sea bottom habitat and change the species composition of coastal ecosystems to a point where the local fish catch can drop precipitously. Such conflicts between foreign industrial fleets and small-scale coastal fishers are becoming increasingly prevalent in Asia and Africa, with small-

scale fishers gradually losing ground” (Kura et al. 2004). Since the UN Food and Agricultural Organization (FAO) estimates that over 90 percent of people engaged in marine fishing are small-scale operators—yet the industrial sector catches more fish and generates more revenue—it is essential to understand the interactions between these two sectors (Platteau 1989, Kura et al. 2004, Jacquet and Pauly 2008, FAO 2016b).

2 Background

“Any tendency to over-fishing will meet with its natural check in the diminution of the supply. This check will always come into operation long before anything like permanent exhaustion has occurred.”

-T. H. Huxley to the International Fisheries Exhibition in London, 1883

“The Third United Nations Convention on the Law of the Sea yielded one of the most profound institutional changes to global environmental governance during the twentieth century.”

-Frank Alcock, *UNCLOS, Property Rights, and Effective Fisheries Management: The Dynamics of Vertical Interplay*

Simon Fairlie states, in his 1999 essay *Fisheries: Confrontation and Violence in the Management of Marine Resources* that, “many wars have been fought between people competing for the right to exploit the resources of the land. Few, if any, have been fought by people competing for the right to harvest the ocean” (Fairlie 1999). Fairlie attributes this lack of marine resource-based war to two primary factors: 1) fishing technology was not advanced enough to exhaust fish stocks until relatively recently, and 2) oceans are not—in the strict sense—inhabited, and are therefore less likely to engender conflict with prior territory or resource users. He notes that, despite the fact that fishing “can be viewed as an inherently conflictual activity”—in that individuals compete for a limited resource—fishermen tend to be familiar with these challenges, and disputes are rarely violent (Fairlie 1999). However, he notes that “the conditions under which fisherfolk live and work are changing rapidly, and this may be having an effect upon the ways in which conflict is managed” (Fairlie 1999).

What are the ways in which these conditions are changing, and what are the potential implications for violent conflict? In order to gain a better understanding of the current state of marine fisheries and the points of friction within them, it is worthwhile to assess some of the recent trends in fisheries governance and exploitation, and how they have changed over time. First, one of the fundamental trends in marine fisheries during the twentieth century is that of industrialization. The inception of steam-powered trawlers in the late nineteenth century created a new era of fishing capability, which was furthered in the 1930’s and 1940’s, with the arrival of large factory ships, modernized gear and vessel technology, and sonar (Scheiber 2001, Roberts 2007). The consequences of these developments cannot be overstated, and they facilitated a number of subsequent fisheries trends such as the expansion of area and depth fished, the rise in global fish catch, and the increasing amounts of capital invested in fishing fleets (Myers and Worm 2003, FAO 2010). However, trends such as increased catch masked another significant development in

marine fisheries: that of overexploitation. Regardless of these dramatic increases in catch—indeed, likely because of it— a general decline in the catch per unit effort (CPUE) began to emerge in the 1970s and 1980s, and in some cases, stock depletion became evident (Scheiber 2001, Pauly et al. 2002, FAO 2005). Currently, the exploitation status of all fisheries monitored by the FAO is the highest on record, with only 10 percent of stocks considered to be underfished; in 2013, 58 percent of fish stocks were deemed fully exploited, with 31 percent overexploited (FAO 2016b).

In addition to these trends in resource exploitation, another phenomenon is critical in understanding modern marine fisheries. In 1982, the Third United Nations Convention on the Law of the Sea (UNCLOS III) created the Law of the Sea Convention (LOSC), a new regime for ocean governance. Frank Alcock states that “[UNCLOS III] converted a vast swath of oceanic space from a global commons to a regime characterized by 200-mile exclusive economic zones (EEZs) that extend from the shores of every coastal state... The establishment of EEZs transformed the prevailing property rights institutions among states: EEZs now account for more than 30 percent of oceanic territory and over 90 percent of its fisheries resources. The EEZs also triggered a cascade of changes to property rights institutions within states that has been more subtle and is still ongoing” (Alcock 2011). The dominant regime before the establishment of LOSC was built on the principle of *mare liberum*—freedom of the seas—and recognized a coastal state’s territorial sea out to three nautical miles (nm) from shore (Rothwell and Stephens 2010). Therefore, it can be understood that the expansion of coastal state jurisdiction to 200 nm represented a tremendous change in maritime governance and interstate relations regarding the ocean and its resources.

Platteau (1989) and Bavinck (2005) emphasize another transition that emerged alongside the changes in governance and exploitation (Platteau 1989, Bavinck 2005). Before WWII, small-scale fishers dominated marine capture fisheries, characterized by passive fishing gear, limited range of operation, and much lower CPUE than industrial fishing fleets. However in the mid-twentieth century, several developing country governments embarked on fisheries modernization programs with the help of development agencies, creating significant industrial sectors alongside existing small-scale sectors (Platteau 1989, Bavinck 2005). Bavinck states that, “One of the core features of the transition affected in this period is a new dualism in fish production—a result of the fact that governments in this period established industrialized trawler fleets next to existing small-scale fisheries... Scholars and international agencies confirm that conflicts between industrialized and small-scale subsectors permeate coastal fisheries in many developing countries, and are indeed vehement” (Bavinck 2005).

While all of these changes are essential in understanding modern fisheries as a social-ecological-economic system, it is also important to stress their relative newness. Fishing is an ancient occupation that has provided nutrition, livelihoods, and social currency for millennia, however marine fishing in its current form has only existed for a few decades. It is in the context of these dramatic changes in marine resource exploitation and governance that this chapter will explore the existing literature on marine resource-based violent conflict. Specifically, this chapter will consider the conjuncture between industrial fishing fleets, characterized by fossil fuel-powered vessels and export markets, and small-scale fleets, here described as both motorized and non-motorized vessels which

fish for subsistence or local or regional markets¹. Fairlie states that “as fisheries become increasingly overexploited and the opportunities for fishing further afield decline, the potential for conflict increases; and as fisheries become increasingly differentiated between a highly capitalized industrial sector and a hard-pressed artisanal sector, the opportunities for communication and conflict resolution diminish” (Fairlie 1999). Since trends in both industrial fishing and ocean governance have coincided with Fairlie’s conditions for increased conflict, it is critical to assess the degree to which the literature bears this relationship out.

3 Literature Review

A tremendous amount of research has addressed the issue of conflict within and between small-scale artisanal fisheries, and almost as much has been dedicated to the important—if rarer—instances of large scale interstate fisheries conflicts. However, a relatively limited body of literature exists regarding the interface of these two types of fisheries. Furthermore, while much of this literature consists of case study information on these conflicts, few have systematically investigated them as conflict phenomena (Bennett et al. 2001, DuBois and Zografos 2012). Table 1 provides a partial list of case study literature related to conflicts between the industrial and artisanal sectors, and demonstrates the widespread nature of the phenomenon.

Table 1: List of regional case studies documenting conflicts between industrial and artisanal fisheries (Sources: Bavinck 2005, Fairlie 1999)

Southeast Asia	Eurasia and South Asia	Africa	South America
Malaysia (Gibbons 1976, Smith 1979, Anderson 1987)	India (Kurien and Achari 1988, 1990, Bavinck 2001)	Throughout West Africa (Vercrujisse 1984)	Brazil (Cordell and McKean 1986)
Indonesia (Collier et al. 1979, Bailey 1988, Zerner 2003)	Throughout South Asia (Mathew 1990)	Ghana (Bennett et al. 2001)	
The Philippines (Cruz 1986, Pomeroy and Pido 1995, Russell and Alexander 2000)	Turkey (Berkes 1986, Bornstein et al. 2016)	Tanzania (Masalu 2000)	
Thailand (Panayotou 1980, Torell and Salamanca 2001)	Bangladesh (Bennett et al. 2001)	Mozambique (Lopes et al. 2015)	
Throughout Southeast Asia (Bailey 1997, Pollnac 2007)		Senegal (DuBois and Zografos 2012)	
		Somalia (Osei-Tutu 2011)	

¹ Although the specific characteristics of artisanal and industrial fishing vary from region to region, it is still possible to compare and contrast their characteristics. For more in-depth treatment of the differences between the sectors over time, please see the Thompson tables and other analyses available in (Thompson 1980, Lindquist 1988, Berkes et al. 2001, Pauly 2006, Jacquet and Pauly 2008, Swartz et al. 2010, Mills et al. 2011).

3.1 Typologies

A number of typologies have been formulated in order to explain the incidence of conflict in fisheries. The goal of these typologies is to identify the most pertinent features of fisheries conflicts, organize and classify these features or variables, and assist in formulating hypotheses about how those features interact (Bennett et al. 2001).

Charles identifies a typology based on four principal categories: philosophical conflict, management/institutional issues, internal allocation, and external issues “between the fishery and ‘outside’ players” (Table 2)(Charles 1992). Charles applies the typology to all marine fisheries, and states that the “conflict classes are intended to be comprehensive but not necessarily mutually exclusive, and... certainly some will fall under more than one” (Charles 1992).

Table 2: Charles’ 1992 typology of fishery conflicts (Adapted from Charles 1992)

Fishery Jurisdiction / Philosophical Conflict	Management / Institutional Issues	Internal Allocation	External Allocation
Conflict over: <ul style="list-style-type: none"> • Property rights • The role of government • Intergovernmental conflicts 	Conflict over: <ul style="list-style-type: none"> • Fisheries management plans • Enforcement conflicts • Consultation processes or fisher/government interactions 	Conflict within a specific fishery system: <ul style="list-style-type: none"> • Horizontally (i.e. between user groups) • Vertically (i.e. between fishers and processors) 	Conflict between internal fishery players and outsiders, such as: <ul style="list-style-type: none"> • Foreign fleets • Aquaculturists • Non-fish industries • The public at large

In addition to this typology classifying fishery conflicts, Charles goes further, describing a framework for understanding the *causes* of these conflicts. Charles states that conflict arises because of the differing priorities pursued by various actors in the fishery, and outlines three paradigms and their characterizing traits (Table 3). The framework is constructed as a pyramid connecting the three paradigms, and in which individual actors or policy debates are situated spatially between the three. Charles states that, “fisheries conflicts can be viewed as reflecting tensions between the triangle’s three corners, with ‘extreme’ policy proposals lying relatively close to one of the corners, and attempts at conflict resolution typically aiming at the ‘middle ground”” (Charles 1992).

Table 3: Characteristics of three fishery paradigms (Adapted from Charles 1992)

	Conservation Paradigm	Rationalization Paradigm	Social/Community Paradigm	
Priorities	To take care of the fish stocks, ensure provision in the future	Pursuit of economic efficiency and increased wealth in the fishery	Community welfare, distributional equity	
View of fishers	Members of a predatory fleet	Individualistic firms, economic actors	Members of coastal communities	

Warner develops a different typology, and applies it more selectively to conflicts that occur primarily between actors at the community level (Warner 2000). Therefore it can be seen that Warner's typology fundamentally differs from that of Charles' in that it is heavily concentrated on issues of community-based natural resource management (CBNRM). Furthermore, while Charles' categorization can be seen as part topical (philosophical conflict and management/institutional issues) and part actor-based (internal and external allocation), Warner creates a typology based solely on the conflicting parties. Warner states that conflicts can be categorized as:

1. Intra micro-micro (within the community group directly involved in management)
2. Inter micro-micro (between a community group involved in management and one not directly involved), or
3. Micro-macro (between community groups and outside government, private, or civil society) (Warner 2000, Bennett et al. 2001).

Like Charles, Warner also separately outlines the primary causes of conflict, as distinct from the typology. According to Warner, these causes include:

1. Demographic change
2. Natural resources competition
3. Developmental pressures (e.g. capitalization, privatization, introduction of new technologies, etc.)
4. Structural injustices (e.g. inequalities in legal definitions of land ownership, local and regional economic and political inequalities, ethnic and cultural differences, etc.)

Similar to Charles, Warner does not stress mutual exclusivity, and instead emphasizes that "disputes and conflicts over CBNRM need to be viewed in the context of a complex web of demographic change, sensitive natural environments, new development pressures, structural economic and legal inequalities, personal and ethnic differences, and the multiple interests of different individuals, groups and organizations from both inside and outside rural communities" (Warner 2000).

Bennett et al. combine this previous work by Charles and Warner, creating a third typology that seeks to synthesize the two, with the explicit addition of institutional considerations. Bennett et al. identify the five main types of fisheries conflicts as (Bennett et al. 2001):

1. *Type I*: Who controls the fishery (e.g. access issues)
2. *Type II*: How the fishery is controlled (e.g. enforcement, allocation, management issues)
3. *Type III*: Relations between fishery users (e.g. different groups such as ethnic or religious, or different scales such as artisanal or semi-industrial)
4. *Type IV*: Relations between fishers and other users of the aquatic environment (e.g. tourism, conservation, and industrial development)
5. *Type V*: Relationship between fishers and non-fishery issues (e.g. issues over environment politics, economic change, corruption, etc.)

Types I-IV of this typology closely follow the four categories of Charles', while Type V seeks to incorporate some of the more abstract concepts described in Warner's idea

of structural injustices. Of note, while Charles' typology is meant to apply to global fisheries, the analysis is drawn from fisheries in the global North, specifically Canada (Charles 1992, Bavinck 2005). Warner's typology, on the other hand, is geared specifically toward community based fisheries in the South Pacific, and case studies are drawn from Fiji and Papua New Guinea. One of the most significant contributions of Bennett et al. is their focus on the global South, and the combination of disparate regions in their analysis of Ghana, Bangladesh, and the Turks and Caicos Islands (TCI) (Bennett et al. 2001, Bavinck 2005). A summary of the main attributes of each typology is available in Table 4.

Table 4: Synthesis of Charles 1992, Warner 2000, and Bennett 2001 typologies of fisheries conflict

	Conflict actors	Typology	Conflict causes	Potential conflict resolution
<i>Charles 1992</i>	All fisheries (i.e. national, industrial, local, etc.); Study focused on global North (Canada)	Fishery jurisdiction conflict; institutional issues; internal allocation; external allocation	Tensions between paradigms (conservation, rational, and community)	Policies that lie in intermediate space in the paradigm pyramid, specifically co-management scenarios
<i>Warner 2000</i>	Community members involved in fisheries management; Study focused on the South Pacific (Fiji and Papua New Guinea)	Intra micro-micro; inter micro-micro; micro-macro	Demographic change; natural resource competition; developmental pressures; structural injustices	No ideal policy for managing conflict, however key strategy is community-based consensus-building and mediation
<i>Bennett et al. 2001</i>	Tropical artisanal fishing communities; Study focused on global South (Ghana, Bangladesh, Turks and Caicos Islands)	Type I Who controls the fishery; Type II How the fishery is controlled; Type III Relations between fishery users; Type IV Relations between fishers and other resource users; Type V Relations between fishers and non-fishery issues	Lack of transparency and information, perceived inequalities, and the institutional failure in addressing these	Increase institutional capacity, flexibility, adaptability; co-management

Two gaps within these three typologies merit specific attention for this study. First, while the Charles, Warner, and Bennett et al. analyses all bear specific mention of the conflict between artisanal fisheries and larger industrial fisheries, each describes the interaction differently, and it appears to fit multiple classifications within each typology (Charles 1992, Warner 2000, Bennett et al. 2001). Second, while each typology makes general recommendations about conflict resolution mechanisms (i.e. co-management, institutional capacity building, etc.), the potential for these mechanisms to address the specific conjuncture between small artisanal and large industrial fisheries is not clear.

With these two issues in mind, Pomeroy et al. contribute a quantitative analysis of conflicts over fishery resources "caused by technological change" and assess the potential of community-based management and co-management policies to reduce these conflicts (Pomeroy et al. 2007). Using these three typologies as a theoretical base, Pomeroy et al. apply an empirical method to determining the saliency of different variables to the

incidence of conflict in the fisheries of the Southeast Asia (Pomeroy et al. 2007). They identify seven independent variables from the three typologies, testing each for their impact on user conflicts over coastal fishery resources. Variables include:

1. Demographic characteristics
2. Social stratification
3. Security issues and civil tension
4. Resource condition and harvest activity
5. Community and resource conflict and resolution
6. Marine resource governance and tenurial arrangements, and
7. Community organization

Using structured questionnaires and descriptive and inferential statistics, Pomeroy et al. identify a number of trends in the fisheries of Indonesia, the Philippines, Thailand, and Vietnam (Pomeroy et al. 2007). They found that, although country-wide results differed somewhat, a number of trends were visible in the regional analysis. They found positive correlations between the incidence of conflict and education levels, improved resource conditions, and village level conflict, however there were significant negative correlations with religious stratification, improvements in crime levels, food security, and the presence of co-management (Pomeroy et al. 2007). In other words, one of their essential findings was “the [negative] relationship between fisheries co-management and marine resource conflict, and between marine resource conflict and food and economic security” (Pomeroy et al. 2007).

While this finding is undeniably significant, it is important to clarify what is meant here by marine resource conflict, and when it is—or is not—aided by the application of cooperative co-management policies. Since the potential for co-management policies to reduce conflict is premised on “giving resource users and local citizens groups greater voice and more responsibility in resource management,” and bringing decisions “down to levels more appropriate to the functioning of the resource and social systems,” it seems that this effect may only be observed in cases where the industrial fishery is strongly governed by those co-management policies (Pomeroy et al. 2007). In other words, the power of co-management mechanisms to reduce conflict *between industrial and artisanal fleets* may be limited to systems in which industrial and artisanal fisheries are integrated, and which have strong enforcement—and less so where illegal fishing is prevalent and where artisanal and industrial fisheries are governed by separate policies or institutions (Pomeroy et al. 2007, DuBois and Zografos 2012). This observation is supported by Bennett et al., as well as DuBois and Zografos in their recent study of Senegal, where a local initiative to exclude industrial inshore vessels was not supported by the central government, and was later outlawed in national legislation (DuBois and Zografos 2012).

This is one of the challenges that Maarten Bavinck seeks to address in *Understanding Fisheries Conflicts in the South—A Legal Pluralist Perspective*. The study is conducted in response to three weaknesses that Bavinck identifies in the literature. First, Bavinck believes the abundance of studies on overfishing has marginalized research on the conflict between small-scale and industrial fisheries. Since evidence exists that this conflict is more acutely felt by artisanal fishers than absolute resource depletion, it is essential to reinsert this line of questioning into fisheries research. The second weakness is the

“unidimensional” fashion in which this conflict has previously been analyzed. Bavinck states that characterizing this conflict as a simple case of opposing economic interests is insufficient, and “interests must be connected to the people and the societies of which they are part. Their pursuit is governed by rules and norms that are particular to specific social systems. Conflicts are therefore always more than interests alone; they connect to dimensions such as law, culture, and social organization” (Bavinck 2005). Thirdly, the “exogamous” nature of this conflict renders it uniquely difficult to address, and it must be specifically studied if effective policies are to be identified. Stating that “assuming that small-scale and modern fishers belong to different social orders, the conflicts themselves may consequently, in Rapoport’s (1974) terms, be of an exogamous kind—they take place across, and not within, the boundaries of social systems. Not only are such conflicts, as Rapoport points out, frequently more intransigent than endogamous conflicts, they are also embedded in different normative perspectives, social realities, and economic concerns”(Rapoport 1974, Bavinck 2005). In this way, Bavinck suggests that the fisheries policies proposed by previous authors to have conflict resolution potential (i.e. co-management, institutional capacity building) may be inappropriate to address conflicts between artisanal and industrial fishers. This conclusion is supported by DuBois and Zografos, who state that, “while at-sea conflicts are known to take place between artisanal and industrial fishers in Senegal, the specific character of these conflicts has not been carefully studied, nor has any research been done on existing mechanisms—formal or informal—of resolving them (DuBois and Zografos 2012).

One of Bavinck’s strongest contributions is the interpretive and grounded approach of the study. While Charles, Warner, Bennett et al., and Pomeroy et al. seek to identify general trends and conflict typologies, Bavinck applies a thorough qualitative approach to understanding dynamics at play within the fisheries of Tamil Nadu’s Coromandel Coast in India (Bavinck 2005). Bavinck’s study is based on an observation made by Cordell with regard to industrial-artisanal conflicts in the Pacific: “The inevitable collision of traditional and industrialized fishing is not merely technological. It involves converging, antagonistic systems of sea tenure (Cordell 1984). In this context, sea tenure is meant to be understood as an analogy to land tenure, indicating notions of property ownership, stewardship, regulation and management. Bavinck explains that small-scale fisheries tenure is based on territorial privilege, kinship, passive fishing gear, and subsistence practices—which lies in direct contrast to the sophisticated technologies, specialized labor, and profit-driven objectives that characterize industrial fisheries tenure (Platteau 1989). Indeed, Platteau describes these two sectors as completely, or almost completely cut off from each other (Platteau 1989).

Within the fisheries of Tamil Nadu, Bavinck makes a similar observation, explaining that the two sectors have completely separate priorities, leading to a small-scale management approach based on regulation of technology, while industrial trawlers focus rulemaking on the size of the fleet, through limited entry regulations (Bavinck 2005). Bavinck demonstrates that on the Coromandel Coast, small-scale fisheries are “a hamlet affair,” and issues of decision-making, implementation, monitoring, and enforcement are addressed on that level, whereas the mobile, heterogeneous, and profit-driven industrial fishery represent a different culture with different norms and practices (Bavinck 2005). State law operates in both spheres, as it officially excludes industrial trawling within the

innermost coastal zone where small-scale fishing occurs, yet enforces these regulations only “when excessive violence threatens to erupt” (Bavinck 2005). In this way, the friction between industrial and artisanal fishers can be explained as a “meeting of sea tenure systems” (Bavinck 2005). Bavinck suggests that a legal pluralist approach is necessary in understanding, and responding to, this context of overlapping sea tenure and overlapping “legal systems prescribing varying uses of one and the same good” (Bavinck 2005). Therefore, Bavinck’s central thesis is that “small-scale and industrialized fishers often operate disparate sea tenure systems, and that the conflicts between them are connected to the fractures between them” (Bavinck 2005). Though Bennett frames it as a case of failed institutions rather than a fundamental disconnect of systems, this sentiment is echoed in her belief that conflict arises because of imperfect or missing information and the corresponding perception of inequalities or injustices between stakeholders (Bennett et al. 2001). The contribution of the legal pluralist perspective is an awareness “to the possibility of substantial rather than marginal differences,” as well as a more holistic problem solving approach that encompasses the various economic, legal, and social influences on those involved in conflict (Bavinck 2005).

3.2 Discussion

One notable issue that arises out of the literature on fisheries conflicts is the lack of consensus regarding the prevalence of violent conflict. On the one hand, Charles states that conflicts tend to be prevalent, but does not address the issue of violent conflict explicitly, instead applying terminology of dispute management. Warner and Bennett et al. specifically emphasize the significance of *non-violent* conflict, and Bennett et al. state that while all the fisheries in their case studies demonstrated conflict, none demonstrated “violent or acute conflict” (Warner 2000, Bennett et al. 2001). In contrast, Pomeroy states that since the establishment of EEZs, “disputes have become more frequent and more violent than ever before,” and that “armed conflict and violence is increasingly being reported as a common issue in relation to increased coastal fisheries competition” (Pomeroy et al. 2007). Smith states that, “conflicts between industrial trawlers and traditional fishermen are increasingly frequent occurrences... In several instances these have resulted in violence and even deaths” (Smith 1979). Bavinck also supports this notion, stating that within the area where industrial and artisanal fishers exploit the same resources, clashes are frequent and the violence of confrontations has led to governmental intervention (Bavinck 2005). Perhaps the strongest voice for the importance of violent conflict in fisheries is that of Fairlie: “Over the last thirty years these disputes [between inshore fishermen and offshore trawling fleets] have cost the lives of several hundred fishermen” (Fairlie 1999). The lack of consensus on not only the specific numbers, but even the general prevalence of violent conflicts within fisheries, is important to note. Bavinck provides a potential explanation for this in the case of Tamil Nadu. He explains that, not only does the conflict between industrial and artisanal fisheries exist across cultural norms and management regimes, but that furthermore, the government has extremely limited capacity to monitor and enforce the regulations that do exist to separate them. Therefore, Bavinck suggests that even when there is *de jure* regulation, there is a *de facto* vacuum of both dispute resolution institutions and enforcement mechanisms that exists “in the interstices of fishers tenure systems” (Bavinck 2005, DuBois and Zografos 2012). Since these conflicts lie on the margins of two systems, they escape the notice of both, leading to

a lack of information regarding their prevalence as well as their violent nature. Fairlie supports this view, stating that, “most of the violence [between industrial and artisanal fishers] has been ‘incidental’ and hence disguised (Fairlie 1999).

Throughout the literature, there are also similarities in the specific manifestations of conflict between industrial and artisanal fisheries. Although no comprehensive study is available as to the proximate drivers of these conflicts, authors explain that confrontations usually occur when industrial vessels (normally trawlers) incur into inshore areas, and point to a number of ways in which conflict commonly arises (Smith 1979, Schlager and Ostrom 1992, Fairlie 1999, Bennett et al. 2001, Bavinck 2005, Pomeroy et al. 2007). DuBois and Zografos list four conflict categories in the artisanal-industrial conflicts of Senegal (DuBois and Zografos 2012):

1. Destruction of artisanal fishing equipment (e.g. damage or loss of equipment or catch due to contact with an industrial vessel, equipment or crew)
2. Gunwale-to- gunwale violence (e.g. throwing bottles, rocks or ignited objects from boat decks, spraying water at high pressure, etc.)
3. On-board non-violent conflict (e.g. artisanal fishers board an industrial vessel without authorization and refuse to disembark or are prevented from returning to their vessel)
4. On-board violent conflict (e.g. attempts to set vessels on fire, threats to throw a person over- board and threats and attacks involving weapons such as knives, chains or rocks).

While proximal causes are of course only one factor in the creation of conflict, and broader context must be considered, Fairlie notes that, “although these confrontations have often occurred between vessels of different nations, the impetus for the conflicts has not been national difference but sectoral differences. It makes little difference to a Malaysian fishing community whether a large boat trespassing on its waters is Malaysian, Thai, Vietnamese or Indonesian. What is important is the damage that such a vessel will inflict upon the community’s fishing gear, fish stocks, and marine habitat” (Fairlie 1999). This observation—combined with the types of conflict observed above—is significant in that it demonstrates that conflicts occur not between clearly defined institutions such as state governments, but rather among diffuse actors and along shifting lines of perceived injustice and inequity.

Related to these commonalities, another notable theme that emerges from the literature is the change in spatial distribution of these conflicts over time. Although a thorough spatial analysis of these conflicts is also not available, there seem to be general impressions from a number of scholars. Fairlie states that during the period 1975-2000, “recorded violence in the fishing industry has been centered around Southeast Asia,” and this impression is borne out by the bulk of the literature (**Error! Reference source not found.**)(Smith 1979, Bailey 1997, Fairlie 1999). Violent conflicts have been documented in other coastal regions of the global South, and while evidence from Latin America and Africa is more limited, the growing trend of conflict between industrial and artisanal sectors is supported (Bavinck 2005). In considering the spatial trends in marine resource conflict, it is interesting to note two previously mentioned and potentially related phenomena. If

incidences of conflict are closely connected to the expansion of trawlers into inshore areas (Fairlie 1999, Pomeroy et al. 2007), and the expansion of these fleets has followed an observable trajectory (Myers and Worm 2003, Swartz et al. 2010), it might be expected that the incidence of conflict would parallel that expansion.

4 Conclusion

“Commentators on the fisheries should not forget what fishermen know through experience: that every fisherman on the sea, whether skipper of a Spanish freezer-trawler or crewman on an African pirogue, is a simple mortal trying to gain a living by pitting his wits both with and against the elements, with and against the fishing bureaucracy, and with and against his fellow fishermen. By and large this competitive and cooperative occupation is carried out with considerable good humour. When it is not, then something has gone awry in the structure of the fishery, and that something needs to be addressed.”

- *Simon Fairlie Fisheries: Confrontation and Violence in the Management of Marine Resources*

A substantial number of studies have examined the relationship between conflict and marine capture fisheries. A number of typologies have been developed in order to classify the conflicting actors, their interests, and the fault lines along which conflict occurs. However, despite the availability of this research, much of the literature is inadequate to explain the conflicts that occur between artisanal and industrial fishing fleets. Since these two fleets oftentimes operate through different regulations, institutions, cultures, and markets, the policies recommended to mediate conflicts within each sector—such as co-management and institutional capacity building— may prove ineffective when applied across the sectors.

Of note, the literature regarding marine resource-based conflicts has remained relatively static over time, and issues deemed salient in the 1970's are virtually identical to those of the current day. While this may indicate a lack of success in addressing identified challenges, it could also indicate that these issues may not be the most pressing for marine fisheries, or simply that they are not well understood. One fact that the literature does support, however, is the significant gap in information on those conflicts that occur between industrial and artisanal sectors. While many studies reported that these conflicts were on the rise, little to no quantitative evidence bears this out (Bennett et al. 2001). DuBois and Zografos state that, “the various theoretical issues notwithstanding, the paucity of empirical research on the topic suggests that researchers and policy makers simply do not yet understand enough about the character of actual [artisanal-industrial] conflicts and conflict resolution mechanisms to effectively interrogate the institutional dimensions of the problem and propose appropriate policies to address sources of friction between the sectors” (DuBois and Zografos 2012). While the prevalence of these conflicts is oftentimes proclaimed in news reports and non-government organization (NGO) publications, there is very little official documentation, and academic literature is scarce (Fairlie 1999). Similarly, while there is a lack of literature on the specific conflicts between industrial and artisanal fishers, there is also a lack of information on the informal mechanisms of conflict resolution currently in practice. For example, some studies give anecdotal evidence of informal

compensation and cooperation between industrial and artisanal vessels, emphasizing that this is in fact the dominant mechanism of conflict resolution (DuBois and Zografos 2012). This indicates that while significant cultural and institutional barriers do exist, there are potential commonalities between the sectors which might increase communication and conflict resolution (Fairlie 1999, DuBois and Zografos 2012).

The area in which modern industrial and small-scale artisanal fishing fleets overlap represents a critical juncture—both literally and conceptually—in understanding the future of marine fisheries. The two sectors represent different environmental, economic, social, and political perspectives, and in studying the ways in which the fleets both conflict and converge, it may be possible to gain insight into many of the problems facing modern fisheries. In many developing coastal states, questions of food security, livelihoods, and development will play out within the marine fisheries, and only in understanding the interactions of these two critical sectors will those questions find answers.

Chapter 1: Fish, Fishers, & Fleets: Characterizing fisheries interactions at sea

“At sea, anonymity is the rule.”

-Charles N. Dragonette, Office of Naval Intelligence (Urbina 2015)

1 Introduction

The utilization, study, and governance of marine resources occur primarily on land, separated in time and space from exploitation of the system itself (Allison and Bassett 2015, McCauley et al. 2016). Yet it is the interactions that occur *at sea* that have the strongest implications for marine resource sustainability and governance. Conflicts between fishing vessels are some of the most significant of these interactions, and embody the evolving landscape of marine resource exploitation, competition, and governance (Bavinck et al. 2014a, Urbina 2015). Accounts of rising fisheries conflicts have been reported from dozens of countries across the globe, particularly between small-scale fishing boats and more capitalized industrial vessels.² In addition to the increasing prevalence of conflicts, evidence also indicates they are growing more severe, oftentimes involving destruction of artisanal boats, assault, abandonment at sea, and murder (Bavinck 2005, Environmental Justice Foundation 2007, Pomeroy et al. 2007). Conflicts between small-scale fishers and industrial fleets have also been implicated in piracy and a host of human rights abuses (Murphy 2007, Fishwise 2014, Brashares et al. 2014). Considering current global trends in coastal population growth, fisheries exploitation, and fish consumption, this inter-sectoral conflict and competition is likely to worsen in coming years.

While anecdotal evidence of these incidents is often reported in media and grey literature, there is very little documentation of fisheries interactions at sea, and academic literature is scarce (Bennett 2000, DuBois and Zografos 2012). Our understanding of the interface between industrial and small-scale fleets is incredibly limited and, to date, little empirical and no quantitative research is available. Understanding the conflict, cooperation, and competition that occurs between fleets is essential in planning for fisheries equity and sustainability, and represents a major gap in our understanding of marine resource governance and utilization. With these issues in mind, this chapter seeks to characterize these incidents and asks the following questions:

Who are the actors involved in inter-sectoral incidents at sea?

What are the characteristics and drivers of incidents between vessels at sea?

What are the outcomes of these incidents for various actors?

² See for example: <http://www.americandailyherald.com/world-news/africa/item/fishery-surplus-claim-hurting-biodiversity-artisanal-fishing-say-african-fishermen>, <http://pakobserver.net/detailnews.asp?id=228861>, http://www.nzherald.co.nz/world/news/article.cfm?c_id=2&objectid=11180409, <http://www.hirunews.lk/74415/448-indian-fishermen-220-sl-who-violated-maritime-boundaries-arrested>, <http://www.bdlive.co.za/business/agriculture/2014/01/07/fishing-furore-has-hawkers-organising>, <http://www.businessweek.com/articles/2013-11-19/china-s-illegal-fishing-expeditions-threaten-world-waters>, <http://www.egyptindependent.com/news/fm-egypt-fishermen-held-tunisia-be-released-soon>, <http://www.gulf-times.com/Qatar/178/details/369420/IN-BRIEF>

In addressing these research questions, the goal of this chapter is to conduct a quantitative and spatial analysis to begin characterizing these incidents at sea. This chapter will identify common traits of incidents, discuss trends through time, and highlight the differential outcomes of these incidents for various parties. By characterizing the cooperative and conflictual relations between fishing fleets, this research seeks to improve conditions for resource users and contribute to the improvement of fisheries sustainability.

2 Methods

2.1 Data Collection

This study includes two main data sources: The Incident at sea database and sector, vessel, and effort data from the Ghana Ministry of Fisheries and Marine Resources. The Incident at sea database was compiled from existing records on interactions at sea from the Ministry of Fisheries and Aquaculture Offices in Tema, Takoradi, and Accra, as well as archives in Tema and Takoradi. This data consists of 1063 individual cases of interactions at sea over the time period 1984-2013. Records represent cases that were brought to the Arbitration Committees in Tema and Takoradi from all four coastal regions in Ghana: Western Region, Central Region, Greater Accra Region, and Volta Region. Since the data only reflect those cases that were brought to the Committees, it is likely that a large number of incidents at sea occurred, which were never reported. It is also possible that the issue of reporting may bias data toward cases that are more severe or more proximal to Arbitration Committee locations, however the diversity of locations and estimated losses do not suggest strong bias. Cases were considered discrete units as they were reported to the Arbitration committees, though in some cases multiple petitioners or multiple accused parties were named in a single case. The records included narrative information from incident participants as well as administrative and official documentation from Ministry officials, fishing companies, and Arbitration Committee members. The records were not uniform, and each included a range of information, which was coded for various characteristics (Table A-1).

Vessel and effort data for all fishing sectors throughout the time series were obtained from the Ghana Ministry of Fisheries and Marine Resources. Data on vessels registered and operational within the industrial and semi-industrial fleets were available annually beginning in 1989. Data on operational vessels in these sectors is collected through positional analysis at Tema and Takoradi, where industrial fishing vessels land catches, as well as all seven sites where semi-industrial vessels land catches (Tema, Apam, Mumford, Elmina, Sekondi, Takoradi, Axim) (Finegold et al. 2010). For information on methodologies employed to estimate operational industrial and semi-industrial vessels, see Finegold et al. 2010 and AGRER 2011. Data on vessels within the small-scale sector were gathered through intermittent frame surveys, and those used in this study include those conducted in 1989, 1995, 1997, 2001, 2004, and 2013. A frame survey was conducted in 1992, however was omitted in this study due to discrepancies in recorded values. Frame surveys are censuses conducted on a regular basis to assess total numbers and types of active vessels and gear in the small-scale sector. Small-scale vessel and gear numbers and distributions were linearly interpolated between frame survey years (Figure A-1). For information on frame survey methodologies, see Banerji 1974, Amador et al. 2006, Finegold et al. 2010, and Anonymous 1993.

2.2 Statistical analysis

Descriptive statistics were employed to understand the basic characteristics of incidents at sea and of actors in those incidents (e.g. average number of persons onboard, dominant gears used, dominant sectors involved). Descriptive crosstab analyses were also conducted to understand the combined effects of variables on different outcomes. Three crosstab analyses were applied: 1) petitioner subsectors and accused subsectors, 2) petitioner gears and accused gears, 3) accused subsectors and encounter types.

A chi-square test of independence and a series of binomial tests were applied to understand the relationship between petitioner's gears and their involvement in an incident at sea. To further understand the difference in gear classification associated with incidents, each individual gear was classified into "active," "passive," and "both" (Table A-2). Passive gears were defined as those that capture fish by the movement of target species toward the gear, while active gears capture fish through direct pursuit of target species (Cochrane 2002). A generalized mixed model was applied with month as a random effect to test the hypothesis that involvement in an incident is independent of petitioner's gear classification.

Since Ghana's coastline is approximately five degrees north of the equator, sunset and sunrise only vary by 30 minutes between the summer and winter solstices, and nighttime was defined as between 6pm-6am throughout the year. Time information was thus further classified into daytime (06:00-17:59) and nighttime (18:00-05:59) and a generalized mixed model with month and year as random effects was applied to test the hypotheses that incident prevalence is independent of the time of day.

In Ghana, fishing is heavily influenced by the seasonal upwelling of the Guinea Current, which brings cooler more productive waters to Ghana's coast (Wiawe and Nyadjro 2015). The major upwelling largely occurs from the end of July through the beginning of October, while the minor upwelling occurs from January through March (Perry and Sumaila 2007, Wiawe et al. 2008). To test the effect of seasonality, date information was classified into high fishing season (July 15-October 15), low fishing season (January-March), and off-season (all other dates) in order to understand seasonal and oceanographic influences on incidents and their outcomes. A generalized mixed model with month and year as random effects was used to test the hypotheses that incident prevalence is independent of the fishing season.

To better understand outcomes, incidents at sea were further divided into two stages: encounter and interaction. The encounter represents the initial contact that a vessel or its gear has with another vessel or its gear within seaspace. An interaction involves verbal or physical contact between individuals onboard the vessels, and follows the initial encounter. Encounter and interaction characteristics are highly variable in detail and since data were only coded for mention of specific factors, analyses of outcomes in this chapter are considered very conservative, and it is highly likely that these characteristics occurred without explicit mention in the case narratives. More detailed exploration of incident outcomes will be addressed in Chapter 2: Conflict at sea as resource conflict? Tracing patterns of conflict and cooperation in Ghana. In addition to the coding in Table A-1, encounter types were further coded into negative (argument, threatening, violence, and abduction), neutral (attempted compensation and compensation) and positive (cooperation).

A crosstab analysis of the accused sector and the interaction type (Table A-3) was performed to explore the nature of encounters relative to incident parties. The seven encounter types in Appendix 1 were given a severity index of 1-7 with 1 being the least severe (cooperation) and 7 the most severe (abduction). Multiplying the severity index by the number of encounters, and dividing by the total encounters with each accused subsector, a composite severity index was produced for each accused subsector.

2.3 Spatial analysis

To visualize spatial and temporal trends in incidents at sea, narrative information from the database was used to create a spatial model of possible historical incident locations. 380 incidents in the database included information on both the depth and village waters in which an incident occurred (Table A-1). For each of these incidents, Python v.2.7.3 was used to assign a point for all locations that met both depth and location criteria, creating a set of possible points for each incident. Additionally, each of these points was divided by the number of possible points produced for each incident, thereby weighting each for degree of belief in incident occurrence. Lastly, a kernel density hotspot analysis was performed with radius 10km to create a spatial model of possible historical incident locations. ArcGIS v.10.2 was used to create all original data layers and perform spatial analysis.

To more fully capture the implications of spatial trends, this landscape of possible incidents was considered in relation to the spatial governance regulations employed within Ghana. Despite the clear legal definition of Ghana's Inshore Exclusion Zone (IEZ) as the farthest limit of either the 30-metre isobath or the 6 nm offshore limit (Government of the Republic of Ghana 2002), the 30-meter depth contour is oftentimes used as a proxy. Therefore, two additional spatial data layers were applied to the analysis. The first was a polygon layer representing the 30-meter isobath used by the Government of Ghana as an indicator of the Inshore Exclusion Zone. The second layer was created using bathymetry and a distance function from shore, and was intended to provide a more accurate representation of the Inshore Exclusion Zone as defined in the Ghanaian Fisheries Act of 2002. Information on all spatial data layers is available in Table A-4.

3 Results and Discussion

3.1 Who are the actors involved in incidents at sea?

3.1.1 *Petitioning parties*

Of the cases with information on petitioning parties (n=906), the vast majority was from the artisanal sector (92%, n=841). The remaining cases represented petitioners from the semi-industrial (7%, n=61) and industrial fishing sectors (0.4%, n=4). This finding is notable in that actors from any sector are eligible to file a case with the Arbitration Committee, however artisanal fishers comprise almost the totality of petitioners. This result is partially explained by the fact that other institutions are likely better equipped to address incidents within sectors, such as the role of the chief fisherman in adjudicating matters within the artisanal sector (Walker 2002, Coastal Resources Center SustainaMetric 2010, Underwood 2011). However, no other institutions are more prominent than the

Arbitration Committee in mediating inter-sectoral disputes, and the dominance of artisanal petitioners merits examination.

The reasons why artisanal vessels may be disproportionately affected by incidents at sea are varied, and a number of possible explanations are included in case narratives within the incident at sea database. These explanations are discussed below and include: the limited capacity artisanal vessels have to avoid other vessels (e.g. through adequate propulsion or radar technology) or be avoided by vessels (e.g. through sufficient lighting and alarm systems); the tendency for artisanal fishers to fall asleep or be unresponsive during nighttime fishing activities; the overall abundance of artisanal fishing vessels in Ghanaian waters; and the tendency for artisanal vessels to fish and navigate in areas frequently used for navigation.

However, regardless of *why* artisanal vessels are most often the petitioners in these cases, it is important to emphasize the consequences of these incidents in the artisanal sector. Artisanal fishers and boat owners represent the most economically vulnerable of the fishing sectors in Ghana, with wooden vessels, simple gears, and no insurance program in effect in the case of damaged capital. Although insurance schemes in the artisanal sector have been proposed and discussed in recent years (Agbekporu et al. 2014), to date no program is operational. Furthermore, catches from artisanal fishing in Ghana are shared amongst capital owners and crew, so wealth accumulation is not as pronounced as sectors that do not participate in sharing systems (Amador et al. 2006). Although vessel and gear damage are common, and are usually addressed through hand mending, incidents at sea between two parties oftentimes include extensive damage or complete loss of gear. Furthermore, the existence of a suspect and potential for compensation creates added incentive to pursue arbitration. The diminished ability of artisanal fishers to remedy these types of damage may contribute to the disproportionate number of cases that are brought by artisanal fishers, since insurance or capital accumulation may alleviate damages to vessels in other sectors.

Ghana's artisanal sector is comprised of small, medium, and large canoes (Table A-5), however the majority of petitioning vessels in these cases were small and medium sized artisanal vessels. The average number of people onboard was 7.22 with a standard deviation of 4.80, the median was 6 and the mode was 5. The maximum number of people on board was 27 and the minimum was 2 (Figure 0-1). Clear quantitative data is not available on the average number of fishers per boat over the time series, however the average number of fishers per canoe in 2013 was 12.6, considerably higher than the 7.22 average involved in incidents at sea (Bannerman n.d.). This finding suggests that the vessels that are involved in incidents at sea are smaller on average than those of the fleet as a whole. Since smaller canoes are poorly equipped for prolonged fishing trips far from shore, this supports the idea that the incidents at sea are less driven by the expansion of small-scale fishing effort, and more by the incursion of industrial vessels into inshore areas.

While many of the petitioners (47%, n=501) did not specify the type of gear they were using at the time of the incident, of those that did (n=568), the distribution of gears was widespread. The set net was most prevalent with 37% of reporting petitioners (n=211) using them at the time of the incident, followed by ali-poli-watsa nets (29%, n=162), and the anifa-nifa, or drift gill net (19%, n=110). **Error! Reference source not found.** represents the full distribution of petitioner's gears, and Table A-6 explains the design, use, and specifications of each gear type in Ghana.

Involvement in an incident at sea was found to be highly influenced by the petitioner's gear type (p-value < 0.001). Furthermore, set nets and drift gill nets show a significantly greater involvement in incidents at sea than their prevalence would suggest, while ali-poli-watsa, beach seine, and line gears show significantly less involvement than their prevalence would suggest (

Table A-7). In classifying petitioner's gears, passive gears were found to be significantly more associated with incidents than active gears, with gears that act as both active and passive lying in between ($P < 0.001$) (Figure A-2).

The results on gear type and gear classification suggest that use of passive fishing gears such as set nets and drift gillnets increase chances of being involved in an incident at sea. This is intuitive, as passive gears may by nature be more susceptible to damage than active gears since they occupy a large area of sea space, are submerged, and are often poorly marked. In line with the narratives mentioned above, passive gear may also enable fishers to decrease vigilance while fishing, further adding to the potential for an incident at sea. In contrast, active gears such as lines and purse seines are negatively related to conflicts, since activity by fishermen at the surface alerts neighboring vessels to the presence of fishing gear and prevents another vessel from occupying the same seaspace. Currently, passive gears comprise less than half of the small-scale fleet, however the proportion has grown in recent years (Figure 0-2), meriting consideration for a future rise in inter-sectoral incidents at sea.

3.1.2 Accused parties

3.1.2.1 Industrial and Semi-industrial fishing vessels

Of the cases with information on accused parties (n=978), the majority of incidents (78%, n=793) show the accused party was a fishing vessel more capitalized than the artisanal sector, with 43% from the industrial sector (n=440) and 35% from the semi-industrial (n=353) (Table A-8). Further, the accused is largely from a highly-capitalized fishery regardless of the petitioner's sector; industrial and semi-industrial petitioners also accused these two subsectors more frequently than any others. Involvement in an incident at sea was found to be highly influenced by the accused's sector ($P < 0.001$), with the industrial

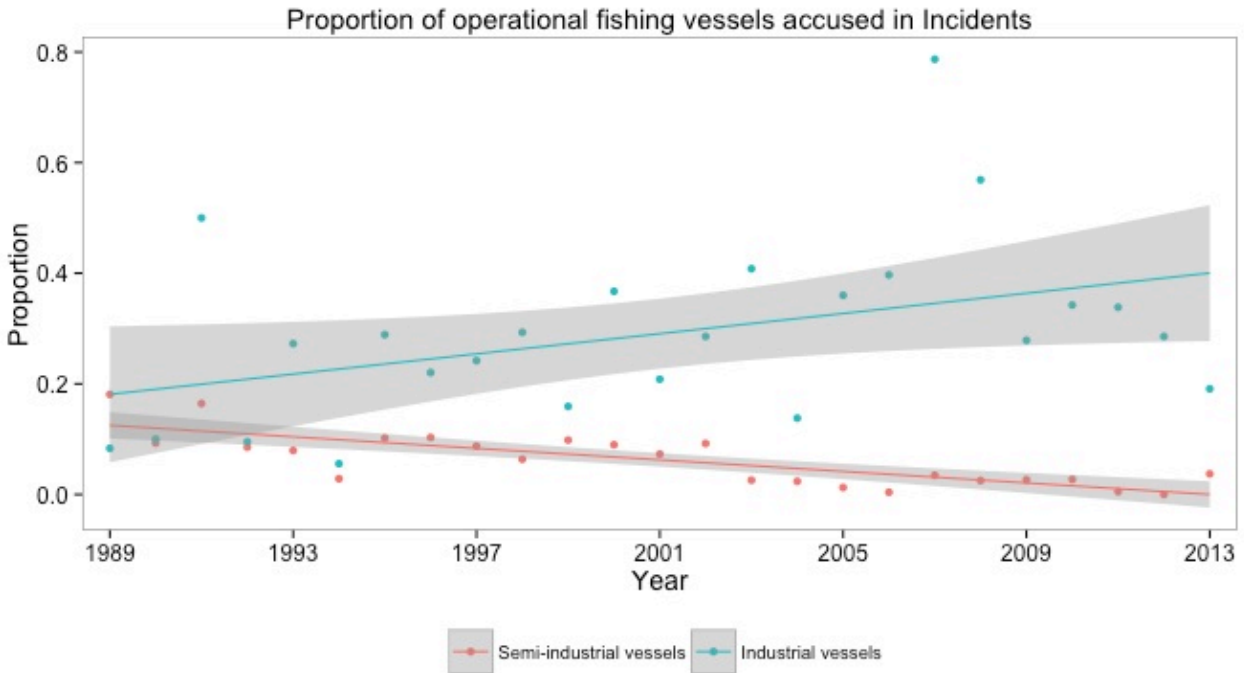


Figure 1: Proportion of operational fishing vessels accused in incidents 1984-2013 sector much more likely to be involved in an incident (average 30% of operational industrial fleet) versus the semi-industrial sector (average 6% of operational semi-industrial fleet) (**Error! Reference source not found.**).

Plotted over time, most accused vessels are from the semi-industrial fishing sector in the 1980-90s, however industrial fishing vessels emerged as the primary accused parties in the early 2000s, and remain so to the present (**Error! Reference source not found.**). Of the cases with information on accused vessel gear (n=978), the majority used trawling gear (53%, n=523) or unknown fishing gear (20%, n=192), followed by no fishing gear (19%, n=183), purse seine (5%, n=47), and pole and line (3%, n=27). Table A-9 represents the full distribution of accused parties' gears, with "no fishing gear" indicating that the accused vessel was not a fishing vessel, and "unknown gear" indicating that the accused was a fishing vessel with unknown gear.

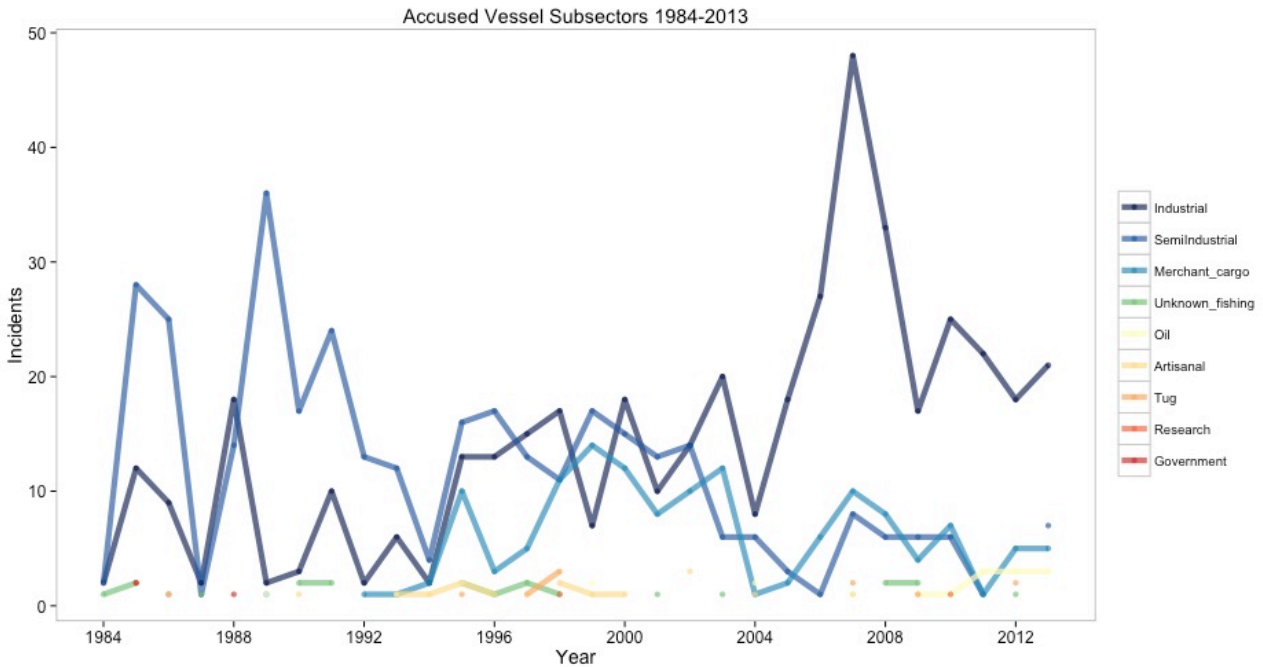


Figure 2: Accused vessel subsectors 1984-2013

Since most accused vessels are fishing vessels, resource competition is likely a strong driver of incidents at sea, rather than simply random presence of vessels navigating Ghanaian waters (i.e. merchant vessels). Here, the concepts of interference competition, defined as direct competition through antagonistic actions, and exploitation competition, defined as indirect competition through mutual effects on a shared resource (e.g. fish) (Cain et al. 2011) are useful to consider. Incidents at sea are a characteristic example of interference resource competition: vessel collisions and gear destruction are direct, antagonistic actions that inhibit a competitor's ability to fish. Whether those antagonistic actions are intentional (e.g. gear sabotage, casting nets upon others) or unintentional (e.g. targeting identical fishing areas), the accused has reduced the petitioner's ability to access fish resources. Exploitation competition, understood here as diminishing a competitor's access to fish by reducing fish stocks, was referenced multiple times in case narratives, usually by artisanal fishers who believe that fish stocks have declined due to industrial trawling or light fishing practices. However, exploitation competition in this system requires an assessment of fish abundance and despite extensive qualitative evidence, is beyond the scope of this study.

In the early part of the time series, semi-industrial vessels represent the majority of accused vessels in incidents at sea, however in the late 1990s-early 2000s, industrial vessels begin to dominate (Figure 2: Accused vessel subsectors 1984-2013). This shift in dominance is not explained by a disproportionate increase in industrial vessels in Ghanaian waters, as operational semi-industrial vessels show a sizeable increase during this time period. Four trends may clarify this change in incident dynamics. First, capacity in the small-scale fishing sector has grown continuously since the late 1980s, when the introduction of a government subsidy on “premix” fuel (i.e., outboard motor fuel) dramatically decreased the cost associated with artisanal fishing (Atta-Mills et al. 2004, Finegold et al. 2010). This growth in fishers and boats in the artisanal sector gave rise to two related trends of increasing motorization (Bannerman et al. 2001, Amador et al. 2006, Finegold et al. 2010) and decreasing overall catch per unit effort (Atta-Mills et al. 2004). The result of these three trends was the overall expansion of the area fished by small-scale fishers, with fishing trips lasting longer and venturing further. In 2000, the fourth trend emerged: the industrial sector began pair trawling—a highly effective fishing method whereby two industrial vessels pull a single trawl between them (Sainsbury 1996). Pair trawling is especially effective in shallower areas targeting demersal and bottom fish, and is often considerably more efficient at catching fish than traditional bottom trawling (Sainsbury 1996). In Ghana, pair trawling was determined to be so efficient and environmentally destructive that it was banned by 2008 (Finegold et al. 2010). The trend of pair trawling, accompanied by an overall growth in the industrial sector, led to not only an increase in industrial fishing, but a likely expansion of the industrial fleet into inshore areas traditionally fished by artisanal fishers. This combination of expanding small-scale fishing and industrial vessels fishing closer to shore may help explain the growth in artisanal-industrial incidents at sea.

Trawls represent the majority of accused gear, and ten times more than any other gear identified for accusers. This supports the idea that incidents are in large part driven by the incursion of trawlers into inshore areas, as purse seine and line gears that are able to operate further offshore are accused in only 8% of incidents compared to 53% for trawlers. Industrial trawlers are legally allowed to operate in waters greater than 30 m depth, however the sea floor beyond 75 m depth is unsuitable for trawl gear; therefore while a range of locations are available for industrial trawling, the upper limit of suitability for this gear creates substantial incentive to trawl within exclusion zones (Finegold et al. 2010). Additionally, a multitude of case narratives describe incidents in which small-scale nets were tangled in deployed trawl lines, ruling out the possibility of mere navigation, and indicating that incidents were associated with trawlers actively fishing in inshore areas.

3.1.2.2 Cargo vessels

Following the industrial and semi-industrial sectors, the third most frequently accused sector was cargo vessels (14%, n=141). In Ghana, there is a perception that cargo vessels are responsible for a large number of incidents at sea, as one case from 1985 illustrates, saying, “accidents do occur quite often between merchant vessels and canoes, which are mostly not reported, and merchant vessels sail away without much concern.” However, the research presented above demonstrates that highly capitalized fishing vessels are accused in incidents far more frequently (78%) than cargo vessels (14%). Cases with accused cargo

vessels have fluctuated over time with a peak in the late 1990s and early 2000s (Figure 2), however in no year do they represent the dominant accused sector.

Cargo vessels are also disproportionately involved in incidents with artisanal vessels over other sectors. Cargo vessels were accused in 130 cases with artisanal vessels, compared to only 4 with semi-industrial vessels and none with industrial vessels. Although a comparison between cargo vessels accused in incidents and total merchant vessels in Ghana is not possible, the disproportionate number of cases with artisanal vessels supports the idea that when incidents do occur with cargo vessels, it is more likely attributable to the characteristics of the small-scale sector (e.g. decreased visibility and propulsion capacity) rather than resource competition or random presence at sea.

3.1.2.3 Oil vessels

Only 2% of incidents at sea between 1984–2013 involved an accused oil vessel (Table A-8), yet a number of stakeholders expressed the belief that oil vessels were responsible for a significant number of incidents at sea in Ghana. In recent years, incidents between oil vessels and small-scale fishers in Ghana have been mentioned in government documents as well as numerous accounts in the popular media (Badgley 2011, Anderson and McTernan 2014).

Despite the small proportion of incidents (Table A-8), historical context of oil exploration in Ghana provides further insight into stakeholder perceptions and trends in incidents involving oil vessels. Oil exploration in Ghana has occurred for decades, however exploration activities increased significantly following the establishment of the Ghana National Petroleum Corporation in 1984 (GNPC n.d.); (Obeng-Odoom 2013). The period from the late 1980s- early 2000s saw a number of milestones, however the most groundbreaking event in the development of Ghana's oil industry was the Mahogany significant discovery in June 2007, the first commercially viable oil discovery in Ghanaian history (McCaskie 2008, Obeng-Odoom 2013, GNPC n.d.). In 2010, the Jubilee Oil Field was constructed and Ghana exported its first oil in 2011 (Obeng-Odoom 2013). **Error! Reference source not found.** shows the number of incidents at sea involving oil vessels throughout the time series. Although sample sizes from the incident at sea database are too small to allow for a rigorous quantitative analysis, the regularity and abundance of incidents involving oil vessels increases markedly following the discovery and extraction of commercial oil in the late 2000s. This is particularly notable considering the growth in conflicts at sea following oil development in countries such as Nigeria and Angola (Neethling 2010, Pérouse de Montclos 2012, Murphy 2013). While oil vessels do not represent a major proportion of accused vessels over the time series in Ghana, incidents with oil vessels are increasing and are likely to grow as offshore oil development expands.

3.1.2.4 Artisanal vessels

While the majority of incidents at sea in this study follow a profile of petitioning small-scale fishing vessel and accused industrial or semi-industrial vessel, some exceptional cases merit discussion. Artisanal vessels were reported as the accused parties in less than 3% of cases (Table A-8), however these cases are oftentimes more violent and represent different dynamics than the average incident at sea. This is likely because as highly capitalized sectors, industrial and semi-industrial vessels face a weaker set of incentives to report incidents at sea with small-scale vessels, and are instead only compelled to do so under

cases of dramatic loss or injury. The particular dynamics of these incidents are explored further below in section 3.3.2 and in Chapter 2: Conflict at sea as resource conflict? Tracing patterns of conflict and cooperation in Ghana.

3.2 What are the characteristics & drivers of fishing incidents at sea?

Although establishing causation of historical incidents at sea is not possible in the scope of this study, a number of factors and conditions are positively correlated with incident occurrence.

3.2.1 Incident time

Of the cases that have the time of incident documented (n=592), the majority (69%, n=406) occurred after dark, and nighttime had a statistically significant effect on incidents (P=0.0143), with the greatest number of incidents occurring between 3-6 AM with a smaller peak around 9 PM (Figure 3). Many types of artisanal fishing in Ghana are conducted at night, including anifa-nifa, set net, and ali net fishing (Doyi 1984, Finegold et al. 2010), and several traits of night fishing may explain the greater number of incidents that occur. As mentioned above, small-scale vessels in Ghana are not always propelled by motor, and those that are often have low-power, old, or unreliable equipment that prevents them from effectively avoiding other vessels in the dark. Small-scale vessels also oftentimes lack the technology to alert other vessels to their presence at sea (e.g. radios, metal hulls that allow visibility by radar, etc.). In many cases, deployed nets are also not adequately lighted to alert vessels to the presence of gear in the water. Furthermore, case narratives

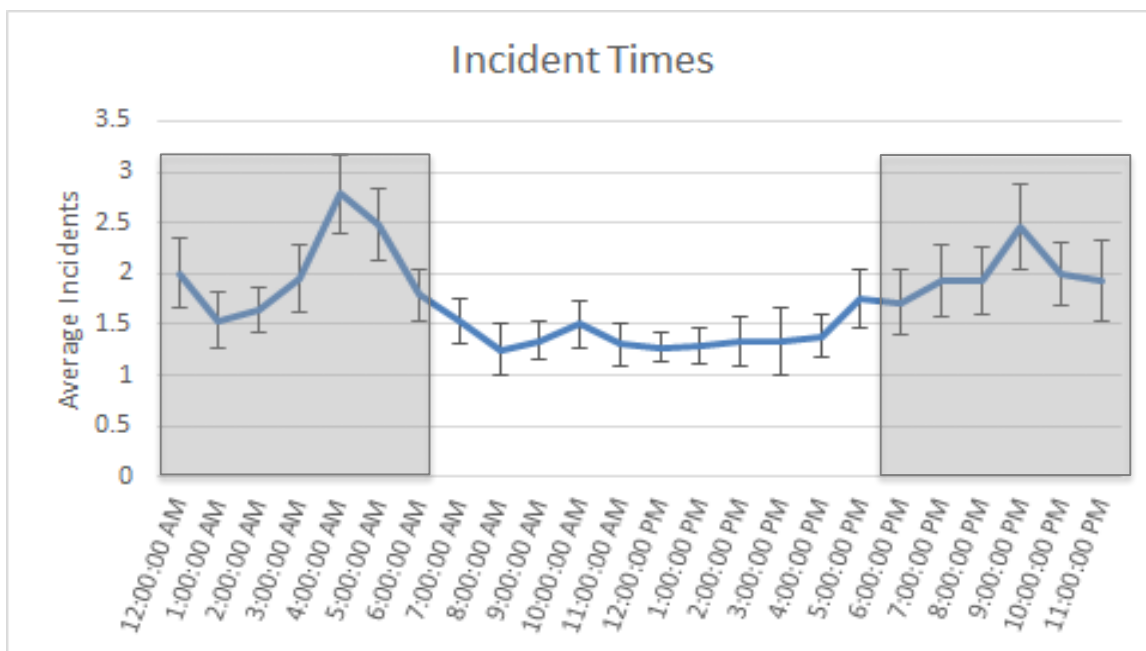


Figure 3: Time of Incident occurrence

suggest that many artisanal fishers are in the habit of sleeping at night while passive gears are in the water, decreasing the response time for preventing an incident in comparison to those which occur during the day.

3.2.2 Incident Season

Of the cases with a date of incident documented (n=432), most occurred during July, August, and September (n=139) with another rise in December (n=49) (Figure 4). The major upwelling had a notable effect on the number of incidents (P= 0.099), however the minor season and off season showed mixed trends. The correlation between high fishing season and incidents at sea is important because reinforces the notion that incidents are driven by fisheries resource competition rather than simple spatial overlap at sea. Furthermore, it suggests that fisheries resource competition in Ghanaian waters is more driven by resource abundance than resource scarcity; in Ghana, it is the seasonal abundance of fish stocks during the upwelling period that increases vessel competition, rather than seasonal scarcity.

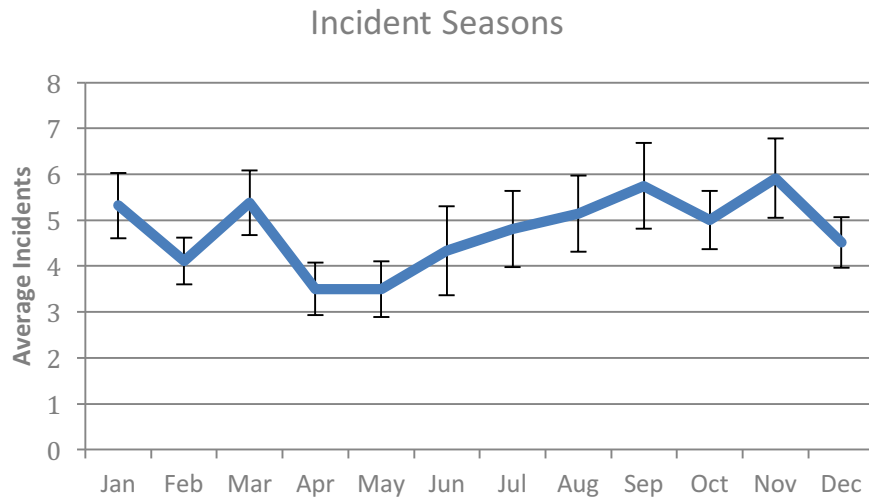


Figure 4: Season of incident occurrence. Dark grey indicates the major upwelling, and light grey indicates the minor upwelling.

The seasonal concentration of incidents at sea is likely attributable to the open access nature of the Ghanaian small-scale fishery. No law or regulation limits the number of small-scale vessels allowed to operate in Ghana's waters, and the number of active artisanal canoes has increased steadily for decades (Bannerman et al. 2001, Amador et al. 2006, Bannerman n.d.). Furthermore, while Article 52 of the Fisheries Act of 2002 states that canoes must be both licensed and registered, this regulation is oftentimes unobserved or ignored (Government of the Republic of Ghana 2002, Finegold et al. 2010). This leads to a *de facto* open access fishery in which the only barriers to entry relate to capital (e.g. vessel, nets, etc.) and social relations (e.g. approval from the local chief fisherman) (Ribot and Peluso 2003). While in some cases those barriers are significant, the perceived benefits from fishing outweigh the costs in the high season, leading to a corresponding increase in effort and incidents at sea. Another factor that likely contributes to this seasonal increase are the seasonal adaptations of local fishers to either reduce effort or switch to alternative livelihoods during the off season (Finegold et al. 2010). This reinforces the idea that competition in Ghana's fishery is not driven by a sort of Malthusian resource scarcity, since the primary assumption there is that as resources decline, resource users have no choice but to increase exploitation (Pauly 1990, 1994, Steneck 2009). Competition in Ghanaian

small-scale fisheries does not support this theory, but rather local fishing communities demonstrate resilience to seasonal fluctuations in fish resources which result in decreased incidents at sea in the off season.

3.2.3 Incident location

The spatial model of possible historical incident locations suggests that incidents at sea concentrate in two primary areas: 1) around major fishing ports accessible to industrial and semi-industrial vessels and 2) on the shallower continental shelf (Figure 5: Model of possible historical incidents at sea 1984-2013 **Error! Reference source not found.**). Sekondi, Takoradi, and Tema represent the three ports in Ghana where large

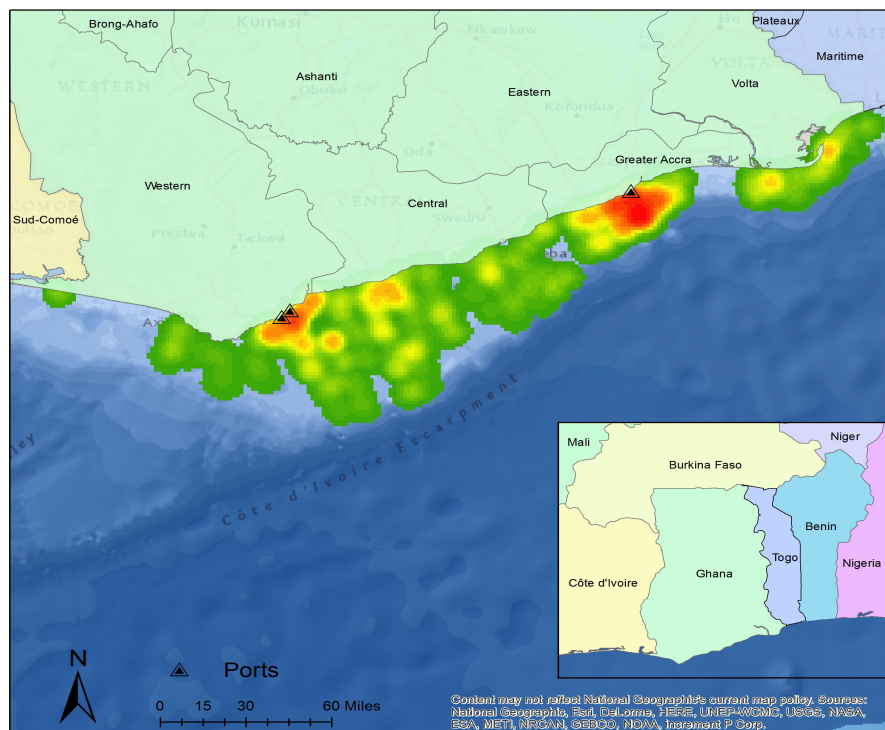


Figure 5: Model of possible historical incidents at sea 1984-2013

vessels are able to access shore in significant numbers, and 14% of all possible incident locations were within 10km of these ports, with 45% within 20km. While neither geological nor legal definitions of the continental shelf stipulate specific depths or distances from shore³ (Rothwell and Stephens 2010, Dodds 2010, Pinet 2011, McConnell et al. 2012),

³ The initial text in Article 1 of the Convention on the Continental Shelf included depth and exploitability criteria, defining the continental shelf as, “The seabed and subsoil of the submarine areas adjacent to the coast but outside the area of the territorial sea, to a depth of 200 meters or, beyond that limit, to where the depth of the superjacent waters admits of the exploration of the natural resources of the said areas” (Oxman 1972). However the ultimate definition included in Article 76(1) of the UN Convention on the Law of the Sea omitted the depth criterion, and defined the continental shelf as “the sea-bed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin, or to a distance of 200 nautical miles from the baselines” (United Nations 1982). The geological definition of the continental shelf is generally considered the relatively shallow area of the seafloor adjacent to the coast where the continental margin slopes down from the landmass until it reaches the shelf break (Cook and Carleton 2000, Pinet 2011).

continental shelves are typically less than 150 meters depth and in Ghana is considered less than 75 meters depth (Koranteng 2001, Pinet 2011). In this spatial model, all potential incident locations lay within depths associated with the continental shelf, with 99.4% of potential incident locations occurring depths less than 75 meters and 59% of all potential locations were within 15km of the coastline.

Without supplemental information, it is difficult to interpret the causal mechanism behind why or how proximity to ports influences prevalence of incidents at sea. Cultural and historical as well as economic and ecological variables may all shape the reasons why vessels interact more closely to ports. However, it bears noting that while merchant, oil, and industrialized fishing vessels are restricted to berthing within these larger ports, small-scale fishing effort is much more dispersed throughout the coastline. Ghana has approximately 300 artisanal landing sites distributed throughout the coast, and according to the 2013 frame survey, only 7% of small-scale fishing vessels are based in one of the three towns with port facilities (Bannerman n.d.). Therefore, ports may act as concentrated

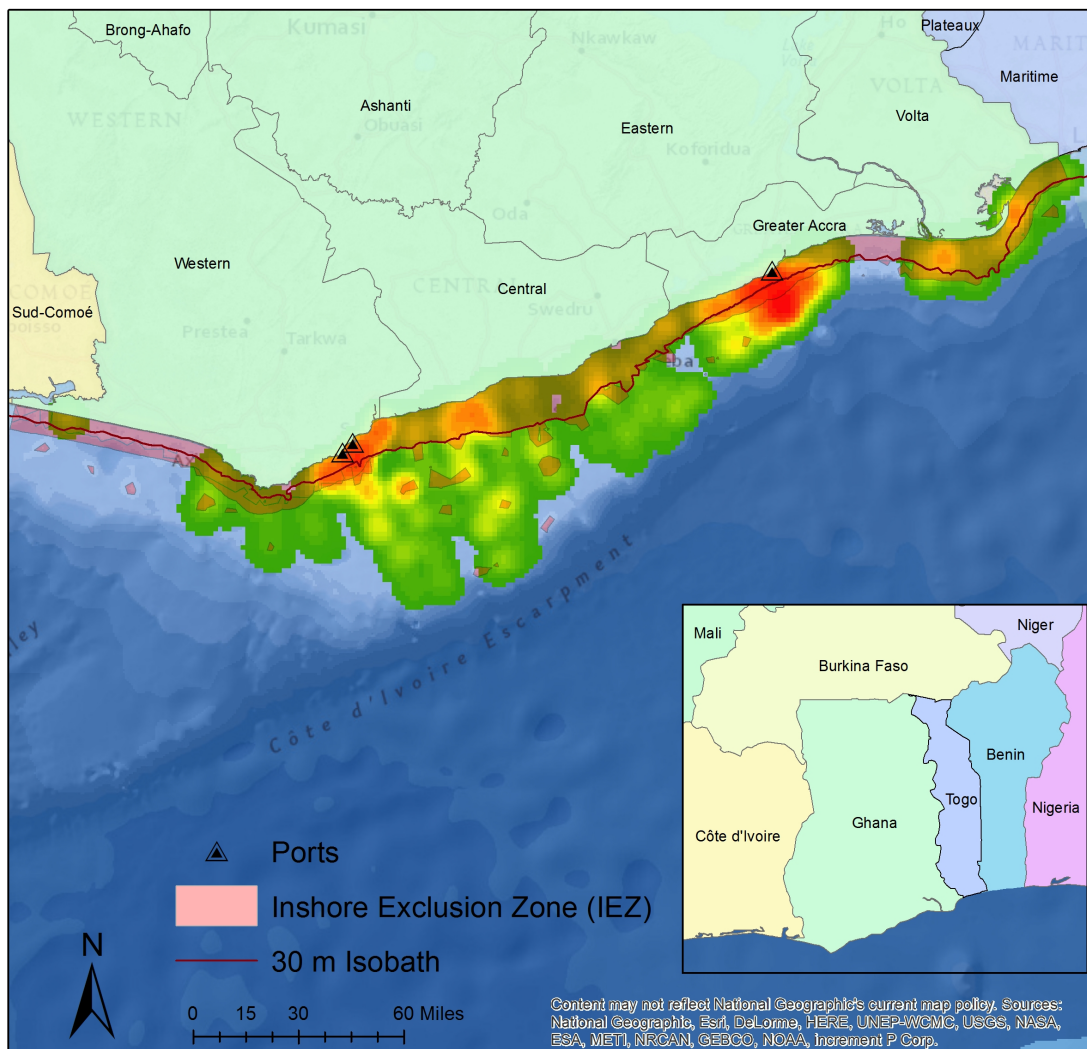


Figure 6: Modeled historical incidents at sea in comparison to Ghana's Inshore Exclusion Zone (IEZ) and 30-meter isobath

areas of vessel interaction because of the increased traffic of large vessels, rather than the disproportionate target of these areas by small-scale fishers.

The results suggesting that the continental shelf may influence incident prevalence are intuitive, since continental shelves represent the most productive fishing grounds in the world (Ingole and Koslow 2005, Roberts 2006, García et al. 2007, Mossop 2007). In coastal upwelling systems, such as Ghana, rich productive waters shoal over the shallow continental shelf, concentrating the most productive fisheries in particular shallow locations. Additionally, areas with relatively shallow depths correlate with inshore areas, which are naturally closer to points of embarkation and therefore more likely to be accessed.

In relation to the spatial governance regulations in Ghana, the spatial model suggests that 36% of possible incident locations fell within the 30-meter isobath used most often by the Government of Ghana in visualizing the Inshore Exclusion Zone. In relation to the IEZ layer created in this study, however, 91% of possible incident locations fell within the Inshore Exclusion Zone based on terminology from the Ghanaian Fisheries Act of 2002 (Figure 6). Spatial governance of ocean areas is a fundamental and growing component of the governance of marine spaces for coastal states (Roberts et al. 2005, Lorenzen et al. 2010). In Ghana, the Inshore Exclusion Zone (IEZ) is one of the oldest and most well-known of these spatial zones, and small-scale fishers are aware of, and often adamant about, the importance of this zone in preserving their fishing rights. However, while the Fisheries Act of 2002 prohibits industrial and semi-industrial vessels fishing in the IEZ, it allows for navigation, and makes exceptions in the case of a) permitted semi-industrial vessels targeting cephalopods and b) fishing vessels exempted by the Director of Fisheries (Government of the Republic of Ghana 2002). Therefore, any spatial monitoring and enforcement of this area requires knowledge not only of industrial vessel presence, but also activity (i.e. fishing versus navigation) and potential special status. It is not possible within the scope of this analysis to determine whether industrial and semi-industrial vessels were engaged in illegal activity, however the numerous case narratives describing fishing in the IEZ combined with the extremely high proportion of incidents (91%) that occurred within the IEZ makes it unlikely that all incidents at sea that occurred within the IEZ were attributable to navigation or vessels with exempt status. An additional result of this analysis is the comparison of incidents at sea in the IEZ as outlined in the Fisheries Act with the 30-meter contour line most often applied by governing agencies. In our analysis, over 2.5 times as many potential incident locations were included in the IEZ than the 30-meter isobath, with potentially considerable implications for monitoring and enforcement.

3.3 What are the outcomes of these incidents for various actors?

3.3.1 *Encounter characteristics*

In the initial encounter, the majority of cases reported damage to nets or other fishing gear, with 952 cases of gear damage (90%), and 120 (11%) explicit cases of damage to vessels. Since data were coded for mention of specific types of damage, some cases represent either vessel or gear damage, while some include both and 78 (7%) of the reported cases were not clear on the type of damage sustained by the petitioner.

According to case narratives, following gear or vessel damage, petitioners attempted to pursue the accused vessel at sea. Few cases reported their vessels' means of pursuit

(n=80), but the majority (61%, n=49) of pursuits described were conducted with small motors, and pursuit by paddle was also prevalent (35%, n=28). In many cases, petitioners were rendered unable to pursue the accused vessel due to the damages incurred, or they preferred to retrieve all pieces of the damaged gear first. Oftentimes, assistance in pursuing the accused vessel was obtained from a neighboring boat when the petitioner was unable to pursue due to limited fuel or propulsion capacity. The response of the accused vessel following an incident was included in 286 cases (n=321 responses) and was comprised of four primary responses: acceptance, denial, fleeing, and covering the vessel's identifying marks. In many cases (11%, n=32), accused vessels demonstrated a combination of responses. Fleeing was the most commonly reported response (36% responses, n=116), followed by denial (34% responses, n=110). Acceptance of the accusation at sea was the third most prevalent response (27% responses, n=87), and vessels covering identifying marks were reported in 3% (n=8) of cases with accused response information.

Results about initial encounters at sea, including diminished ability of petitioning vessels to pursue the accused and accused responses of fleeing and covering identification, act to reinforce the idea that "at sea, anonymity is the rule." If a petitioning vessel is unable to collect identifying information or successfully pursue the accused, the chances of restitution are close to zero. Since there is no current insurance scheme in the small-scale sector, there are few alternatives to restitution, and case narratives suggest that every effort is made to approach and interact with the accused vessel and negotiate a settlement for compensation. Although the Arbitration Committee is set up in Ghana to mediate these negotiations on land, many fishers prefer an encounter at sea over the uncertainty and delay of onshore mediation. The institution of the Arbitration Committee and its role in mediating incident outcomes is addressed further in Chapter 2: Conflict at sea as resource conflict? Tracing patterns of conflict and cooperation in Ghana.

3.3.2 Interaction characteristics

When pursuit occurred, and the petitioner was able to intersect with the accused vessel at sea, various interaction characteristics emerged. 374 cases included information on interactions at sea (n=551) between the petitioning individuals and accused individuals, and many cases involved multiple encounter types (e.g. initial arguing, but eventual cooperation). Of the cases that mentioned the nature of interactions, the most prevalent interaction was arguing, reported in 57% (n=225) of the cases. Interestingly, this was followed by cases of cooperation (30%, n=118). Violence was reported in 18% of cases (n=73), with threatening occurring in 16% (n=65). Compensation at sea was attempted in 10% (n=39) and occurred in 8% (n=32) of cases. Finally, 3% of cases with encounter information reported abduction of a crewmember (n=11). Table A-10 describes the seven different interaction types and their common characteristics from the database cases. Negative encounters were reported most often (66%) followed by positive (21%) and neutral (13%).

A crosstab analysis of the accused sector and the encounter type showed that, averaged over the total number of encounters in each accused sector, the highest severity index is for the artisanal accused vessels, followed by the semi-industrial and then industrial (Table A-3). 336 cases included information on the relative location of encounters at sea (n=571) between individuals on petitioning and accused vessels. The majority of encounters occurred alongside or tethered to the accused vessel (n=340, 71%),

followed by on one of the vessels (n=190, 32%), and 35 cases (8%) described an encounter between the two parties on land following the incident. In 17 of the cases, fatalities were specifically mentioned as a result of the incident at sea, and this figure is particularly conservative considering the fact that cases with fatalities are likely to be primarily addressed by other institutions such as the police. All fatal cases that included narratives were cases of collisions or capsizing due to dragging of anchor lines or other gear incidents. However, notably, in one account the petitioner stated that the accused deliberately caused damage to their vessel, which led to the loss of life. Injuries (n=97) were specifically mentioned in 67 cases, with 45% (n=30) of cases representing unintentional injury through collision or capsizing and 39% (n=26) of cases showing intentional injury through violence or abduction. 16% (n=11) of cases that mentioned injuries were of unknown causes.

The majority of existing literature on incidents at sea explores the perceived growth in and challenges of violent conflict between sectors (Bennett 2000, Bavinck 2005, DuBois and Zografos 2012, Segi 2014). While it's true that negative encounters are still the most prevalent reported in Ghana, the majority of interactions are not violent, and the second most reported encounter type was cooperation. In this way, the claims commonly found in the media and existing scholarly literature on interactions at sea are not borne out in the Ghanaian case. However, while the dominance of violent encounters may not be true in the case of Ghana, the prevalence of abduction, violence and threats of violence are still a marked element of these encounters, and are likely unmonitored and undocumented in law enforcement realms. That cases with an accused small-scale vessel represent the highest average severity index is of particular note. Artisanal vessels were reported as the accused parties in less than 3% of cases (Table A-8), however on the whole they exhibited higher per case severity (Table A-3) than any other incidents. In several of these cases, petitioners apply the term "piracy" or "pirates" to the accused small-scale vessel members, evoking similar claims from Somalia and Nigeria against the hostile actions of small-scale fishermen (Osei-Tutu 2011), Neethling:2010js, Perouse de Montclos:2012gl}. An analysis of the context and conditions for these different interactions follows in Chapter two.

The claim that these cases represent examples of piracy is often supported by the location where encounters occur relative to vessels. Two fundamental components of piracy are that it is unauthorized and occurs on the vessel (United Nations 1982, Renwick and Abbott 1999); in this analysis, 71% of cases with encounter location information occurred alongside or tethered to the accused vessel, and 32% occurred on board one of the vessels. In the vast majority of these cases, the accused vessel is boarded or detained without the consent of the captain or crew, and indeed the captain and crew avoid detention at great cost (e.g. cutting trawl lines that have been used as tethers, throwing projectiles or releasing dogs to chase potential boarders away, etc.). Therefore, while these encounters may not necessarily be considered "piracy" in the strictest sense⁴, unauthorized

⁴ Piracy is defined in Article 101 of the UN Convention on the Law of the Sea as "any illegal acts of violence or detention, or any act of depredation, committed from private ends by the crew or the passengers of a private ship, and directed... a) on the high seas and b) outside the jurisdiction of any state" (United Nations 1982). While this definition of piracy only applies to incidents on the high seas, the IMO applies the same definition in territorial waters to "armed robbery" of ships, and some scholars have pushed for a more inclusive definition of piracy (IMO 2010).

boarding of a vessel has legal implications, both in Ghana and internationally, and has led to the association between fishermen's' grievances and piracy or armed robbery.

Finally, analysis of these interactions lends insight into the causes of inter-sectoral conflict at sea. While evidence suggests that cases with fatalities are largely accidental, 39% of those cases that described injuries were due to intentional violence or abduction. This finding underscores the importance of resource competition in explaining these conflicts and supports the media and scientific evidence of direct hostilities between fishing vessels at sea as a means of retribution.

4 Conclusion

As a natural resource, fisheries are notoriously difficult to study and manage. In 1978, fisheries biologist John Shepherd famously stated that, "Managing fisheries is hard: it's like managing a forest, in which the trees are invisible and keep moving around" (Shepherd 1978). Since fisheries management is really more concerned with altering the behaviors of resource users, a more relevant statement may be that managing fisheries is hard because fishers are invisible (to land-based governance institutions) and keep moving around. Much of this difficulty in managing fisheries is intrinsic to a system in which exploitation is executed beyond the vigilance of land-based institutions and in most of the world, the structures, technologies, and incentives to illuminate those dynamics are not in place. The purpose of this study was to bring some of those "invisible" dynamics to light: to begin to describe intersectoral competition and interactions in seaspace in the hopes of improving resource equity and sustainability in fisheries systems.

One of the most important results of this chapter is the strong indication that incidents at sea between vessels are dominated by the fishing sector and largely point to resource competition as the driving factor. The fact that the vast majority of incidents occur between small-scale vessels and highly-capitalized fishing vessels, in the high fishing season, and close to shore on productive continental shelves, all suggest that the majority of incidents relate to fisheries resource competition. This finding supports the claims of small-scale fishermen in Ghana and elsewhere, and reinforces the accounts of previous scholarly and journalistic work; it suggests that small-scale and industrial fleets are not separate, but operate in similar spaces and times, and when they do, small-scale fishers are disadvantaged. This finding is particularly salient considering the growth and expansion of industrial fishing fleets and the decline of major fish stocks. The last several decades have seen the dramatic expansion of industrial fishing effort into the global south and equatorial regions, with West African waters serving as a prime target for foreign industrial fleets (Swartz et al. 2010, Seto 2016). Furthermore, the majority of commercially exploited stocks in the Eastern Central Atlantic bordering Ghana are considered fully fished or overfished, with 48% of assessed stocks fished at biologically unsustainable levels (FAO 2016b). As industrial fleets continue to expand into traditionally fished areas, and stocks of exploited fish decline, resource competition and the accompanying interactions at sea are likely to rise in the absence of significant changes in management and exploitation patterns.

This research also suggests that incidents between different sectors have different primary drivers: incidents with fishing sectors are driven by resource competition, however incidents with cargo ships are more related to the characteristics of small-scale fishing in Ghana (e.g. poor lighting, wooden hulls) and incidents with oil vessels are most influenced by the rise in oil exploration in Ghanaian waters. This finding suggests that

while fisheries in Ghana are the most important site for inter-sectoral incidents and conflicts, its importance is relative and dependent on the formation and implementation of Ghanaian laws and policies. For example, incidents between fishing vessels may decrease with increased monitoring and enforcement of inshore areas or through policies that completely separate fleets in seaspace (i.e. by removing current exceptions for navigation in the IEZ), as occur in other countries such as Sierra Leone (Government of the Republic of Sierra Leone 1994). Further, the relative prevalence and importance of incidents with cargo and oil vessels may shift substantially with Ghana's continued commercial and energy development (TEN field 2017).

This research also suggests that interactions between vessels are associated with certain vessel characteristics and are concentrated in time and space. This suggests a degree of predictability and that monitoring and enforcement efforts may be targeted to specific seasons, times, and locations in order to maximize effectiveness. For many West African states like Ghana, where resources for fisheries management are limited or unreliable, the ability to direct efforts and funds to achieve goals more efficiently may prove highly beneficial.

“Small-scale fisheries have been historically marginalized and routinely ignored... Large industrial trawlers that fish the waters close to shore often degrade the sea bottom habitat and change the species composition of coastal ecosystems to a point where the local fish catch can drop precipitously. Such conflicts between foreign industrial fleets and small-scale coastal fishers are becoming increasingly prevalent in Asia and Africa, with small-scale fishers gradually losing ground.”

- World Resources Institute (Kura et al. 2004)

A significant amount of research has investigated conflicts within small-scale fisheries (Dahl 1988, Begossi 1995, Sen and Nielsen 1996, Berkes et al. 2001), and almost as much has been dedicated to the important—if more rare—instances of interstate fisheries conflicts (Soroos 1997, Ingimundarson 2003). However, exceptionally little research has investigated the inter-sectoral interactions at sea addressed here. The interface of these sectors presents unique challenges, and represents coinciding and conflicting notions of property, territory, rights, and management. This chapter has sought to describe the actors, characteristics, and drivers of these often-unseen fisheries dynamics, and begin to illustrate the outcomes of these incidents for various parties. In shedding light on the interactions that occur at sea, it has aimed to dispel some of the “anonymity” which dominates fisheries dynamics. This represents the first step in understanding the ultimate consequences of this competition and interaction for small-scale fishers and the resource base, and for shaping appropriate and effective responses in management and policy.

Chapter 2: Conflict at sea as resource conflict? Tracing patterns of conflict and cooperation in Ghana

1 Introduction

Accounts of rising fisheries conflicts have been reported from dozens of countries across the globe, particularly between small-scale fishing boats and more capitalized industrial vessels.⁵ In addition to the increasing prevalence of conflicts, evidence indicates they are growing more severe, oftentimes involving destruction of artisanal boats, assault, abandonment at sea, and murder (Fairlie 1999, Bavinck 2005, Environmental Justice Foundation 2007, Pomeroy et al. 2007, Gupta and Bavinck 2014). These conflicts have often been construed as a form of resource conflict, driven by multiple actors competing for the limited natural resource of fish (Bennett et al. 2001, Pomeroy et al. 2007, Bavinck et al. 2014b). Scholarship on resource conflict may therefore offer substantial insight into the explanation of these conflicts, and consequently, their management and prevention. Previous scholarship on resource conflict focused heavily on the role of scarcity in generating conflict and competition, suggesting an almost “instinctual” response by actors to a disequilibria of resources (Turner 2004, Khagram and Ali 2006). However, scholarship on natural resource conflict in recent decades has challenged one-dimensional and deterministic explanations for conflictual outcomes, emphasizing the importance of history, power, and materiality, as well as the contingent nature of social relations (Turner 2004, Khagram and Ali 2006). This development in thought around resource conflict has substantial implications for policy; understanding how and why users conflict or cooperate directly improves the types of strategies that can be deployed to mitigate these conflicts. While this scholarship has substantially contributed to our understanding of the nuances of resource conflict, few empirical studies have traced the conditions under which resource users conflict in marine spaces, and equally or more important, when they do not. Here I use empirical data from interactions at sea in Ghana’s coastal fisheries to examine the conditions in which resource users conflict or cooperate, and the conditions that contribute to each outcome. Grounding in literatures from political ecology and governance theory, I link these conditions to important broader dynamics at local and global scales, identifying potential policies to promote cooperative, and avert conflictual outcomes. Drawing on principles of resilience theory, I further consider the long-term effects of these patterns of conflict and cooperation for the resilience or vulnerability of the resource base, the fishers, and the institutions governing the system.

1.1 Resource conflict and cooperation: Theories and approaches

Resource conflict gained prominence as a field of study in the 1990s, with the emergence of

⁵ See for example: <http://www.americandailyherald.com/world-news/africa/item/fishery-surplus-claim-hurting-biodiversity-artisanal-fishing-say-african-fishermen>, <http://pakobserver.net/detailnews.asp?id=228861>, http://www.nzherald.co.nz/world/news/article.cfm?c_id=2&objectid=11180409, <http://www.hirunews.lk/74415/448-indian-fishermen-220-sl-who-violated-maritime-boundaries-arrested>, <http://www.bdlive.co.za/business/agriculture/2014/01/07/fishing-furore-has-hawkers-organising>, <http://www.businessweek.com/articles/2013-11-19/china-s-illegal-fishing-expeditions-threaten-world-waters>, <http://www.egyptindependent.com/news/fm-egypt-fishermen-held-tunisia-be-released-soon>, <http://www.gulf-times.com/Qatar/178/details/369420/IN-BRIEF>

several large research projects focused on delineating the relationship between natural resources and violent conflict (Khagram and Ali 2006, Deligiannis 2012). Framed broadly under the field of environmental security, the two most influential of these projects were 1) the Environmental Change and Acute Conflict Project (ECACP), a partnership of the University of Toronto and the American Academy of Arts and Sciences (AAAS) led by Thomas Homer-Dixon (Homer-Dixon 1999), and 2) the Swiss Peace Foundation's Environmental Conflicts Project (ENCOP) led by Gunther Baechler (Baechler 1999, Khagram and Ali 2006, Deligiannis 2012). Using slightly different methods and approaches, both of these prominent research projects set out to identify plausible causal mechanisms connecting scarcity with conflict. The ECACP identified three types of resource scarcity: 1) supply-induced, through resource depletion or degradation, 2) demand-induced, through increased consumption driven by population growth, and 3) structural, or uneven distribution of resources (Homer-Dixon 1999). With this foundation, the ECACP determined that scarcity can indirectly contribute to violent conflict through intervening "social effects," such as constrained economic productivity, migration, or the weakening of state capacity to meet demands (Homer-Dixon 1999, Deligiannis 2012). Similarly, ENCOP found that environmental degradation was a causal factor in conflict through "environmental discrimination," or the process by which "distinct actors—based on their international position and/or their social, ethnic, linguistic, religious, or regional identity experience inequality through systematically restricted access to natural capital (productive renewable resources) relative to other actors" (Baechler 1999). With their heavy reliance on the notion of scarcity and degradation, the environmental security conclusions ultimately evoke policy solutions that aim to either decrease the number of consumers (e.g. population control) or increase the number of resources (e.g. protected areas) as the primary means of avoiding resource conflict.

The findings of these research projects have been strongly influential in both academic and policy spheres. While they succeeded in bringing attention to the substantial role of states, civil societies, and institutions, and generated a tremendous amount of momentum in the study of natural resources and conflict, a number of substantial critiques have emerged in the intervening years. The first is that in taking resource scarcity and degradation as the independent variable and starting point for theories of conflict, these studies fail to actually demonstrate shortage of the resource on which they rely (Ratner et al. 2013). By beginning with the assumption of scarcity and degradation, other causal factors are precluded, and indeed other scholars have found a closer relationship between resource abundance or resource restoration and conflict (Fairhead 2001, Collier 2005, Humphreys 2005). Secondly, as the ECACP definition of scarcity is both environmentally (e.g. supply-induced) and socially (e.g. demand-induced and structural) determined, the term "scarcity" becomes a cumbersome catchall for both actual resource shortages and distributional inequities. In subsuming these very different types of resource dynamics—as well as their details, histories, and origins—under the term "scarcity," the independent variable becomes essentially unanalyzable (Fairhead 2001). Third, while mechanisms linking the independent variable scarcity and the dependent variable of conflict are posited (e.g. resource capture, environmental discrimination), they are never demonstrated as causal (Le Billon 2001). In other words, environmental security theories suggest the presence of resource-driven social injustices, but never reveal *how* scarcity shapes the processes of discrimination, marginalization, and ultimately conflict. Fourth, the process by

which broad social inequality or injustice becomes conflict is also never made explicit, since the moment of conflict is hidden in environmental security analyses. In overlooking the moment of conflict inception as an analytical focus, these studies preclude analysis of the conditions in which conflictual outcomes emerge, and when they do not. The summary of these critiques is that theories advanced by environmental security are overly generalized and unusable in the study of resource conflict, as “the origins, extent, and mechanisms for ending or perpetuating violence remain beyond analysis” (Peluso and Watts 2001).

In response to these perceived shortcomings of the environmental security perspective, two bodies of literature are especially useful. Integrating the fields of cultural ecology and political economy, political ecology provides an essential lens to the study of resource conflict, by emphasizing that the transformation of natural endowments (e.g. fish) into natural “resources” is a profoundly historical and social process (Harvey 1996, Le Billon 2001). By definition, resources possess simultaneous ecological, economic, and political meaning shaped by history; in other words, “resources are not; they become” (Zimmerman 1956). By focusing analysis on the social processes that shape resource production and distribution, political ecology responds to the second and third critiques above, emphasizing the mechanisms linking resources and conflict, rather than conflict “triggers” (Baechler 1999, Le Billon 2001). As the causal mechanisms linking scarcity and conflict posited by environmental security scholars are essentially social, political ecologists argue that the most appropriate analytical focus is in fact on these social mediators (e.g. power, wealth, information, etc.) rather than the oversimplified “factors” that emerge from the scarcity model (e.g. overpopulation, degradation). Focused analysis of the mechanisms and processes leading to conflict shifts the study of resource conflict away from notions of linear causality based on the presence or absence of specific factors, and has the potential to create a more nuanced, holistic, and useful picture of the “origins, extent, and mechanisms of ending or perpetuating” conflict (Khagram and Ali 2006).

While political ecology is useful in revealing the underlying social dynamics that shape the emergence of resource conflict, governance theory on the role of institutions is helpful in understanding the moment of conflict inception and the emergence of instances of cooperation (Ostrom 1990, Agrawal 2001, Giordano et al. 2005, Ratner et al. 2013). Originally developed to understand the establishment of collective action institutions to manage common pool resources, this literature provides a cohesive framework within which to consider both distal and proximal influences on the resource system (Agrawal 2001, Ostrom 2007, 2009, Ostrom and Cox 2010). As such, this literature offers two main contributions to the study of resource conflict. First, by explicitly connecting the broader social dynamics emphasized by political ecology to the moment of conflict inception, this literature responds to the fourth critique of environmental security, tracing how these dynamics are or are not translated into resource conflict. Second, by focusing in on the moment of emerging cooperation or conflict, the institutions literature enables us to highlight the contingent nature of social relations and the potential for cooperative outcomes over conflictual ones. Applying the institutions literature thereby enables us to assume neither the independent variable of resource scarcity nor the dependent variable of conflict, but rather to trace the patterns emergent from empirical data and gain deeper insight into the many facets of resource competition, conflict, and cooperation.

Here I ground the analysis of inter-sectoral interactions at sea between small-scale and industrial fishers in political ecology and governance literatures to ask: *What explains patterns of conflict and cooperation at sea in Ghana's coastal fisheries?* The goal of this study is to use the case of fisheries conflicts at sea to: 1) to illuminate how broad, resource-driven social injustices shape the processes of conflict, and 2) to explicitly focus on the moment of conflict to demonstrate the conditions in which conflictual outcomes emerge, and when they do not. Additionally, this paper will discuss how these patterns shape the long-term livelihoods, utilization, and governance of the system. This paper will proceed as follows: first I will outline the framework used to analyze patterns of conflict and cooperation in fisheries interactions at sea. I will then ground the research in Ghana's coastal fisheries, discussing background, methodologies, strengths, and limitations of empirical data. I will describe findings from the empirical analysis of interactions at sea, tracing the circumstances and emergent patterns of cooperation and conflict. I will then apply the framework to analyze these findings, emphasizing their historical foundations, in order to understand what explains these patterns and how they emerge. Finally, I will discuss the outcomes of these patterns of conflict and cooperation at sea and the implications they have on the future of fisheries exploitation and governance in coastal Ghana.

1.2 Analysis Framework

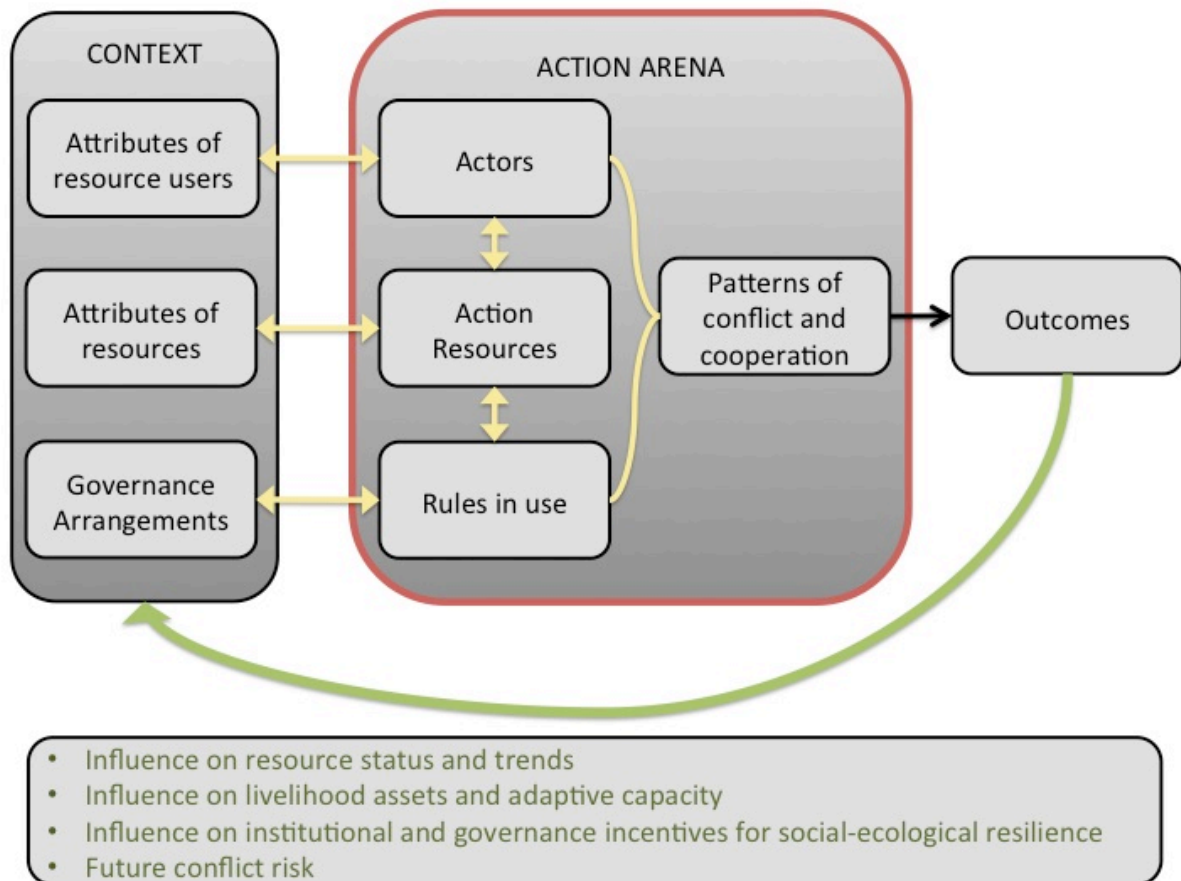
In order to trace the patterns of conflict and cooperation in coastal fisheries, I employ an analytical framework from Ratner et al. (2013). The framework takes as its foundation the Institutional Analysis and Development model (Ostrom 2007, 2009, 2011), which is highly adaptable, applicable at multiple scales, and enables analysis of divergent outcomes⁶. Building upon this institutional governance model, the framework incorporates principles from political ecology and resilience theory to understand when conditions of cooperation or conflict emerge, and the implications for user livelihoods and management of the resource system (Berkes et al. 1998, Allison and Ellis 2001, Folke 2006, Ratner et al. 2013).

The Ratner et al. (2013) framework is comprised of four primary components⁷ (Figure 7). The first component is the overall *context* of the resource system, which is comprised of the resource attributes (e.g. scarcity, observability), the resource user attributes (e.g. ethnicity, wealth), and the governance arrangements (e.g. formal laws, customary institutions) (Figure 7). This general context subsequently shapes the primary moment of analysis, the *action arena*, or the "stage for social bargaining" on which actors engaged in resource competition choose to cooperate or conflict (Ostrom 2005, Di Gregorio et al. 2008, Ratner et al. 2013). Within the action arena, three factors—actors (e.g. individuals, coalitions), action resources (e.g. material assets, social prestige), and rules in use (e.g. local laws, behavioral norms)—combine to shape the third component, the

⁶ While the IAD has most often been used to understand the construction of collective action institutions to cooperatively manage resources, the framework itself is highly adaptable and may be used to understand divergent outcomes at both the operational (Shivakoti et al. 2005, Bushouse 2011, Oakerson and Parks 2011) and policy (Andersson 2006) levels.

⁷ The analytical framework is explained briefly here, however for full discussion of the diverse ways in which these components may influence outcomes, see Ratner et al. (2013). Here I apply the framework in a directed way to analyze empirical data from Ghanaian fisheries, however it is worth examining the framework as a whole to better understand the full diversity of potential factors and how they may influence conflict and cooperation outcomes.

patterns of conflict and cooperation (Figure 7). Concepts from political ecology are particularly salient in understanding these components and the connections between them, as they demonstrate the relative power, material and immaterial assets of different actors and the social processes that shape resource distribution (Figure 7). These patterns of interaction lead to various *outcomes* of interest, identified as those that pertain to livelihood security, resource sustainability, and adaptive capacity (Ratner et al. 2013). Finally, over time, the outcomes of repeated patterns of conflict or cooperation return to influence the broader context of the resource system, potentially altering the system so as to either promote social-ecological resilience or increase vulnerability (Le Billon 2001, Anderies et al. 2004, Folke et al. 2005, Di Gregorio et al. 2008)(Figure 7: *Conceptual framework on resource conflict and social-ecological resilience adapted from Ratner et al. (2013)*). Yellow indicates application of concepts from political ecology. Green indicates application of concepts from resilience theory. The red action arena indicates the primary moment of analysis. Figure 7). Concepts from resilience theory aid in the analysis of these repeated patterns, revealing the influence that historical social processes and moments of conflict and cooperation have in determining



future adaptive capacity and governance approaches. In tracing these four components, the framework enables us to identify general and specific pathways toward conflict or cooperation, identify their influence on broader social outcomes, and perceive the ways in which those repeated patterns may influence future resource cooperation or conflict risk.

Figure 7: Conceptual framework on resource conflict and social-ecological resilience adapted from Ratner et al. (2013). Yellow indicates application of concepts from political ecology. Green indicates application of concepts from resilience theory. The red action arena indicates the primary moment of analysis.

1.3 Case study: Ghanaian fisheries incidents at sea

This study is situated in Ghana and explores patterns of conflict and cooperation between small-scale and industrial fishers in coastal marine fisheries. In recent years, interactions between small-scale and industrial fleets have gained attention as important sites in understanding fisheries competition, sustainability, and management. Oftentimes these interactions are conflictual, involving violence or abduction, and have been reported both within and across national borders (Bennett et al. 2001, Bavinck 2005, Pomeroy et al. 2007). Perhaps most famously, conflicts between small-scale and industrial fishers have been implicated as one of the primary drivers behind the emergence of Somali piracy (Bawumia and Sumaila 2010, Bahadur 2011). Yet interactions may also be cooperative, involving compensation or trade at sea (Nunoo et al. 2009, DuBois and Zografos 2012). For example, scholars have documented the practice of industrial vessels trading or bartering non-target bycatch to small-scale vessels, with important implications for sustainability and local fishing traditions (Nunoo et al. 2009, Ambrose and Obienu 2016). Whether conflictual or cooperative, these interactions that occur in seaspace have profound and long lasting consequences for the resource base, the resource users, and the future of resource management. Yet these interactions at sea are also exceptionally difficult to study, and while anecdotal evidence is often reported in media and grey literature, there is very little documentation of fisheries interactions at sea, and academic literature is scarce (Bennett 2000, DuBois and Zografos 2012).

Here I analyze the dynamics of fisheries conflict and cooperation that occur at sea in coastal Ghana. Ghana is situated in West Africa, with a coastal southern boundary bordered by the Guinea Current, and the Central Eastern Atlantic bordering Ghana serves as prime fishing grounds for both small-scale and industrial fleets. This study is based on empirical data on incidents at sea between these fleets from 1984-2013. Data were compiled from existing records from the Ministry of Fisheries and



Figure 8: Map of Ghana's coast with 118 villages including incident at sea reports

Aquaculture Offices in Tema, Takoradi, and Accra and are comprised of narrative accounts of 396 cases of incidents at sea between small-scale and industrial fishers reported from 118 villages spanning Ghana’s coast⁸ (Figure 8). To adequately trace the progression of incidents, each case was considered in two stages: encounter and interaction (Figure 9). The encounter represents the initial contact that a vessel or its gear has with another vessel or its gear within seaspace. An interaction involves verbal or physical contact between individuals onboard the vessels, and follows the initial encounter. Here I considered the interaction between actors to be the “stage for social bargaining,” and action arena of interest from the Ratner et al. (2013) framework, however the conditions of the encounter are taken into account.

To systematically trace the progression of incidents, all narratives were coded using qualitative data analysis software MaxQDA v.12.2.0 (MaxQDA Standard 12 n.d.). Incidents were also coded with one or more of seven observed interaction variables, three cooperative and four conflictual (Table 5). Data were analyzed to understand which emergent factors created pathways toward conflictual or cooperative interactions, and which factors altered those trajectories.

Table 5: The seven interactions variables observed in cases between small-scale and industrial fishers at sea in Ghana.

	Interaction variable	Interaction classification	Detail
1	Cooperation	Cooperative	May consist of: sanctioned admittance of one actor onto another’s vessel, relaying of contact information for onshore compensation, aid in the case of collision, etc.
2	Compensation	Cooperative	Primarily consists of compensation at sea with money, food, fish, capital such as pieces of net, rope, petrol, and engine oil, or other items such as cigarettes or whiskey.
3	Attempted compensation	Cooperative	
4	Argument	Conflictual	May occur onboard, alongside, or tethered to a vessel, and either small-scale or industrial actors may perpetrate threatening or violence. Violence may be hand-to-hand, though many cases involved knives, stones, clubs, iron rods, water cannons, and bottles, and rarely involved firearms, dogs, and projectiles like crabs and lobsters.
5	Threatening	Conflictual	
6	Violence	Conflictual	
7	Abduction	Conflictual	Most often occurs against small-scale fishers when they board an industrial vessel, however in rare cases an industrial actor was taken by small-scale fishers to ensure compensation.

2 Results: Tracing patterns of interaction at sea

In order to trace patterns of conflict and cooperation, the narratives from the incidents at sea were used to track the progression of events throughout the incident (Figure 9). Most incidents are incited when one vessel, usually an industrial or semi-industrial trawler, damages the net or vessel of a small-scale fisher (Figure 9-2). Most initial encounters occurred because of net damage, while a small minority was due to a collision between

⁸ Since the data only reflect those cases that were brought to the Committees, it is likely that a large number of incidents at sea occurred, which were never reported. It is also possible that the issue of reporting may bias data toward cases that are more severe or more proximal to Arbitration Committee locations, however the diversity of locations and estimated losses do not suggest strong bias.

vessels. While most narratives did not describe in detail the conditions under which the initial encounter occurred, the most common situations were when industrial trawlers either navigated or trawled through a submerged net (Figure 9-1). In a small number of cases, the small-scale vessel's net floated under an industrial vessel, and in fewer cases, the small-scale fishers were accused of casting a net in the trajectory of an industrial vessel. Following the encounter, most accused vessels departed the scene⁹, though in some cases, especially those involving a collision, the vessel would remain to assist the small-scale fishers (Figure 9-3). In cases where the accused departed, the petitioning vessel usually attempted to pursue the accused, however in cases where they did not pursue, it was most often because of extensive vessel damage or the desire to remain in order to collect the remaining catch and damaged capital. When pursuit did occur, but was unsuccessful, it was

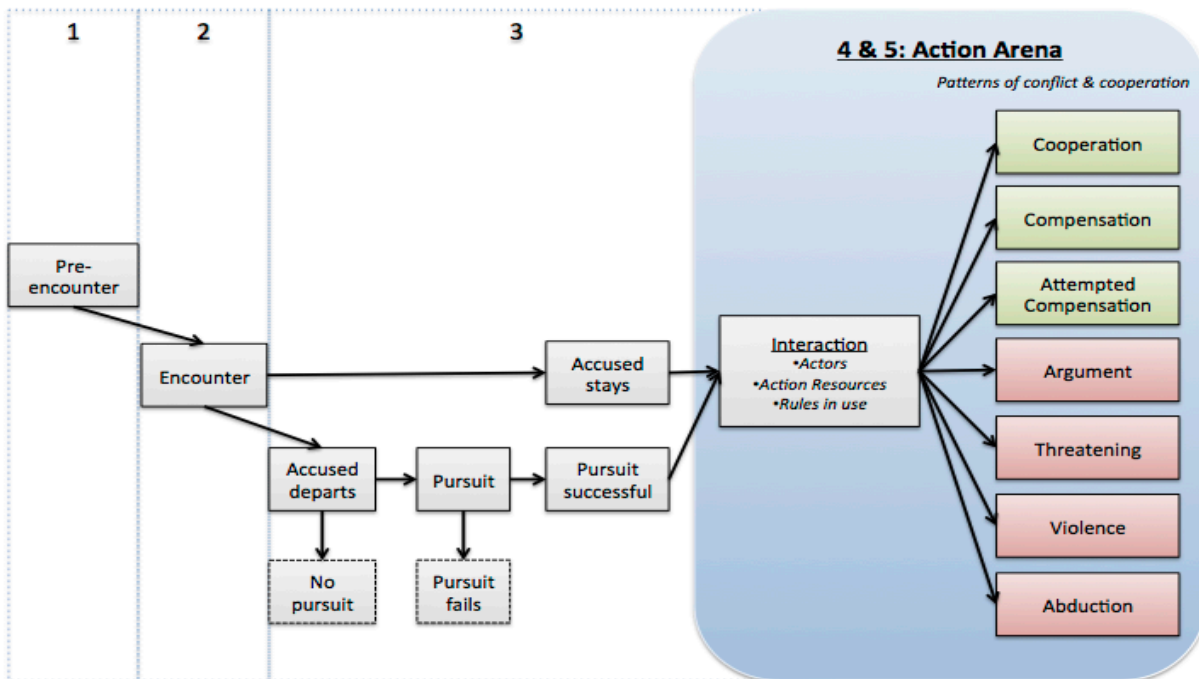


Figure 9: Incidents at sea were analyzed in 5 stages of progression: 1) pre-encounter, 2) encounter, 3) post-encounter and pre-interaction, 4) interaction, and 5) interaction outcome. Within the Ratner et al. (2013) framework, the interaction and the interaction outcomes comprise the action arena and the patterns of conflict and cooperation that are the subject of this study. Seven outcome variables were observed, conflictual indicated in red, and cooperative in green.

most often because of a lack of fuel or propulsion capacity by the small-scale boat (Figure 9-3). Where one of these two conditions occurred, there was no interaction at sea, and thus no pattern of conflict or cooperation emerges. However, in cases where the accused vessel did not depart, or where pursuit by the petitioner was successful, an interaction between parties occurred (Figure 9-4), constituting the action arena of interest from the Ratner et al. (2013) framework, and the moment of conflict or cooperation.

⁹ Of note, in some cases, the departure by the industrial vessel is a clear case of fleeing to avoid an interaction with the small-scale fishers, such as when the vessel covers its identifying markings and increases speed. However in many cases, it is unclear whether the departure of the industrial vessel is for purposes of intentional avoidance, or if they may be unable to stop or unaware that any damage has occurred.

The interaction at sea is considered “the stage for social bargaining on which different actors may choose to cooperate or not” (Di Gregorio et al. 2008, Ratner et al. 2013). It is within this arena that we can begin to trace the emerging patterns of conflict and cooperation at sea. When an interaction occurred, individuals on the accused vessel usually responded by denying culpability for the damage and, when damage occurred during the industrial vessel’s fishing activity, refusing or delaying retrieval of their net for inspection by the petitioners. This response by industrial actors was associated with conflictual outcomes including arguments and threatening by both small-scale and industrial fishers (Box 4: A). Furthermore, these responses oftentimes led to attempts by the small-scale actors to board the industrial vessel to force negotiation. When this occurred, industrial actors most often attempted to prevent the boarding by use of threats and violence (e.g. water cannons, iron rods, knives, stones, bottles, etc.) (Box 4: B, C). If the boarding was successful, however, both conflictual and cooperative outcomes emerged. Conflictual outcomes were by far the most common onboard, and involved all four conflictual outcome variables (Table 5), with the most severe cases involving assault, abduction, starvation, and abandonment at sea (Box 4: D-F). Notably, these conflictual outcomes onboard were bi-directional, perpetrated by small-scale petitioners on industrial fishers and vice versa. When industrial fishers perpetrated violence, it was usually to remove small-scale fishers from their vessel (Box 4: D, F), and when perpetrated by small-scale fishers, violence was meant to compel compensation or seek retribution for lost or damaged capital (Box 4: E). Though less common, all three cooperative outcomes were also

reached following a forced boarding, usually when Ghanaian members of the industrial crew interceded, or when petitioners were compensated with fish or money (Box 4: G-H).

Notably, however, in some cases, actors on the industrial vessel did not deny culpability, but directly cooperated with petitioners by allowing them on their vessel for discussion, sharing contact information for negotiation on land, or aiding small-scale fishermen in searching for lost nets or equipment (Box 4: I). In these cases, conflictual outcomes at sea were circumvented, and the “stage for social bargaining” was shifted to an onshore forum such as the industrial fishing company headquarters or quasi-governmental Arbitration Committee.

3 What explains patterns of conflict and cooperation in Ghana’s fisheries?

Using the Ratner framework to trace the emergent patterns of cooperation and conflict, it becomes possible to highlight the circumstances in which small-scale and industrial fishers do, and do not, conflict in sea space. In contrast with theories from environmental security, narratives suggest that actors do not choose to conflict based on in-the-moment or “instinctual” perceptions of resource scarcity. Instead, actors are compelled toward conflict by their perceptions of a threat to themselves, their property, or their livelihoods in the form of their ability to access fisheries resources in the future (Turner et al. 2003). These perceptions are produced and shaped by three “causal forces” (Peluso and Watts 2001)

Box 1: Emerging patterns of conflict and cooperation: Select quotes from incident at sea reports

- A. Small-scale fisher: "The vessel refused and told us that if they pull up their net and find our net is not on theirs they will kill us... it [was not] time for them to pull up their net; luckily we found our net on theirs"
- B. Small-scale fisher: "We approached the vessel to protest against what they had done but we were met with machete wielding men who prevented us from boarding the vessel to complain and seek a solution."
- C. Small-scale fisher: "I made 2 attempts to get onboard but each time the captain hit my hands with a rod; we tied our rope to the trawling wires but again this same captain cut the rope"
- D. Small-scale fisher: "I managed to get onboard the vessel in order to amicably settle the issue but the captain spoke to the crew sailors... struggled and wrestled with me to throw me overboard. I was onboard for 3 days without food or water"
- E. Industrial fisher: "The crew on the canoes started throwing stones, boarded the [industrial vessel] ... started molesting and assaulting the crew with sticks, cudgels, and cutlasses... captain, boatswain, and one sailor... were badly assaulted.... captain and sailor were kidnapped and taken to Jamestown to answer for destroying the net of the canoes"
- F. Small-scale fisher: "I accused them and asked that they allow me to go onboard the vessel to verify since they were hauling their nets; the crew onboard the vessel pounced on me with an iron rod and knife saying they have not damaged any net but I boarded with one of my crew members... a white man drew a knife threatening to kill us. He then started to punch us with hefty blows that my crew member cried brutally... my crew member attempted to collect the net but he was booted and beating mercilessly that he fell flat on the floor with blood oozing from his ankle..."
- G. Small-scale fisher: "One of my crewmembers tried and jumped into the vessel despite a threat by one of the crew in the vessel to hit him with a rod; a black bosun placated my crew member onboard the vessel to be patient and rang his Tema office..."
- H. Small-scale fisher: "Some of our fishermen managed to get on board the vessel to get a clear response of the accident. While onboard the black crew told us that the captain did not experience such an accident before because he was a new man handling the boat... so they promised to give 5 sacks of fish as compensation to repair our net."
- I. Small-scale fisher: "[Our crew] boarded the boat and approached the captain and he gave them Chinese writing to be given to the officer in charge at Sekondi for compensation."

that emerge strongly from empirical narratives: divergent incentives and vulnerabilities between small-scale and industrial sectors, different notions of legitimacy and cohesion, and disparate rules and norms. While these causal powers compel interactions toward conflict, conflictual outcomes are averted in circumstances where social capital or bridging institutions can minimize asymmetries and promote cooperation.

3.1 Divergent incentives and vulnerabilities guide conflictual outcomes

One of the main causal forces leading to conflictual outcomes at sea is the fact that disparities between industrial and small-scale fishers' "action resources" lead to divergent incentives within the interaction. Ratner et al. (2013) describe action resources as "those intangible and tangible assets that give actors the capability for agency" (Ratner et al. 2013). Ratner et al. (2013) explain that assets provide the basis for choices; the more assets one has (e.g. education, wealth, time), the more choices able to be perceived between pathways of conflict or cooperation. Political ecology and the sustainable livelihoods approach further argue that these assets are more than the sum of their parts, but rather have strategic value and constitute the resource user's livelihood strategy, which can demonstrate relative strength or vulnerability to outside shocks (Le Billon 2001, Stonich and Vandergeest 2001, Allison and Ellis 2001). The differential choices and livelihood vulnerabilities that emerge from variations in action resources between the industrial and small-scale sectors create opposing incentives for each within an interaction at sea.

In Ghana, these differences in tangible and intangible assets between sectors are dramatic, creating a substantial difference in the way each sector is situated toward the other. Small-scale fishers in Ghana oftentimes have limited financial capital; nets and boats are financed through a form of credit, and frequently represent a large proportion of the owner's personal wealth (Box 2: A, B). Furthermore, there is no insurance scheme for damaged capital in the small-scale fishery¹⁰, so losses are incurred solely by the owner of the net or vessel. Ghanaian small-scale fishers are also limited in the availability of alternative livelihoods, so loss of fishing capital may in reality mean the temporary or permanent loss of employment and income (Finegold et al. 2010)(Box 2: C, D). In contrast, the capital and operational costs of industrial fishing are in large part funded by fishing companies, large entities owned by multiple stakeholders who do not engage in fishing activities, and are therefore not present at the time of the interaction. Industrial vessels are also insured by external agencies against accidents or property damage, reducing the likelihood that the costs of loss or damage would be incurred by the fishers themselves. The two sectors demonstrate dramatically different technological assets, with small-scale vessels comprised of dugout or planked canoes, operating by paddle, sail, or small outboard motor, and industrial vessels constructed of metal hulls with inboard motors and hydraulic technologies (Atta-Mills et al. 2004, Finegold et al. 2010). Industrial actors also display a number of intangible assets that improve their choices and ability for agency in comparison to small-scale fishers. Since industrial vessels in Ghana frequently hold licenses to fish in neighboring countries, and because they are provisioned for longer trips of greater distances, industrial actors have greater assets of time and mobility than small-scale actors,

¹⁰ Introduction of an insurance scheme for small-scale fishing vessels in Ghana was announced in 2016, however plans for the scheme remain in the planning stage, and no insurance compensation is currently operational (Agbekporu et al. 2014, Fisheries Ministry, insurance company partner to insure fishers 2016).

who are bound to shore for food and fuel (Box 2: E). In some cases, this increased flexibility imparts on industrial actors the ability to avoid local ports and land-based authorities for extended periods of time, and to require that small-scale actors settle for compensation negotiated in sea space (Box 2: F, G).

These configurations of “action resources” are neither ahistorical nor apolitical, and broader context is essential in understanding the dynamics of the interaction at sea. The tangible and intangible assets that industrial and small-scale fishers hold are a product of their historical development and different patterns of accumulation. As foreign owned and profit-driven vessels that fish for large quantities of export fish, actors on industrial vessels are part of a different “accumulation regime” than that of small-scale fishers, whose efforts are guided by catch share systems and local and regional markets (Peluso and Watts 2001). In the industrial fishery, the accumulation regime separates labor from capital, integrates it into a mechanized means of production, and insurance acts to protect actors from vulnerability to loss (Collins 2008). In contrast, the small-scale actors are integrally connected to the means of production, sharing both profits (i.e., catches) and losses without certain social arrangements (e.g. insurance) to protect them. In this way, the broader context directly shapes the relative positions of actors within the action arena, configuring their incentives and relative power within the interaction (Figure 7).

This divergence in action resources is essential in understanding patterns of conflict and cooperation, as it is the starting point for understanding the opposing incentives that industrial and small-scale fishers have within an interaction at sea (Campling et al. 2012). Within an interaction, the choice to conflict or cooperate depends on the calculus of anticipated benefit, and actors may shift strategies or employ multiple tactics simultaneously (Ramirez 1999, Ratner et al. 2013). However, this uneven distribution of tangible and intangible action resources creates an uneven playing field, wherein small-scale actors have fewer choices, increased vulnerability, and strong motivation to resolve the incident while at sea, as they perceive it to be their best recourse to regaining their means of accessing fish resources in the future (Box 4: E, Box 2: A-D). Meanwhile, industrial actors’ action resources create more choices, less vulnerability, and opposing incentives to avoid interaction and negotiation, as it would likely result in loss of property and time fishing, and could result in harm to the vessel or crew. While differences in action resources are not, in themselves, sufficient to explain incidences of conflict, their role in creating divergent incentives within an interaction lends insight into the emergence of conflictual

outcomes.

3.2 Disparate notions of legitimacy and cohesion guide conflictual outcomes

A second causal force contributing to conflictual outcomes is the divergent sense of legitimacy and historical claim created by disparities between actors' identities and values on small-scale versus industrial vessels. Past work on commons governance suggests that user groups with shared identity, values, and history of cooperation are more likely to engage in effective resource management, whereas actors with substantial differences are more likely to conflict (Ostrom 1990, Baland and Platteau 1996, Agrawal 2001).

Furthermore, where multiple horizontal inequalities align, such as where differences in

Box 2: Patterns of conflict: Select quotes from incident at sea reports

- A. Small-scale fisher: "I am pleading through your office to come to our aid as to recover my lost nets to enable me to repay the huge bank loans and also to be able to continue to cater for my own families including the extended ones as well as the families of my either crews who I am looking after."
- B. Small-scale fisher: "As a result of this accident, we are no more fishing; our wives are threatening to divorce us since the fishing business is our only livelihood coupled with our children crying for food." Official: "The fisherman had to use his retirement money to pay for a new net since he hasn't been compensated"
- C. Official: "Urgent because fishermen cannot continue fishing because of the accident"
- D. Small-scale fisher: "I am appealing to the authorities concern to come to our aid to have an amicable settlement because it is our only livelihood"
- E. Small-scale fisher: "The captain invited us, and we went to them, but he did not compromise with us and we had to leave as we were getting short of fuel."
- F. Small-scale fisher: "After a lengthy discussion they arrived at a conclusion and gave us one crate of fish (kakadiamaa) and one crate of mixed flying fish and ray which was not our desire"
- G. Small-scale fisher: "The captain a white man... asked us to leave the vessel but we refused. We struggled with them to go with us to search for our nets but the crew asked us to go... we left one of our crew and the rest of us went to search for the nets. They gave us fish to go and buy fuel. We refused and insisted they go with us. After some time, we took fish as evidence they have destroyed our nets"
- H. Small-scale fisher: "About twenty minutes later the vessel returned to the scene of the accident and we saw the captain taking pictures and the crew members in life jackets ready to rescue us. The vessel stayed for about one hour more but due to language barrier we could not communicate with each other. She therefore left westwards."
- I. Official: "After all the canoe fisher are not pirates as he originally thought but rather local fishers who were asking of their net"
- J. Small-scale fisher: "Punish [the perpetrators], since we the local fishermen cannot stay in our country to suffer inhuman from these unscrupulous people in the fishing industry"
- K. Small-scale fisher: "We went to the ship and they told us the captain has gone ashore; as we waited a little while they pulled out a water hose to pump water on us so we told them we cannot be destroyed in our own waters and if they dare we will send them to court"
- L. Small-scale fisher: "This is our source of income; these vessels always come so close to the coastal areas that they pose a threat to us"
- M. Small-scale fisher: "Although our dinghy went alongside [the industrial vessel] they failed to come to our aid and absconded against maritime regulations"
- N. Small-scale fisher: "Since the two parties are all seafarers, we should make effort to resolve this issue amicably, so as to promote peace at sea"
- O. "Industrial fisher: "The [industrial vessel] cannot be held fully responsible for the following reasons: a) Appropriate Navigational lights were not placed on the fishing net to alert on coming vessels. b) Majority of the artisanal fishermen were ignorant of unauthorized fishing zones."

identities or values correlate with differences in assets or historical claim, risk of violence and conflict increase (Stewart et al. 2008). Political ecology further suggests that this increased likelihood of conflict is rooted in the historical development of these identities, and conflict represents the process by which differentiated individuals and communities contest the allocation and distribution of resource benefits (Peluso and Watts 2001, Turner et al. 2003). Just as identities and values of the two different sectors are shaped by the historical differences in their development and entitlements, so do they shape the distribution of future resource access and conflict. Furthermore, resource conflicts often intersect with other issues around identity, including racial, ethnic, class, and other historically relevant social tensions, thereby reinforcing the legitimacy of one group's claim over another (Barbrow-Strain 2001, Peluso and Watts 2001).

In Ghana, these historically situated differences in identity profoundly affect the ways that small-scale and industrial fishers perceive each other and interactions at sea. Small-scale fishers in Ghana have operated regionally for centuries and locally for time immemorial; in contrast, the industrial fishery emerged in the 1950s and 1960s in response to development programs aimed at generating foreign currency (Adjetey 1973, Atta-Mills et al. 2004, Overå 2011). While the small-scale fishery is almost exclusively Ghanaian, the industrial fishery is more diverse; captains and first mates on industrial vessels in Ghana are oftentimes Chinese (Nunoo et al. 2014), while crews are required by law to be at least 75% comprised of Ghanaian laborers (Government of the Republic of Ghana 2002). These ethnic and national differences between fleets result in a situation where many industrial actors share different cultures, languages, and values than local small-scale fishers, complicating interactions and challenging communication between vessels (Box 2: H, I). In addition to these differences in historical development and culture, actors in the small-scale fishery demonstrate strong group identity linked to place, whereas industrial fishers' identity is more closely tied to their vessel than their local residence or the industry as a whole. For example, small-scale fishers are located throughout the entire Ghanaian coast, with the majority embarking from their village or town of residence for trips of a day or less, and notions of community and reciprocity are foundational (Walker 2002, Atta-Mills et al. 2004). The industrial fishery, on the other hand, operates out of two centralized urban ports, and although no foreign flagged vessels have been allowed to operate in Ghana for years, many vessels are ostensibly owned and operated by foreign companies, with catches destined for foreign market (Nunoo et al. 2014). These dissimilarities contribute toward conflictual outcomes as small-scale fishers cite their Ghanaian nationality, their occupational identity as fishermen, and their historical entitlement as support for their prevailing legitimacy and reasons their claim to resource access surpasses that of industrial fishers (Box 2: J, K).

The disparate notions of legitimacy and historical claim based on actors' identities are critical in understanding patterns of conflict and cooperation, as they reveal the ways in which fishing communities are differentiated, exert agency, and contest resource allocation. Small-scale fisheries are ancient, rooted in nationalist, ethnic, racial, and linguistic identities, and tied to fishers' communities and place of residence. In contrast, industrial fisheries are only a few decades old, and largely operated by foreign interests stationed in two large urban ports. These divergent histories give way to equally different senses of historical claim, perceived legitimacy, and entitlement to the resource (Bavinck 2005), acting to reinforce small-scale fishers' beliefs in their right to fisheries resources, and

thereby the strength with which they pursue compensation and reparation at sea. If fishing is the means of resource access, and loss or damage to small-scale capital is perceived as a decrease in that access relative to industrial actors, then an interaction at sea represents their best opportunity to contest that preferential allocation. As discussed below in section 4.4, different identities are not sufficient to explain conflictual outcomes at sea, however they provide the framework for understanding the relationship between fishing sectors, between these sectors and the resource, and the perceptions of benefit that guide conflictual outcomes.

3.3 Different rules and norms of behavior guide conflict

The third causal power contributing to patterns of conflict at sea pertain to the fact that different sets of laws and norms guide the behavior small-scale versus industrial fishers, and subsequently their relations toward each other. Here the concept of legal pluralism is particularly salient, where there are different legal mechanisms applicable within a given situation, oftentimes each associated with a different institutional framework (Vanderlinden 1972, Bavinck 2005, Tamanaha 2008). In some cases, legal pluralism has been credited with producing positive outcomes for cooperative resource management, increasing the resilience of the system by promoting redundancy and flexibility, providing multiple alternatives for conflict resolution, and accommodating the claims of marginalized resource users (Berman 2006, Ostrom 2010). For example, Meinzen-Dick et al. found that with regard to water rights, “multiple, flexible and dynamic legal orders are more responsive to uncertainties and changes than a single, fixed legal system with static property regime” (Meinzen-Dick and Pradhan 2002). However, in other cases, legal pluralism has been linked to conflictual outcomes, as where different actors abide by separate sets of rules and norms that make competing claims of authority or impose conflicting demands (Jentoft et al. 2009, Ratner et al. 2013). For example, Bavinck finds that legal pluralism “when applied to a single sea space or fish resource... may lead to accommodation or varying degrees of social unrest” (Bavinck 2005).

In Ghana, legal pluralism is evident in the different sets of “rules in use” that industrial and small-scale fishers appeal to within an interaction at sea. Within the narratives, small-scale fishermen oftentimes draw upon national laws to increase the legitimacy of their claims (Box 2: L, M). Ghanaian small-scale fishers most commonly cite a national law that prohibits industrial vessels from fishing in the Inshore Exclusion Zone (IEZ), an inshore area reserved for small-scale fishing within the Ghanaian Fisheries Act¹¹ (Government of the Republic of Ghana 2002). Fishers also refer to state laws that prohibit light fishing, pair trawling, and the destruction of nets at sea; whether or not these laws pertain to the incident itself, small-scale fishers draw upon these official and well-known state laws to shame industrial fishers and convince them of the need for cooperation and compensation. Yet small-scale fishers also draw upon certain norms within the fishing community in order to rebuke industrial fishers for unethical practices, claim preeminent

¹¹ Schedule 81(1) of the Fisheries Act of 2002 defines the Inshore Exclusion Zone as “the coastal waters between the coastline and the 30-metre isobath or the 6 nautical miles offshore limit whichever is farther.” It stipulates that “The IEZ shall be used exclusively by small semi-industrial vessel (SIV)*, canoes, and recreational fishing vessels; A person shall not use a large semi-industrial vessel* or industrial fishing vessel for fishing inside the IEZ.” * Small semi-industrial vessel is of a length below 10 metres, large semi-industrial vessel is of length 10 metres or above

user status, or engender compassion and commonality. Small-scale fishers sometimes appeal to a sense of kinship or commensuration with industrial fishers, employing norms of reciprocity and shared identity to compel cooperation and compensation (Box 2: N). Similar to small-scale actors, industrial fishers also refer to state laws to support their actions in an interaction at sea. Industrial actors most often cite Ghanaian laws regarding vessel and gear lighting and traffic zones in order to bolster their position and assign blame to small-scale fishers (Box 2: O). However, industrial actors do not frequently draw upon ethical norms of behavior as do small-scale fishers, but most often appeal to international laws outlined from the UN Convention on the Law of the Sea (UNCLOS) or the International Maritime Organization (IMO). For example, industrial actors cite laws about navigation, unsanctioned boarding of a vessel, and piracy to legitimize their actions and undermine the claims of small-scale fishers (United Nations 1982, IMO 2010). For industrial actors, the “rules in use” are primarily national and international laws, not local or cultural norms of behavior.

In addition to the “rules in use,” legal pluralism is also evident in the diversity of institutions addressing fisheries governance. Likely the most influential institution governing Ghanaian small-scale fishers is that of the chief fisherman and the council of elders. The chief fisherman is an ancient institution and exists in each fishing village and town along the Ghanaian coast (Walker 2002, Finegold et al. 2010). While inland chieftaincies were targeted and disassembled by the colonial government as a precursor to privatization and capitalism, the institution of the chief fisherman was largely overlooked, as their authority pertained to the seas, where colonial notions of private property were minimal (Walker 2002). As a result, chief fishermen have retained a substantial amount of power and influence over fishing activities in the small-scale sector, setting rules and taboos, determining access rights, and mediating disputes (Walker 2002, Finegold et al. 2010). In the industrial sector, individual fishing companies are the institutions that exert the most influence on the behavior of vessels, with some influence from industrial fishing associations.

This multitude of laws and norms is critical in understanding patterns of conflict and cooperation, as it comprises the framework within which actors perceive and assert claims, convey relative power, and conceptualize the positions of other actors. The separate sets of rules and institutions for small-scale and industrial fishers constitute separate “sea tenure systems,” indicating independent notions of ownership, participation, and regulation (Bavinck 2005, Cordell 2013), and wherein not all actors are subject to every governance arrangement. For example, the chief fisherman is the most influential institution governing small-scale fisher behavior, however it is not recognized by the industrial subsector and has no jurisdiction over the actors within it. Similarly, small-scale fishers are oftentimes unaware of international laws and regulations under UNCLOS that shape industrial fishing endeavors. Bavinck et al. (2014) describe this as a situation where conflicts between actors are both exogenous and asymmetrical (Rapoport 1974, Bavinck and Gupta 2014). Exogenous refers to the fact that the different fishing sectors belong to different systems of norms, and asymmetrical describes a situation where conflicting parties are of dissimilar “weights” and may perceive each other very differently (Rapoport 1974, Bavinck and Gupta 2014). In tracing these concepts through the incident at sea narratives, the sea tenure system of the small-scale fishery emphasizes commensuration and compels fishers to negotiate at sea, whereas the industrial system emphasizes the

autonomy of the vessel, obliging them to avoid negotiation and prevent boarding at great cost. These differences in motivations and perceptions are a primary contributor toward pathways of conflict and violence.

3.4 Bridging social capital guides cooperation

While much research has focused on the factors, triggers, and conditions of resource conflict, one of the strengths of the current framework is identifying the circumstances in which actors are able to avert conflict and cooperate. Where cooperative outcomes emerged, the ability for some actors to create commonality between industrial and small-scale actors proved essential. Studies of social capital suggest that social bonds and norms are important for individual and community function, and by lowering the transactions costs of working together, social capital can facilitate cooperation (Pretty 2003). Pretty (2003) identifies three kinds of social capital: 1) bonding—connections between people with similar identities and goals, 2) bridging—connections between groups that may have different or opposing views, and 3) linking—connections between a group and an external agency able to influence their situation (Woolcock 2001, Pretty 2003).

In the case of fisheries interactions at sea, bonding social capital is most often observed between individuals within a single fishing vessel or multiple vessels within one sector (Box 3: A). However as mentioned, there are substantial differences in the identities, values, assets, and norms between the sectors, and in general these differences contribute toward conflictual outcomes. However, as the Ghanaian Fisheries Act of 2002 requires that 75% of industrial vessel crew be Ghanaian nationals, a mixed industrial crew composition emerges, and in some cases, Ghanaian actors on industrial vessels were able to provide the bridging social capital needed to formulate a cooperative outcome (Government of the Republic of Ghana 2002). These Ghanaians acted to: enhance communication and act as interpreters; refer small-scale fishers to land-based institutions such as their fishing company, the Arbitration Committee, or the police station; communicate the industrial vessels identifying information; express sympathy and warn small-scale fishers of potential threats or violence; and enable small-scale fishers' boarding, appease arguments, and suggest means of resolution (Box 3: B-G). The Ghanaian fishers that are able to bridge the gap between industrial and small-scale sectors' values and tenure systems represent "change agents" that are able to influence other actors toward pathways of conflict or cooperation (Ratner et al. 2013). Within the incidents at sea, both kinds of change agents are present, in some cases defusing what began as a conflictual interaction, and in others, escalating what had begun as cooperation (Box 3: B, H). However, where cooperation did emerge, the role of Ghanaian industrial crew was often pivotal.

Box 3: Patterns of cooperation: Select quotes from incident at sea reports

- A. Industrial fisher: "We were traveling when all of a sudden our propeller got entangled with a drift gill net. After the damage, about 3 other drift gill net operators all from Komenda rushed on us to aid their fellow fishermen. There was a big confrontation between my crew and the other fishermen."
- B. Small-scale fisher: "The vessel suddenly stopped and pulled out her net at which time the canoe fishermen were able to get closer to them and made a formal complaint (through the Ghanaians on board) to one white man who appeared, to cooperate with them to resolve the issue. However, in a turn of events another Ghanaian officer appeared and ordered the vessel to leave."
- C. Small-scale fisher: "The trawler started to runaway to deep sea and my people also ran after them. There [were] some crewmembers who came from the same district with us, told them not to run after them but they should rather go to their head office"
- D. Small-scale fisher: "We approached the vessel and the crew confirmed the incident... When captain woke up he didn't show concern and started to motor away when the crew asked us to write the name and number of the vessel and report the captain and the vessel to the fisheries office."
- E. Small-scale fisher: "After the incident we went to them and the Chinese captain on board failed to compromise with us concerning the damage they have caused our nets. It was the few Ghanaians onboard who sympathized with us."
- F. Small-scale fisher: "I boarded the vessel to collect my net but the crew tried to deny causing any damage. I was warned by the black crew members that the white man will injure me with a knife because he attempted to do so when a canoe came to them"
- G. Small-scale fisher: "We approached them and report the damage of our net to the crew... They told us to come on board to meet the captain he said he will call the agent to solve the problem"
- H. Small-scale fisher: "We gave the vessel a hot chase; one of my crew members tried and jumped into the vessel despite a threat by one of the crew in the vessel to hit him with a rod; a black bosun placated by crew member on board the vessel to be patient and rang his Tema office"
- I. Small-scale fisher: "We told them about the damage caused, at this point they disagreed with us, rather attempting to beat us, but we insisted and came to the fishing harbor together for amicable settlement."
- J. Small-scale fisher: "We flashed lights and burned petrol flares but they still hit the boat and one man fell overboard... We approached the boat and one crewmember said we should file a report in Tema"
- K. Small-scale fisher: "[Our] fishers held their trawl ropes to tell the vessel about damage, and crew (white man started it) threw various objects at them--broken bottles were kept as evidence."
- L. Small-scale fisher: "Four crewmembers went onboard the [industrial] vessel to retrieve and determine cost of the damage. The white sailors attacked them with shovels and a long bamboo pole with hook at one end which is in my custody."
- M. Small-scale fisher: "The captain... offered to give some sacks of fish to the canoe crew members to defer the cost of damage of the net which the canoe crewmembers rejected. The captain then agreed to give them a letter written in Chinese to be given to the authorities... for settlement."
- N. Small-scale fisher: "We resisted for our net to be taken away and that resulted in a struggle but due to the dangers of their knives I suggested that the rules governing the sea reveals that if such a thing happens the only alternative is to take the number of our vessel and report to the appropriate quarters for investigation but they insisted on taking our net"
- O. Small-scale fisher: "When the attention of the crew of the boat was drawn to the damaged causes, they rather took offense and were throwing water on the crew of my canoe. [As it] drew nearer to their boat they became furious and aggressive, seeing the situation and in order to avoid an attack on us by them my crew left them while they dragged the net of my canoe away... as all attempts to get the owners of the said fishing boat to replace my fishing net have failed me, I lodge this complaint"
- P. Small-scale vessel: "We made an attempt to board the vessel to go and collect our net. Immediately the crew onboard the vessel released two dogs who growled at us threateningly. Being afraid, we went back into our canoe but still hanging beside the vessel"
- Q. Small-scale fisher: "When we attempted to go near them so as to discuss the case with them a certain man probably one of the crew brought out a pistol and attempted to shoot at us so we had to run back. Every one of the boats went ashore out of fear."

In contrast to theories that assume resource conflict and seek to explain their origins with certain “triggers,” the framework employed here analyzes various resource configurations and how they do or do not result in conflict. While differences between small-scale and industrial fisheries do contribute toward conflict, the particularities of the industrial sector in Ghana facilitate cooperation in specific circumstances. These circumstances occur when Ghanaian industrial crew are able to de-escalate conflictual scenarios or facilitate negotiation with the culturally and linguistically similar small-scale fishers. The heterogeneity of the industrial crew—created through a specific regulation—complicates straightforward notions of sector differentiation and conflict. Peluso and Watts state that, “There is no single theory of violence... It is important to ask, therefore, why violence occurs in some places and not in others, why some factors are more important than others, and why brutal acts defines some conflicts and not others... to reveal how these causal forces articulate in specific circumstances” (Peluso and Watts 2001). Here the case of cooperation at sea demonstrates that conflict is not the inevitable consequence of certain triggers, but that even in the presence of these triggers, resource conflict is a social process, and the contingent nature of social relations enables cooperative outcomes.

3.5 Bridging land based Institution promotes cooperation

While the legal pluralism mentioned above contributed to many patterns of conflict, where shared laws and institutions were known, they were oftentimes essential in guiding cooperative outcomes. Scholarship on interactive and adaptive governance suggests that many traditional institutions are poorly suited for conflict management between groups with different or opposing characteristics (Folke 2006, Sanginga et al. 2007, Jentoft et al. 2009, Jentoft and Bavinck 2014). Customary approaches (e.g. chief fishermen) are often unable to operate across communities or scales, while legal and administrative mechanisms are frequently inaccessible to marginalized user groups (e.g. rural communities) or lack the subject matter expertise to effectively solve resource conflicts (e.g. police) (Sanginga et al. 2007). Further, within traditional institutions, actors have unequal relative power, as where an industrial vessel enters arbitration through the chief fisherman or a small-scale fisher negotiates with an industrial fishing company (Adger et al. 2005, Sanginga et al. 2007). However, hybrid and cross-scale institutions can provide an alternative wherein both sets of actors trust in the negotiation of outcomes (Folke 2006).

In Ghana, the Arbitration Committee, which is comprised of small-scale and industrial fisher representatives as well as Ministry officials, serves as an example of a cross-scale institution. Based at the Fisheries offices in Tema and Takoradi, the Arbitration Committee acts as a quasi-governmental institution through the Fisheries Commission, however it arbitrates incidents outside the official legal and judicial system within Ghana, providing a faster, cheaper, and more sector-appropriate venue for dispute resolution than the court system. In the incident at sea narratives, where individuals knew of the existence of the Arbitration Committee (Box 3: I), or were informed of it at sea (Box 3: J), interactions were often able to avoid conflictual outcomes and reflect more cooperative relations. In these cases, small-scale fishers were able to directly connect the “rules in use” within the interaction at sea to the broader governance arrangements by collecting proof and testimony of the incident for evidence at the Arbitration Committee. Evidence may include contact information, weapons used against them, accounts of industrial actors or nearby observers, or other materials that are used to further their claims in onshore proceedings

(Box 3: K-M). Since limited government capacity constrains monitoring, control, and surveillance (MCS) of fishing laws in seaspace, the ability to access land-based mechanisms of enforcement and accountability provided a secondary means of restitution.

As mentioned above, the choice to conflict or cooperate depends on each actor's calculus of anticipated benefit (Ramirez 1999). In cases where actors knew of, or were informed of, the existence of an onshore institution that was capable of arbitrating between industrial and small-scale sectors, the anticipated benefit of conflict at sea was altered. Despite the diminished negotiating position that small-scale fishers often have in relation to industrial fishers in seaspace, when it is perceived as the only avenue to compensation, there is strong incentive to compel negotiation and compensation at sea. This is one of the primary precursors to conflictual interactions described above. However, knowledge of the presence of a cross-scale institution alters that necessity by providing an alternative, land-based means of settlement and potential compensation. While in some cases, actors used their knowledge of the Arbitration Committee to engender cooperation (Box 3: N), in others it was used more as a last resort by small-scale fishers, less prompting cooperation so much as avoiding conflict escalation and providing a channel for onshore restitution (Box 3: O). Similar to the Ghanaian industrial crew creating circumstances to avoid conflict, the presence of the Arbitration Committee also provides an exception to notions of a deterministic pathway to conflict. While the differing incentives and "rules in use" between small-scale and industrial fishers were main causal forces behind conflictual interactions, these forces are not fixed. In some cases, knowledge of an appropriate cross-scale institution provided the circumstances to avert conflict and shape cooperative interactions.

4 Discussion: How do conflict and cooperation patterns shape fisheries livelihoods, utilization, and governance?

Having identified factors that contribute to cases of both cooperation and conflict at sea, an important final step in applying the Ratner et al. (2013) framework is to consider the long-term effects of these patterns for the resilience or vulnerability of the resource, the fishers, and the institutions governing the system (Figure 7). While each incident of conflict or cooperation results in immediate outcomes for the actors involved, the repetition of these patterns over time may also result in broader changes for the system as a whole. For example, how might current patterns of conflict or cooperation at sea shift the characteristics of the resource or the relative positions of the resource users? As political ecology and governance theory highlight the broad social relations that shape resource conflict, link those broad dynamics to the moment of conflict occurrence, and suggest conditions in which cooperative outcomes emerge, resilience theory aids us in understanding the implications of these patterns over time. Resilience theory has its foundations in the field of ecology (Holling 1973, Gunderson 2000), however, it has been applied to various social processes to understand the capacity of a system to maintain or regain its structure and function in response disturbance¹² (Adger 2006, Folke 2006, Gallopin 2006). With regard to resource conflict, resilience theory may improve our understanding of how the repeated use of certain adaptations, strategies, and institutions

¹² For a more thorough treatment of the diverse applications of resilience theory to social and social-ecological systems, see Folke et al. (2006).

may help build resilience to, or contribute to the vulnerability of, the resource system and the ability of actors, institutions, and resources to recover from conflict.

One example of the implications of these recurrent patterns in Ghana is the emergence of a dedicated “fishery” for trawler bycatch. In recent decades, trawlers operating in Ghanaian waters have engaged in the practice of transferring their bycatch to small-scale canoes for a fee or barter, effectively offloading their “trash fish” to local fishermen and markets (Nunoo et al. 2009). This form of cooperation between industrial and small-scale fishers has increased in recent years, and has had diverse and substantial impacts on both the resource and resource users. First, small-scale fishers in a number of fishing villages have come to prefer the trade for bycatch to “seek and capture” fishing, raising fears of the erosion of deep fishing traditions in Ghanaian coastal communities. Second, tensions have risen between small-scale fishers who engage in this practice and those who do not, due to the increased potential for profits when fishing gear is not required, the market changes due to the influx of fish obtained from this trade, and the perceptions of unsustainability attributed to this practice, which is rendered illegal by the prohibition on transshipment in Ghana (Government of the Republic of Ghana 2002, Nunoo et al. 2009). The practice of trading “trash fish” also has considerable implications for the resource base, as it is perceived to incentivize the use of nets with small mesh sizes and enable trawlers to fish longer without coming to shore to land bycatch. This, combined with the fact that fish traded to small-scale fishers are not counted in the estimates of either small-scale or industrial catches, leads to the perception that this trade promotes overfishing and unsustainable harvest practices. Finally, and perhaps ironically, the cooperation between industrial and small-scale fishers through this bycatch trade is ultimately perceived to encourage trawlers to fish closer to shore and within the IEZ, increasing the number of incidents at sea and conflictual interactions with small-scale fishers (Nunoo et al. 2009).

In addition to cooperation, conflictual outcomes may also alter the characteristics of both industrial and small-scale fishers. Within the narratives, small-scale fishers state that their employment and livelihoods are threatened by the loss of capital and fishing time caused by the incident at sea (Box 2: A-D). In some cases, those impacts may lead to defaulting on loans (Box 2: A), using savings or retirement funds to replace fishing inputs (Box 2: B), or ultimate situations of poverty traps originating from the incident at sea (Box 2: A-D) (Barrett and Carter 2013). Conflictual outcomes appear to have already altered the behavior of industrial fishers, as narratives recorded the presence of guns and dogs kept onboard the industrial vessel ostensibly to deter boarding by small-scale fishers (Box 3: P, Q).

With regard to resource conflict, resilience theory may improve our understanding of how the repeated use of certain adaptations, strategies, and institutions may help build resilience to—or contribute to the vulnerability of—the resource system (Ratner et al. 2013). In Ghanaian fisheries conflicts at sea, the strategies predominately employed by small-scale and industrial fishers can be seen as largely contributing to vulnerability. The high cost of fishing inputs, deep asymmetries between the two sectors, and their relative separation on land, combine to create strong and divergent strategies to respectively compel or prevent interactions at sea. These strategies, repeated through time, can be seen as intensifying risk to both sets of actors, as their escalation perpetuates livelihood vulnerability, leads to the use of increasingly violent tactics, and intensifies distrust.

However, a number of adaptations are notable. For example, some adaptations effectively promote cooperation between sectors—such as the growth in bycatch trade—but may also undermine resource sustainability or internal cohesion within the small-scale fishery over the long term. Further, while this trade may indicate cooperation by industrial vessels with specific small-scale actors, it does not necessarily represent a trend within the entire subsector, and cooperation with some may intensify conflict with others. Compensation at sea represents another adaptation, with mixed consequences for the fishery system. While undoubtedly many cases of compensation at sea have resolved grievances, in other cases it has led to conflict escalation or complicated overall assessment of damages and restitution. Furthermore, the repeated use of this strategy has led industrial fishers to claim that small-scale gear damage is an intentional tactic to extort money from industrial fishers, and a precursor to piracy.

However, other adaptations have more positive long-term implications, such as cases where industrial actors do not attempt to prevent negotiation, and immediately cooperate by suggesting onshore arbitration or compensation (Figure 9). In these cases, repeated cooperation appears to better relations between actors, improving the capacity for continued learning and collaboration. Two institutions in Ghana are key in creating the potential for this long-term cooperative pattern. The first is the Arbitration committee mentioned above, which establishes a cross-sector forum for negotiating and compensating claims. The second is the Ghanaian requirement that industrial vessels land catches in Ghanaian ports (Article 134) and be owned or controlled by a majority Ghanaian entity (Article 47)(Government of the Republic of Ghana 2002). By ensuring that legitimate industrial fisheries representatives are available onshore in Ghana, these two institutions enable the transfer of at sea negotiations to onshore fora capable of effectively resolving conflicts. These institutions and adaptations represent promising advances in the mediation of fisheries conflicts at sea, and may present potential examples for other states and regions challenged by distant water fishing fleets and low monitoring, control, and surveillance.

5 Conclusion

This paper uses empirical evidence to investigate the moment of conflict inception, seeking to illuminate the process by which broad inequality or injustice becomes conflict, and the conditions in which conflictual outcomes do or do not emerge. The analysis above found that three primary causal forces contribute to conflict: divergent incentives and vulnerabilities between small-scale and industrial sectors; different notions of legitimacy and cohesion; and disparate rules and norms. However, in some cases, cooperation emerges in circumstances where individuals or institutions are able to alter the incentives of actors and create alternatives to conflict at sea. The Ratner et al. (2013) framework aided the analysis by providing a structure through which to consider each element of the resource system. By taking conflicts at sea as a process, assuming *a priori* neither specific causal factors (e.g. resource scarcity) nor specific outcomes (e.g. conflict), the framework enables insight into moments of contingency, and thus moments of potential intervention. In emphasizing the moment of social bargaining at sea, but taking seriously the relationship it has to history and broader context, we are able to see both the proximal and distal factors that shape conflictual and cooperative outcomes.

This approach to the study of fisheries conflicts is important in understanding the foundations of these conflicts not simply as driven by scarcity or “too many fishers fighting for too few fish” (Pomeroy et al. 2016), but as deeply rooted in the histories, identities, and relative power of the actors in seaspace. This finding leads us not to reductive policies that seek to create more fish or fewer fishers, but to more nuanced solutions with the potential to address the roots of conflict at sea. The analysis suggests that one potential approach to lessen the severity of some of these conflicts, and in some cases to prevent them altogether, is to implement laws that act to reduce the differentiation of actors between the sectors. In the case of Ghana, specific laws requiring industrial catch be landed in Ghana and industrial ownership and crew be majority Ghanaian, were found to perhaps inadvertently increase communication and reduce cultural barriers between sectors, making way for situations of cooperation. Another more nuanced approach suggested by this analysis is the establishment of appropriate land-based institutions that are capable of functioning across scales and sectors to arbitrate the conflicts. In Ghana, the Arbitration Committee, with its distinctive relationship to the Ministry of Fisheries and Aquaculture Development, chief fishermen, and industrial fishing associations, was uniquely situated to address these conflicts and the fact of its existence acted to prevent and deter some conflicts at sea. Previous policy prescriptions aimed at reducing conflicts at sea have focused on resource intensive monitoring, control, and surveillance (MCS) efforts, seeking to enforce spatial or temporal regulations separating the two fleets. However, in refocusing on these conflicts as social phenomena, this research suggests that the best approaches to reducing conflicts at sea would work to reduce the economic and cultural disparities between sectors, rather than separate them entirely.

Chapter 3: Household effects of incidents at sea: Does industrial competition reduce access for small-scale fishers?

1 Introduction

Studies on incidents at sea between small-scale and industrial fishers frequently assert their profound consequences for the socio-economic status and livelihood strategies of small-scale fishers and fishing households. Previous scholarship on the subject claims that for a small-scale fisher, these conflicts represent a “struggle for income and livelihood” (Bavinck 2005), “regularly lead to violence, and even fatalities” (Pomeroy et al. 2007), and that “because of their important socio-economic role (e.g. employment, income, food supply) conflict may produce hardships for some of the poorest members of society” (Bennett et al. 2001). These assertions are often supported by journalistic and grey literature, and validated by testimony from small-scale fishers throughout the world (Environmental Justice Foundation 2005, 2012, BBC News 2016). Furthermore, many accounts portray these intersectoral incidents and conflicts not only for their immediate negative consequences for small-scale fishers, but also as potential triggers in the creation of poverty traps and detrimental cycles of migration, unemployment, and conflict (Bennett et al. 2001).

While evidence of these impacts is often convincing, many of these accounts rely on cursory or anecdotal evidence, and few if any studies have empirically assessed the consequences of having an incident at sea for small-scale fishing household dynamics. Improving our understanding of these consequences is essential for several reasons. First, it is essential in order to better understand how competition with industrial vessels may mediate access to fishery benefits for small scale actors. Currently, the majority of the literature on intersectoral competition emphasizes the impact it has on small-scale fishing households as mediated through the abundance of the resource (Atta-Mills et al. 2004, Environmental Justice Foundation 2005, Pauly et al. 2005). The claim is made that small-scale fishers’ income, livelihoods, and food security are imperiled by industrial fishers due to the fact that they out-compete small-scale vessels, reduce fish stocks, and thereby threaten the ability of small-scale fishers to obtain a sufficient catch (Atta-Mills et al. 2004, Pauly et al. 2005). Yet very little research has focused on the direct impacts competition at sea with industrial vessels has on small-scale fishers. Empirically assessing the consequences of incidents at sea on small-scale fishing household dynamics broadens our understanding of how this competition may alter small-scale access to fisheries benefits. Second, it is essential in order to understand the coping strategies employed by small scale actors in response to a disturbance or shock in their ability to access fishery-based food, income, and employment. Equally important as the immediate incident impacts are the adaptations, social structures, and tactics utilized by small-scale fishing households to prevent and mitigate negative consequences. Third, it is critical to illuminate the consequences of incidents at sea in order to begin understanding the potential long term effects of these disturbances for fishing households and communities. Literature on poverty traps suggests “risk matters and shocks have permanent consequences” (Barrett and Carter 2013), therefore there may be substantial long-term costs to the poor from the uninsured risks of fishing activities. However, these costs may be mitigated through broader social and economic dynamics such as safety net programs and social protection

schemes (Ravallion 2003, Barrientos 2007, Barrett et al. 2016). The first step in understanding the role that incidents at sea may play in the long-term socioeconomic and livelihoods dynamics of small-scale fishers is to understand their immediate consequences. Finally, an empirical study of the consequences of incidents at sea is also essential to begin designing policies that might prevent or mediate their negative effects, and design appropriate institutions to build resilience to these shocks.

In order to gain a greater understanding of the consequences of incidents at sea for small-scale fishing households, three questions demand attention: 1) How common are incidents at sea in comparison to other disturbances? 2) What factors are most associated with having an incident at sea? 3) What are the consequences of having an incident for employment, socioeconomic status, and food security in small scale fishing households? This chapter presents an empirical case study that examines these three questions using a historical database of incidents at sea and paired household surveys in coastal Ghana. This chapter is organized as follows. Section 2 (Background and Context) discusses the broad context of Ghanaian small-scale fisheries, their national and regional importance, and the positionality of small-scale fishing households. Section 3 (Methods) describes the historical and household data used in the empirical analysis and outlines the descriptive and analytical methods used to analyze these data. Section 4 (Results) identifies the overall relative prevalence of incidents at sea as well as those small-scale characteristics most associated with having an incident. It further outlines the impacts of incidents on small scale fishing household food security, socioeconomic status, and livelihoods, as well as coping strategies currently employed by households who have experienced an incident. Section 5 (Discussion) and Section 6 (Conclusions) discuss the main results and potential implications, outline key conclusions and policy implications, and suggest areas for future research.

2 Background & Context

Ghana is one of the most fishery-reliant countries in the world. Fisheries provide a major source of employment, with approximately 2.2 million people dependent on the sector for their livelihood, including 135,000 marine fishers (Finegold et al. 2010, Government of the Republic of Ghana 2011). Fisheries in Ghana are also unusually high income and employment multipliers, and one study estimated that one fishing job may lead to the creation of seven additional livelihoods (Finegold et al. 2010). Overall, fisheries directly or indirectly employ between ten to twenty percent of the workforce in Ghana, and contribute 4.5 percent to annual gross domestic product (GDP) (Atta-Mills et al. 2004, Government of the Republic of Ghana 2011). Fish also provide half of all total animal-source protein for the Ghanaian population, in comparison a to 17 percent global average (FAO 2016b). In addition to their economic and dietary importance, fisheries in Ghana also have substantial historical and cultural significance, and Ghanaian fishing communities have some of the oldest and most influential fishing and boatbuilding practices in the West African region (Overå 2001, Atta-Mills et al. 2004, Seto et al. 2017).

The substantial importance of the fishing sector is further emphasized by limitations in Ghana's broader economic development context. Despite its political stability and relatively consistent economic growth, Ghana continues to suffer from development challenges and remains classified as a low-income food deficit country (LIFDC) by the FAO (FAO 2017). Overall, 24 percent of the population lives in poverty and 38 percent of the

population age fifteen and older is considered to be unemployed or underemployed (Ghana Statistical Service 2014, Cooke et al. 2016). Ghana has also recently transitioned to become a net importer of food and fish products (FAO 2016a). In this context of limited economic opportunity, fisheries are profoundly important, providing a source of employment and income as well as a cheap and accessible source of nutrient-rich food (Finegold et al. 2010). Considering the array and diversity of benefits provided by Ghanaian fisheries, it is also essential to understand potential threats to those benefits. Previous chapters have suggested that incidents at sea between small-scale and industrial fishers are driven by resource competition and may act to disrupt small-scale fishers' access to resources. Chapter one showed that the majority of incidents occur in spaces reserved for small-scale fishers, and that they are disproportionately affected by incidents at sea. Chapter two demonstrated that the limited resources and relative power of small-scale fishers increased their incentives for high-risk behavior, and increased their vulnerability to the effects of having an incident at sea. Evidence from these chapters suggests that incidents with industrial fishers may present a considerable impediment to small-scale fishers' ability to access fisheries benefits.

3 Methods

3.1 Data Collection

To understand the impacts of having an incident at sea (IAS) on household dynamics, I triangulated evidence from the historical database (Chapter 1: Fish, Fishers, & Fleets: Characterizing fisheries interactions at sea with a cross-sectional survey of marine fishing households. Historical data were compiled from existing records from the Ministry of Fisheries and Aquaculture Offices in Tema, Takoradi, and Accra and are comprised of narrative accounts of 396 cases of incidents at sea between small-scale and industrial fishers reported from 118 villages spanning Ghana's coast¹³ (Figure 10-A). First, I conducted a content analysis of these narratives, identifying major themes and qualitative findings. Second, I identified primary beach landing sites along Ghana's coast, encompassing three of four coastal regions: Western Region, Central Region, and Greater Accra Region. The Volta Region was omitted, as the primary fishing conducted there is not marine but riverine and estuarine. I then selected nineteen villages and towns based on their importance as fish landing sites and for the historical occurrence of incidents at sea (Figure 10-B). Locations and full sample scheme are available in Table B-1 and Figure 10-B. Following the selection of sample sites, we conducted 1323 surveys over a six-month period, between November 2014-May 2015, representing 771 fisher/boat owner surveys and 552 female surveys. Surveys were conducted with randomly sampled fishers and paired female heads of house¹⁴. Unless noted otherwise, the analyses below were

¹³ Since the data only reflect those cases that were brought to the Committees, it is likely that a large number of incidents at sea occurred, which were never reported. It is also possible that the issue of reporting may bias data toward cases that are more severe or more proximal to Arbitration Committee locations, however the diversity of locations and estimated losses do not suggest strong bias.

¹⁴ Since no census of fisher and boat owner houses was available, respondents were selected via two random techniques based on the size of the fish landing site. For large towns, respondents were selected by dividing the site into quadrants, and fishers in the fourth fishing tent in each quadrant were selected. For small towns and villages, enumerators started at a randomly generated spot and walked 50 steps between each selected

conducted only with complete household surveys involving both a fisher/boat owner and female head of house (n=548). Surveys were conducted by local enumerators in English, Fante, Twi, or Ga, depending on the preferred language of the respondent. Recruitment of respondents was approved by local chief fishermen, who were offered a small token of appreciation for their facilitation.

respondent. Female respondents were selected as female heads of house of the fishers and boat owners randomly selected above.

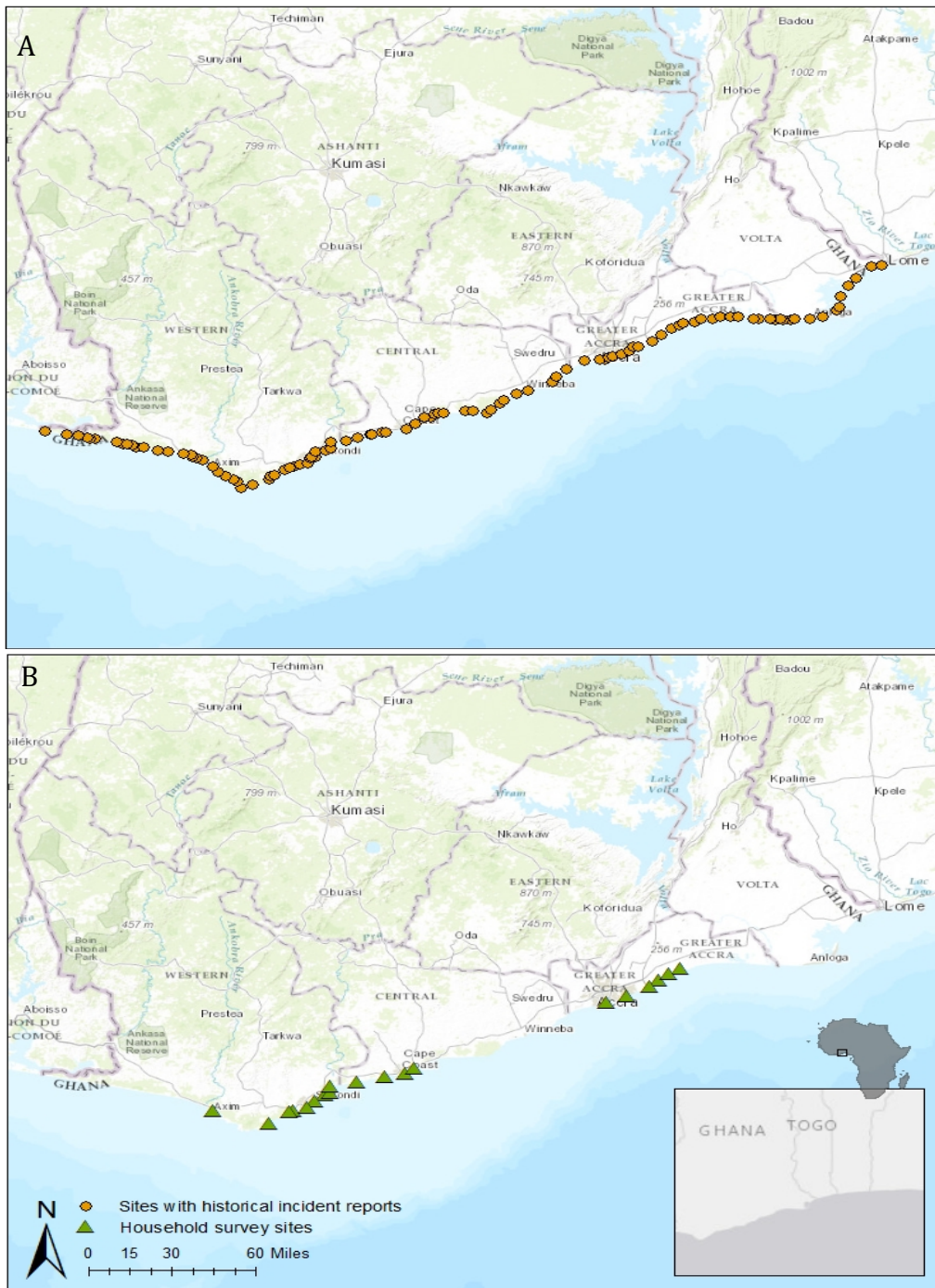


Figure 10: Coastal Ghana with A) 118 villages with historical incidents at sea and B) 19 survey site villages

3.2 Characterization of variables

I characterized an incident at sea as any physical encounter with another boat or its gear while at sea (i.e. collision, net damage by another boat, etc.), and excluded any incidents that may have occurred from contact with non-vessel objects (e.g. rocks) or due to accidental circumstances (e.g. weather, fire). In addition to incidents at sea, I collected data on other forms of disruption to fishing activities, including: 1) stolen fishing gear, 2) lost fishing gear, 3) closure of a fishing area or beach landing site, and 4) other.

I characterized household socioeconomic status based on reported monthly income from all employment activities by all individuals within a household, an asset scale, household expenditures, number of boats owned, average household adult education, average age of the household, and household size. Monthly income was omitted due to systematic inconsistencies in reporting values between regions. I conducted a principal component analysis (PCA) of a 22-item asset scale to develop a single asset measure among several potentially collinear predictors. The asset index was calculated from the first principal component (The World Bank n.d.). Household expenditures were calculated from a combination of male and female surveys in order to encompass a diversity of expenses traditionally applying to both genders. I calculated the number of boats owned by a respondent as an ordinal variable; zero was used if the respondent was a day laborer. Household education was characterized as the average educational attainment for all adults within the household; children were omitted, as education levels would reflect continuing education and were not a reflection of highest levels attained. Educational attainment encompassed five categories ranging from no school (i.e., 0) to tertiary/college/university level schooling (i.e., 5). Age of the household was calculated as an average of all individuals¹⁵. Household size was all individuals included in the household as reported by the female head of house.

I characterized food insecurity using an adapted version of the Household Food Insecurity Access Scale (HFIAS) Generic Questions (Coates et al. 2007). Responses to these questions were used to create continuous household HFIAS Scores.

I characterized fishing type with two metrics: vessel effort and trip length. I characterized vessel effort as the number of hours per month that each boat spent at sea, whether owned or fished upon. For fishers, this was calculated as the cumulative number of hours spent fishing on all boats within a month, divided by the number of boats. For boat owners, this was the cumulative number of hours that all boats owned spent at sea, divided by the number of boats owned, whether the owner was present or not. I characterized trip length as a binary variable of single day or multiday. Multiday was defined as when fishing occurred for more than 24 hours, or more than a single day, as defined by the respondent. I characterized fishing effort as the cumulative number of hours spent fishing on all boats within a month per respondent. This metric was meant to capture the total effort of all vessels for which a respondent was impacted.

I characterized distance from port as the shortest distance from the village where the respondent embarked to one of two industrial ports in Ghana (Tema and Takoradi). The distance was calculated as the shortest distance in kilometers between that village and

¹⁵ Average age of all individuals was found to be a superior metric than average age of income generating individuals, as there was no systematic relationship between income generating individuals and age, and dependents were found to be in every age bracket.

the closest port, by coastal road. As Ghana has a distinct continental shelf which is substantially wider in the west, and tapering in the east (Figure 10), I characterized the continental shelf as a binary variable with only those villages embarking from the two western regions defined as those on the continental shelf. I characterized disturbance duration as the total time in days that the respondent was unable to fish following an incident at sea or one of the other four recorded disturbances.

3.3 Qualitative and statistical analyses

Qualitative analyses of historical incident narratives were conducted using MaxQDA Version 12.2.0; descriptive and analytical statistics of surveys were conducted using RStudio Version 1.0.143 and R Version 3.4.0 (MaxQDA Standard 12 n.d., R Core Team n.d., RStudio Team n.d.).

To understand what household characteristics were most associated with having an incident at sea, I used the lme4 package (Bates et al. 2015) glmer() function for multivariate logistic regression. I included all available variables that were thought to potentially differentiate households. I performed a multivariate logistic regression to assess the variance explained by each independent variable (per vessel fishing effort, total fishing effort, trip length, number boats owned, association with continental shelf, distance to port, asset index, and household size) on the outcome variable of having an incident at sea. The logistic regression was stratified by including the village of respondent residence as a random effect. I calculated 95% confidence intervals (CIs) for all odds ratios and report the *p*-value for the associated regression coefficient.

To investigate the consequences of having an incident at sea for small-scale fisher household socioeconomic status and food security, I conducted a series of linear mixed effects models using the lme4 package (Bates et al. 2015) lmer() function. Here I assessed the relationship between independent household variables (average household age, average adult education level, household size, number boats owned, asset index, and disturbance duration) and four response variables of HFIAS score, asset index, total household expenditures, and recent household savings. Each response variable was analyzed independently in a linear mixed model. The models were stratified by including the village of respondent residence as a random effect. I tested interactions with covariates that were most significant and had large estimates of coefficients and, where possible, conducted a model comparison in order to test the role of having an incident at sea on household metrics.

4 Results

Of the complete household surveys (n=548), 17% experienced an incident at sea (n=92) within the past six months, while 4% experienced a loss of fishing gear at sea (n=22), 2% had their fishing gear stolen (n=9), 1% experienced the closure of a fishing area or landing site (n=7), and 1% experienced another form of disruption to their fishing activity (n=3) (e.g. the death of a crew member)(Figure 11). Fifteen households experienced more than one kind of disturbance within the six-month study period (e.g. lost gear and an incident at sea). The distribution of disturbances experienced by complete households was not significantly different ($\chi^2 = 1.4827$, *p*-value = 0.8297) from those of the total fisher/boat owner surveys—including those without a female head of house or whose female head of

house was unavailable¹⁶. Overall, evidence from the surveys suggests that the prevalence of incidents at sea is higher than other kinds of disturbances, as well as anecdotal estimates from interviews conducted with fisheries experts in Ghana.

4.1 Household characteristics and incidents at sea

Descriptive statistics of the complete household surveys (n=548), including those that experienced an incident at sea (n=92), and those that did not (n=456) are found in Table 6.

Based on the results of the multivariate logistic regression, I found that four variables were significantly associated with having an incident at sea (Table 7). Three variables pertained to fishing vessel characteristics, including per vessel fishing effort, association with the continental shelf, and distance from port. The fourth variable, total fishing effort, characterized fisher/boat owner behavior. Results indicated that every additional hour of fishing effort per vessel led to a decrease in the odds of having an incident at sea by a factor of 0.99 and embarking from a village associated with the continental shelf increased the odds of being in an incident at sea by a factor of 9.54 (Table 7, Figure 12). Every increase of 50km in the distance of embarkation to nearest port led to an increase in the odds of having an incident at sea by a factor of 1.5 (Table 7, Figure 12). I also found that every additional hour of total fishing effort per respondent led to an increase in the odds of having an incident at sea of 1.004 (Table 7, Figure 12).

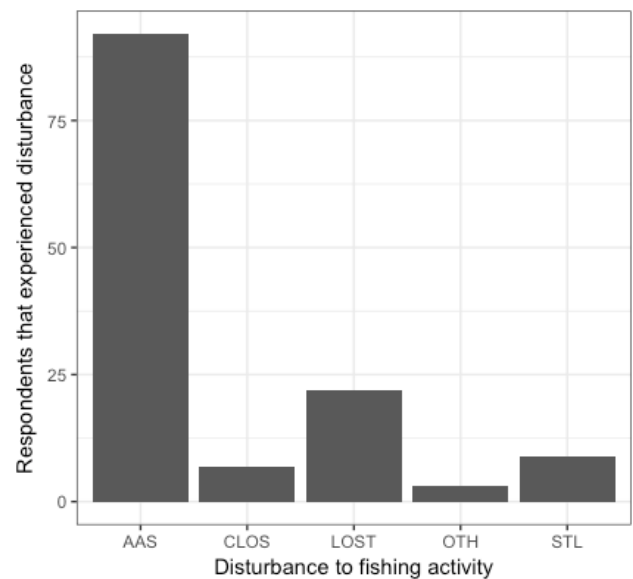


Figure 11: Number of individual respondents that experienced each type of fishing disturbance within the last 6 months. (AAS= Incident at sea, CLOS= fishing area or beach landing site closure, LOST= lost gear, STL= stolen gear, OTH= other disturbance)

¹⁶ Of the total fisher/boat owner surveys (N=787), 15% (n=117) percent experienced an incident at sea, 5% (n=37) lost fishing gear at sea, 1% (n=12) had their fishing gear stolen, 1% (n=7) experienced the closure of a fishing area or landing site, and 1% (n=6) experienced another form of disruption

Table 6: Descriptive statistics of all complete fishing households (e.g. including both fisher/boat owner survey and paired female head of house, n=548), including those who did experience an incident at sea within the past 6 months, and those that did not.

Variable	Range	All households (548 households) n (%) or N (SD)	IAS households (92/17% households) n (%) or N (SD)	No IAS households (456/83% households) n (%) or N (SD)
Per vessel fishing effort (hours ⁻¹ vessel ⁻¹ month)	12-504	254.16 (87.55)	255.78 (87.63)	253.84 (87.62)
Total fishing effort (hours ⁻¹ month)	24-1148	273.66 (128.40)	314.80 (184.36)	265.34 (112.27)
Trip length	Single Multiday	434 (79%) 114 (21%)	66 (72%) 26 (28%)	368 (81%) 88 (19%)
Boats owned	0-3	0.44 (0.59)	0.66 (0.72)	0.39 (0.55)
Continental shelf	Yes No	392 (72%) 156 (28%)	89 (97%) 3 (3%)	303 (66%) 153 (34%)
Distance from port	0-147 km	31.77 (33.69)	44.47 (39.71)	29.21 (31.77)
Household size	2-22	6.12 (2.25)	6.75 (2.90)	5.99 (2.07)
Asset index	-3.92-3.82	0.96 (1.19)	1.35 (0.77)	0.89 (1.24)
Average household age	22.5-64	37.59 (8.00)	39.42 (8.09)	37.21 (7.94)
Average household adult education level	0-3.75	0.91 (0.75)	0.94 (0.61)	0.90 (.077)

Table 7: Variables associated with having an incident at sea, including odds ratios and 95% confidence intervals for all households (n=548) within the multivariate model.

Variable	Range	Odds Ratio (95% CI)	p-value
Per vessel fishing effort (hours ⁻¹ vessel ⁻¹ month)	12-504	0.99 (0.99-1.00)	0.003
Total fishing effort (hours ⁻¹ month)	24-1148	1.00 (1.00-1.01)	0.006
Multiday fishing	Yes/No	0.96 (0.54-1.69)	0.88
Boats owned	0-3	1.44 (0.93-2.22)	0.10
Continental shelf	Yes/No	9.54 (2.70-33.74)	0.0005
Distance from port (km)	0, <50, <100, >100	1.50 (1.09-2.07)	0.013
Asset index	PCA 1 of 22 item scale	0.84 (0.32-1.12)	0.23
Household size	2-22	1.02 (0.91-1.14)	0.77

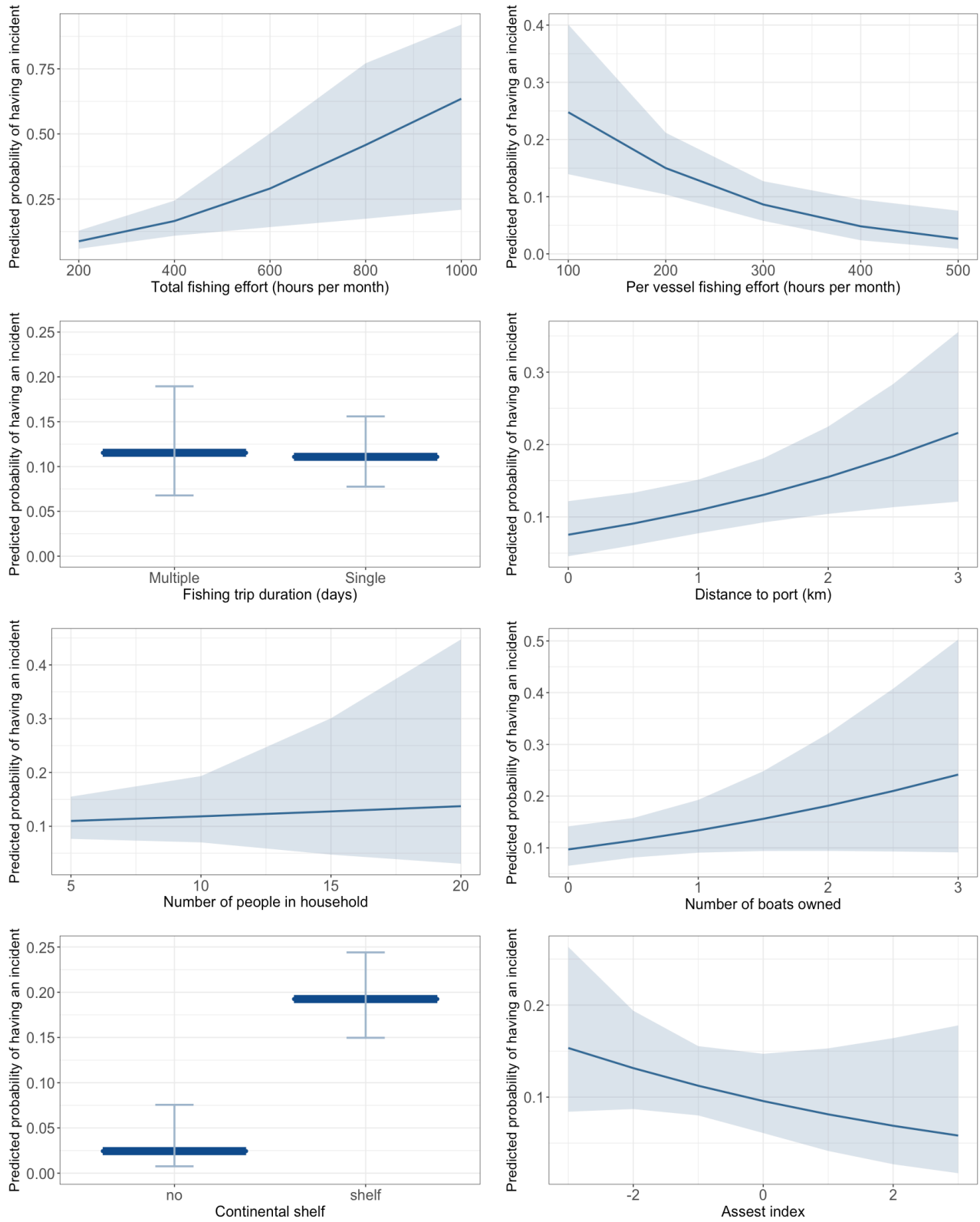


Figure 12: Impact of individual variables in multinomial logistic regression on predicted probability of having an incident at sea in Ghana

4.2 Incidents at sea and livelihoods

The [incident] has... grounded their business and put into jeopardy their very livelihood.” -August 2002

Analysis of historical cases suggested that having an incident at sea with an industrial vessel has a strong negative effect on the employment and livelihoods of Ghanaian small-scale fishers. In many of the historical incident at sea narratives, fishers and boat owners stressed the fact that fishing was their only livelihood (Box 4: C, E, G, L), and that having an incident at sea led directly to prolonged periods of unemployment and deprivation (Box 4: A, E, H, K, O, Q). They stressed the profound impact not only on the owners of the damaged capital, but also on the fishers and dependent families employed through use of the nets and boats. Fishers and boat owners also emphasized the substantial additional stress that incidents placed on fishing households when they occurred during the peak fishing season, when employment and income generation is highest (Box 4: D). Historical narratives also suggested that the loss of employment and livelihoods associated with having an incident at sea directly and negatively affected household dynamics, including familial relations and multiple psychosocial costs (Box 4: H, P, R).

Overall, the average time spent not fishing following an incident at sea was the highest of any disturbance at an average of 42 days, while the average times for other forms of disturbance were 30 days for closure of a fishing area or landing site, 22 days for lost fishing gear, and 11 days for stolen gear (Figure 13). No responses were recorded for days unable to fish following an “other” fishing disturbance. Following an incident at sea, two fishers/boat owners abandoned fishing, stating that “all [their] nets were destroyed” and they “couldn't go to sea.” One fisher/boat owner changed fishing grounds, and one sought other employment in agriculture. Two households also had another household member seek new or increased employment activities (e.g. selling charcoal) because of an incident at sea.

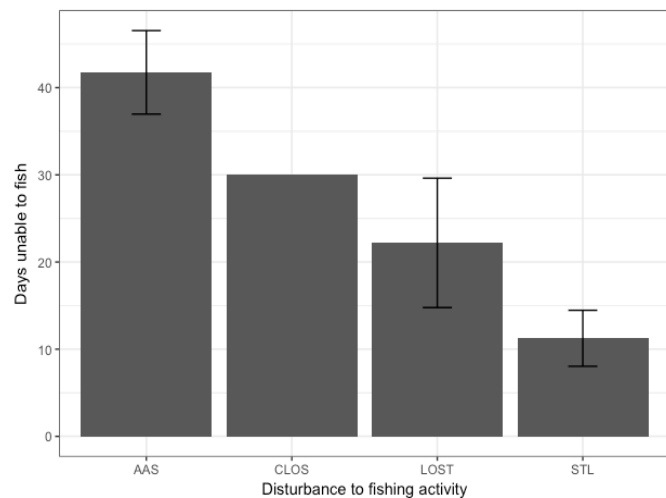


Figure 13: Average number of days a respondent was unable to fish following each type of disturbance to fishing activity. (AAS= Incident at sea, CLOS= fishing area or beach landing site closure, LOST= lost gear, STL= stolen gear, OTH= other disturbance)

4.3 Incidents at sea and socio-economic status

“This damage of my nets has caused my livelihood to be stopped midway. I am finding it difficult to maintain my wife and children, including my parents, financially” -June 2013

Initial data from the historical database suggested that having an incident at sea with an industrial vessel may result in strong economic hardship for small-scale fishers. Fisher and

boat owner narratives recounted challenges with paying debts (Box 4: R), supporting themselves, their families, and the families of their hired workers (Box 4: A, B, C, N, P, R), and being forced to deplete savings (Box 4: H, I) following an incident at sea with an industrial boat. Content analysis of the historical database suggested substantial effects in both the short-term (e.g. not being able to pay school fees) and long-term (e.g. needing to withdraw funds from retirement), as households employed different coping strategies following an incident (Box 4: H, N).

Box 4: Socio-economic status, food security, and livelihoods: Select quotes from incident at sea reports

- A. October 1998: "for ten months the fishermen and our families had been denied our daily bread"
- B. September 1999: "since the accident occurred we have been feeding the fishermen and their wives and children"
- C. October 1999: "fishing is my sole business and bread earner for me and my family"
- D. August 2007: "we are now in the fishing season and the extent of damage is near impossible to bear"
- E. September 1995: "this is our source of income; these vessels always come so close to the coastal areas that they pose a threat to us in, which sometimes they halt our fishing activities"
- F. December 1996: "urgent because fishermen cannot continue fishing because of the accident"
- G. August 2003: "I am appealing to the authorities concerned to come to our aid to have an amicable settlement because it is our only livelihood"
- H. February 1996: "As a result of this accident, we are no more fishing; our wives are threatening to divorce us since the fishing business is our only livelihood coupled with our children crying for food." Fisheries officer: "The fisherman had to use his retirement money to pay for a new net since he hasn't been compensated after 2 years"
- I. March 2010: "I am presently in financial crises since I do not have materials to work with"
- J. February 1995: "I sharply cut the rope fastening the canoe to the nets and saw that our daily bread (nets) sadly vanished in the darkness of the sea"
- K. August 2002: "I wish to draw your attention to the fact that your trawler has not only caused damage to the net of my clients but you have also thereby grounded their business and put into jeopardy their very livelihood"
- L. December 2013: "In fact, we had noticed or seen the worry, the desperation and the predicament of the fishermen because this is their livelihood and we wish to advise you to speed up the process to clear this case as soon as possible"
- M. December 2007: "our nets are our source of our daily bread"
- N. March 1986: "the net is taking good care of eight mothers and about twelve school children and their school fees"
- O. November 1996: "the operation of the nine fishermen has been long overdue and they are doing practically nothing, yet feeding them is still in existence"
- P. June 2013: "this damage of my nets [has] caused my livelihood to be stopped mid-way. I am finding it difficult to maintain my wife and children, including my parents financially"
- Q. November 1989: "Those whose net was damaged are still not operating because their damaged net is still with the boat which has caused the damage"
- R. April 2013: "come to our aid as to recover my lost nets to enable me to repay the huge bank loans and also to be able to continue to cater for my own families, including the extended ones, as well as the families of my crews who i am looking after"

Descriptive household survey data supported these claims and showed that of the 92 households that experienced an incident at sea in the last six months, 75 percent (n=71) stated that their household income had decreased as a result of the incident at sea (Figure 14). Twenty-four percent (n=23) stated that they were able to spend less money on school

fees, goods, and services because of the incident, and six percent (n=6) responded by increasing the total number of gifts and remittances received from outside the household. Respondents reported decreased income from an incident at sea significantly more frequently than from lost gear or the closure of a fishing ground or landing site (comparison to stolen nets or other disturbances was not significant due to extremely small sample sizes)(

Table B-2, Figure 14). Further, respondents reported that incidents at sea decreased income, limited household expenditures on basic goods and services, and increased household remittances more frequently than any other form of disturbance (Table B-3).

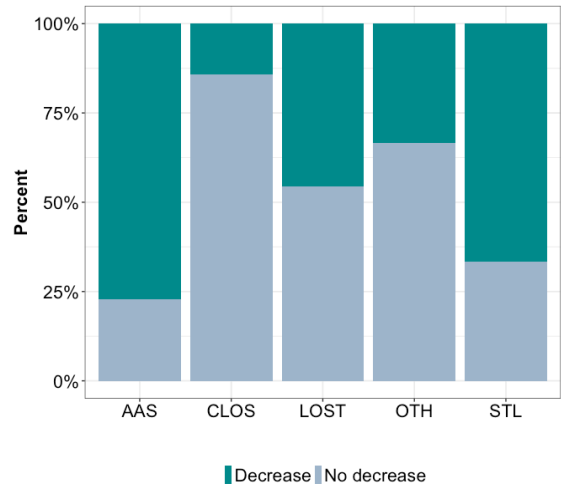


Figure 14: Percent of respondents that experienced each type of disturbance who stated that the event had decreased their household income

The linear mixed effects model of asset scores did not show a significant difference between households that experienced an incident at sea and those that did not. Due to significant interactions with important covariates, savings and expenditures could not be directly compared between those who did and did not experience an incident at sea. However, analyses of the linear mixed effects models suggest that there are substantial and

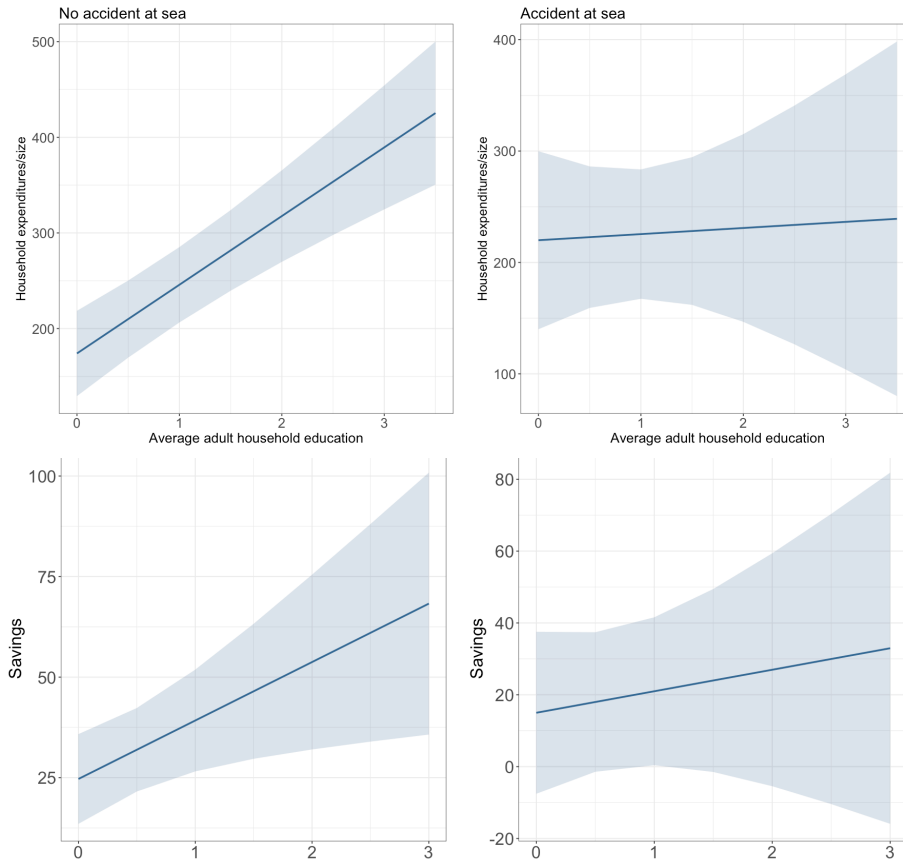


Figure 15: Differences in primary socioeconomic indicators A) expenditures and B) savings between respondents who did (right) and did not (left) experience an incident at sea.

consistent differences in savings and expenditures between those who experienced an incident and those who did not (Figure B-1 and Figure B-2; Figure 15). Comparison With regard to both savings and expenditures, having an incident at sea acted to dramatically alter the relationship between the socioeconomic indicator and its primary driver. With regard to savings, the model suggested that the normal relationship between the number of boats a respondent owned and the amount of money they saved was altered by having an incident such that they were no longer correlated for those who experienced an incident. The model also suggests that all those who experienced an incident saved less than those who did not. A similar phenomenon was found with regard to total expenditures per household member, wherein the normal relationship between expenditures and average adult education was altered such that they were no longer correlated for those who experienced an incident. The model also suggested that those with lower educational levels increased expenditures, and those with higher educational levels substantially decreased expenditures. Overall, the models suggest that, for those who experienced and incident at

sea, normal indicators of relative socioeconomic status are broken, and there are substantial and consistent financial differences between the two groups.

4.4 Incidents at sea and food security

“As a result of this accident, we are no more fishing; our wives are threatening to divorce us since the fishing business is our only livelihood coupled with our children crying for food” -February 1996

The historical records of incidents at sea also demonstrated that small-scale fishers believed their ability to provide food for their families was strongly negatively impacted by having an incident at sea. They emphasized that their families—including dependent children, parents, and extended families—were often heavily reliant on their provision as fishermen and boat owners (Box 4: A, B, C, H, N, O, R). Small-scale fisher historical narratives repeatedly referred to fishing as the primary or sole “bread earner” available to themselves, their families, and the day laborers reliant on their fishing activity (Box 4: A, C, J, M). In this way, the historical narratives emphasized that strong reliance on the sector as the primary or sole source of income directly linked fisheries disturbances and periods of unemployment with household food insecurity outcomes.

Household survey data supported this claim, and fishing was found to be the primary source of income in fishing households, contributing an average of 1006 GHS per month, as compared to 609-850 GHS for other occupations such as shop worker and charcoal seller. The household surveys further showed that of the 92 households that experienced an incident at sea in the last six months, 55 percent stated that they consumed fewer preferred foods, and 40 percent stated that they consumed smaller variety of foods due to the incident at sea. Due to significant interactions with important co-variates, food insecurity could not be directly compared between those who had accidents and those who did not. However, analysis of the model demonstrates a strong relationship between household food insecurity and the amount of time that a fisher or boat owner was unable to fish following an incident at sea (Figure 16).

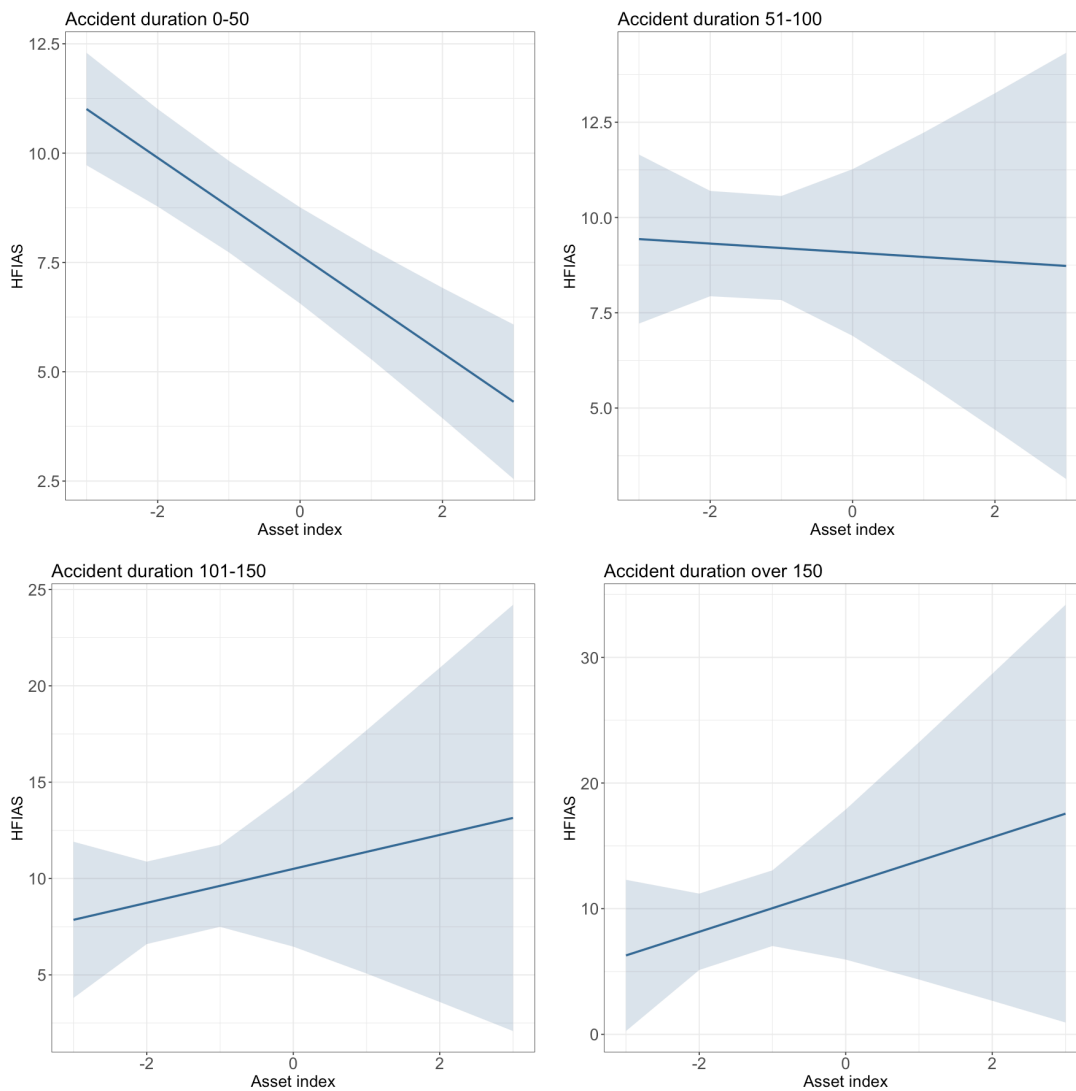


Figure 16: Differences in household food insecurity scores between respondents with a range of days they were unable to work following an incident at sea. Duration=0 represents respondents who did not experience an incident at sea.

5 Discussion

By far the factor most associated with having an incident at sea was embarking from a village or town associated with the continental shelf. As the continental shelf represents the most productive fishing grounds, this finding supports the evidence from previous chapters that incidents at sea are strongly driven by fisheries competition rather than transit or other factors. It is important to note, however, that since the continental shelf variable was defined by the region of Ghana's coast, it is possible that the role of continental shelf is conflated with other regional influences which could not be controlled for by stratifying by the respondent's village. The second factor most associated with having an incident at sea was distance from port. This factor initially appears to counter the findings in Chapter one that incidents at sea are associated with ports, as here, distance from a port is positively associated with having an incident. However, two issues are important to keep in mind. First, the spatial analysis in Chapter 1: Fish, Fishers, & Fleets: Characterizing fisheries interactions at sea represents a spatial model of where incidents were reported *in seaspace*, whereas in the model presented here, distance to port is the shortest distance from port to the village from which the fisher *embarked*. While the intent is that the distance from port variable may act as a proxy, it is imperfect and measured differently than historical cases. Second, as both association with the continental shelf and distance from port were measured as locations along the Ghanaian coastline, they are intrinsically linked. In other words, since the western and central villages associated with the continental shelf tend to be further from the major ports, this is likely an artifact of village location rather than an indication of fishing activity further from ports. For example, Cape Coast is a major fishing town associated with the continental shelf, but located approximately 80 km from the nearest port; this means that the model would only capture the distance of the embarkation location, and not actual fishing activity, which may occur closer or farther from port activity.

The two remaining factors were substantially less influential on the likelihood of having an incident at sea, however the implications are notable. Individual vessel effort, or the number of hours that each vessel fished in a month, was negatively associated with the occurrence of an incident, suggesting that not only does the likelihood of an incident not increase with the more hours a vessel is fishing, but actually slightly decreases. This may be due to a variety of reasons, related to things such as fisher experience (e.g. the more practiced fishers are less likely to be in an incident) or other trends in fishing vessel behavior (e.g. time of day) associated with fishing hours. This finding is notable, as it contrasts but does not contradict the fourth factor, total respondent effort, or the total time that vessels which a respondent claimed spent fishing in a month. This finding suggests that regardless of fishing type, or the number of hours an individual vessel fishes, respondents were more likely to experience an IAS if they were associated with more vessels. This finding has substantial implications for distinguishing impacts on boat owners versus day laborers, and the different socioeconomic particularities of each group.

One of the strongest findings of this research is that the overall prevalence of incidents at sea with industrial vessels is surprisingly high, and appears in Ghana to be the biggest driver of fishing disturbances and time spent not fishing. In contrast to some theories of rural development (Ellis 2000), and evidence from some other countries (Allison and Ellis 2001, Cinner et al. 2009, Cinner and Bodin 2010), small-scale fishers in

Ghana do not easily switch between alternative livelihoods when these disruptions to income and employment occur. Similarly, in contrast to theories proposed by some economists and conservation biologists (Slater et al. 2013, Roe et al. 2015), fishers also do not frequently respond to competition and conflict by exiting the fishery. Instead, results from this study suggest that fishers who experience an incident at sea most frequently stay within the fishery and rely on fishing institutions and various household tactics and social structures (e.g. savings, remittances) as coping strategies.

Within the scope of this study, I found no evidence that incidents at sea affect household assets. There may in fact be no association in Ghanaian fishing communities between incidents at sea and household assets, especially within the relatively short time frame (six months) within which fishing households were asked to recall. Indeed, as assets tend to represent more durable goods than recent expenditures, the sale or purchase of assets based on a disturbance seems unlikely, however further research is needed here, especially on the long-term effects of incidents at sea. Unfortunately, income data which may have enabled the analysis of more short term effects was available due to village particularities in data collection.

Although no association was found between incidents at sea and household assets, both qualitative and quantitative evidence suggested that incidents at sea affect other socioeconomic indicators, such as recent household savings and expenditures, as well as household food insecurity. With regard to food insecurity, it was not only the experience of an incident at sea that influenced food insecurity outcomes, but also the amount of time following the incident in which a fisher or boat owner was unable to fish. Findings suggest that the longer the amount of time a respondent was unable to fish, the more the relationship between assets and food insecurity was altered. The quantitative analyses found substantial and consistent differences in savings and expenditures between those who experienced an incident and those who did not. They also found that having an incident at sea acted to dramatically alter the relationship between these two socioeconomic indicators and their primary driver. Coupled with the qualitative data from the surveys, these findings suggest that reducing savings and reducing food security (by limiting preferred foods and overall food amounts) both represent short term coping mechanisms of small-scale fishing households to having an incident at sea. Since, controlling for the number of boats owned, all those who had incidents at sea saved less than those who did not, the effect of incidents on household savings is relatively straightforward and intuitive. However, controlling for average adult household education, expenditures showed a divergent response whereby those with higher adult household education levels reduced expenditures, while those with the very lowest average adult education actually increased expenditures. Potential explanations for this divergent outcome may include different degrees of financial literacy, livelihood options, or simply preferred coping strategies between those with lower versus higher education, and further investigation is necessary.

Overall, the empirical case study presented here supports previous reports that incidents at sea with industrial fishers present substantial impacts on small-scale household dynamics. However, one notable finding is that the impacts observed here are not mediated through the abundance of the resource, as suggested by much of the existing literature. Instead, the primary way in which access to fish is mediated by these incidents is through direct competition with small-scale fishers. Here the ecological concepts of

exploitation competition versus interference competition are particularly useful. In the notion of exploitation competition, one actor reduces access of another actor by reducing the overall abundance of the resource base (Cain et al. 2011). This is the kind of competition that has previously been suggested as the means by which industrial fishers reduce access to fish for small-scale fishers. However, interference competition is defined as direct competition through antagonistic actions (Cain et al. 2011), and better represents the findings of this chapter, wherein access to fishery benefits is reduced via direct action between the sectors. While these findings do not preclude the possibility that exploitation competition does occur between these sectors, and further investigation is necessary, this study demonstrates and impacts for small-scale fishers can be observed without expensive and highly technical fisheries abundance surveys.

This study also sheds light on some of the coping strategies employed by small-scale actors in response to incidents at sea. Of those observed, the most prevalent involved staying within the fishery and altering household economic strategies (e.g. pursuit of compensation through fishing institutions, reducing saving activity, and altering expenditures). Broader tactics beyond the sector such as increasing remittances from those outside the household and increasing or pursuing other employment activity were very rare. While the design of the study was not longitudinal, and therefore does not allow for a deeper understanding of the long-term effects of having an IAS, some insights are possible. For example, this case study suggests that in Ghana, the limited availability of alternative livelihoods suggests that, when faced with an income and employment shock such as an IAS, that fishers and boat owners are likely to stay within the sector and rely in savings or credit structures to replace capital and continue fishing. This finding suggests that two additional issues merit further investigation with regard to understanding the consequences of incidents with industrial vessels on small-scale fishing household dynamics. First, the role of credit within the small-scale fishery is essential in understanding the consequences of an IAS. While a relative diversity of credit institutions are available in many Ghanaian coastal areas in the case of damaged capital, they present a variety of lending practices ranging from family or community loans with little or no interest to highly predatory practices (Overå 2001, Thampi 2003). When few alternative livelihoods are available, and fishers frequently opt to remain in the fishery, the terms of credit may prove pivotal in determining the short or long term effects on a household following an IAS. Secondly, the role of insurance may also alter the ultimate consequences of experiencing an incident by providing a safety net and source of aid in the event of lost capital and income. Small-scale insurance schemes were not available in Ghana at the time of research, however following a recent pilot program, a public/private partnership insurance scheme was launched for multiple villages in coastal Ghana¹⁷. While no assessment of this scheme is yet available, this represents a timely and much needed area of research.

¹⁷ For more information see:

<http://www.ghananewsagency.org/science/insurance-for-fishermen-to-be-launched-in-december-94656>

<http://www.myjoyonline.com/business/2016/November-20th/fisheries-ministry-partner-insurance-company-to-provide-insurance-for-fishers.php>

<http://www.myjoyonline.com/business/2016/September-6th/nationwide-insurance-scheme-for-fishermen-launched.php>

6 Conclusion

As one of the few empirical, and the only quantitative study to date of the effects of incidents at sea, this chapter represents an essential first step in understanding how incidents with industrial fishers affect small-scale fishing households. As a first step, this study demonstrated that incidents at sea with industrial vessels mediate access to small-scale fisheries benefits by reducing employment, income, and household food security in the short and medium term. It further highlighted the unexpectedly high prevalence of these incidents and the means through which small-scale fishing households were most frequently influenced. Instead of industrial fisheries indirectly impacting small-scale fishing communities by reducing fish stocks—the most frequently cited pathway—this study showed that the most common effect was industrial vessels directly reducing the ability of small-scale fishers to access fish. While these findings are limited to the short and medium term, and further research is needed on the long-term effects of incidents at sea, this chapter lends credence to the claims of small-scale fishers that conflict and competition with industrial vessels jeopardizes their health and livelihoods. The implications that these findings have for fisheries policy and management are substantial. First, they suggest that the intersection of small-scale and industrial fisheries is an important juncture in fisheries, and merits markedly greater examination. Incidents at sea were cited by small-scale fishers in this chapter as the most frequent and most detrimental disturbance that they experienced to their fishing livelihoods. Current management practices are theorized, designed, and implemented separately between the two sectors, with profoundly negative consequences for small-scale fishing communities. This study suggests that those management practices and institutions that are able to bridge sectors and scales—such as those identified in Chapter 2—are not just notionally relevant, but may also provide material and perceptible assistance to small-scale fishing communities. Second, it suggests that fisheries management and policies must be considered in concert with regulations in other sectors. In the fishing communities of Ghana, the availability and acceptability of alternative livelihoods, as well as access to insurance schemes and fair credit, may provide instruments to dampen the negative effects of incidents at sea and build resilience and adaptability within the sector.

Beyond the implications for management and policy, this chapter also contributes a few key theoretical insights. Incidents at sea between small-scale and industrial fisheries represent a confrontation between different fleets, but also a collision of different sea tenure systems and their accompanying economic, social, and ecological perspectives. When conflict and competition occurs between industrial and small-scale, the two actors are not often equivalent and, as WRI stated, “such conflicts between foreign industrial fleets and small-scale coastal fishers are becoming increasingly prevalent... with small-scale fishers gradually losing ground” (Kura et al. 2004). While many incidents at sea may be understood as an unfortunate but intrinsic aspect of fishing activities, those that occur between small-scale and industrial fishers also represent an unexamined form of neocolonialism wherein the resources of the developing world are transferred to the global north to the detriment of local community development and wellbeing.

While this study represents an important initial step in understanding how industrial vessels mediate access for small-scale fishing communities, much further work is needed. In particular, longitudinal and econometric studies would be especially valuable in

expanding our knowledge from immediate impacts to broader resilience and vulnerability frameworks. The chapter presented here demonstrates that the collision of small-scale and industrial fishing fleets in seaspace is not merely of theoretical interest, but has substantial impacts for small-scale fishers, their households, and communities.

Conclusion

Incidents at sea with industrial vessels are a common fisheries phenomenon, and one that substantially affects small-scale fishers in Ghana and throughout the world. In Ghana, evidence suggests that these incidents are strongly driven by resource competition, as they tend to occur primarily between fishing vessels (e.g. not transport, merchant, or other vessels with freedom of navigation) and concentrate seasonally, temporally, and spatially around fishing activities. In this way, these interactions exemplify the classic challenges characteristic of common pool resources; when it is difficult to exclude actors from the fishery, competition for finite resources increases, with detrimental effects for both the fish stocks and the less powerful resource users.

While assessment of the fish resources themselves was beyond the scope of this research, detrimental effects on small-scale fishers were evident in the loss and damage of fishers' and boat owners' capital (e.g. nets and boats) as well as substantial lost employment. These effects also reverberated more broadly in fishing households, where decreased employment was associated with decreased food security. Overall, incidents at sea had substantial—and overwhelmingly negative—effects on fishing households, impacting their income, savings, and expenditures as well as employment and food consumption activities.

Using a unique data set, this research demonstrates that incidents at sea between small scale and industrial fishers are frequent, impactful, and present one of the greatest challenges to the viability of small-scale fishing livelihoods. This research further showed that many traditional approaches to fisheries management, and common pool resource management more broadly, are poorly suited to govern at the intersection of these two fleets. Structures and institutions of comanagement, community-based management, spatial governance, and exclusive rights active within Ghana were ill-designed to address the interactions at sea between industrial and small scale vessels. This ineffectiveness was due to the large disparities between the legal and economic regimes, as well as cultural norms, expectations, and incentives of the two sectors. Further, these differences ultimately challenged management approaches and contributed to conflictual interactions. However, while these traditional management approaches were largely unsuccessful at separating the two fleets and governing the interactions between them, this research does not support evidence of a tragedy of the commons or the inevitable digression into violent resource conflict. Instead, while these differences between small-scale and industrial sea tenure do contribute toward conflict, the particularities of the industrial sector in Ghana facilitate cooperation in specific circumstances. Here, cases of cooperation at sea demonstrate that conflict is not the inevitable consequence of certain triggers, but that resource conflict or cooperation are social processes contingent on specific social relations.

The implications of this research for management and policy are substantial. Previous policy prescriptions aimed at governing the intersection of these two fleets have focused on resource intensive monitoring, control, and surveillance (MCS) efforts, spatial and temporal regulations, and increasing enforcement of methods separating the two fleets. However, in refocusing on these conflicts as social phenomena, this research suggests that the best approaches to reducing conflicts at sea would work to reduce the economic and cultural disparities between sectors, rather than separate them entirely. The

institutions that accomplish this work are more frequently cross-scale, decentralized and polycentric, with strong grounding in existing cultural values and norms—in contrast to many state-centric approaches based on top-down enforcement. Furthermore, while many resource management approaches (e.g. co-management, community-based management, private rights) may be well-suited for a single fishing subsector, their demonstrated overlap suggests that even these should be designed with consideration of intersectoral interactions.

The research in this dissertation has provided some of the first empirical evidence about the characteristics, drivers, and consequences of intersectoral fisheries interactions, and situated them in the broader dialogues on resource conflict and competition. It has also taken substantial strides in illuminating the role that these interactions play in small-scale fishing livelihoods and resource management. However, this conjuncture within fisheries remains poorly understood, and much work is needed to understand the complexities of incidents at the interface of divergent social, economic, and technological systems. In particular, three areas of study are especially pressing. First, comparative case studies with diverse systems and actors would enable broader understanding of the generalities and particularities of these interactions. For example, intersectoral incidents and conflicts have been observed in all four oceans, encompassing demersal, reef, and pelagic fisheries, and involving individuals with diverse cultures, politics, and economies. Comparative research is essential in gaining a broader understanding of these incidents as a distinct phenomenon. Second, the research presented here highlighted the direct effects that incidents at sea had on small-scale fishing households through the interactions of vessels, gears, and actors. However, the most frequently alleged means by which industrial fishers imperil small-scale fishers is indirectly mediated through the resource itself; industrial fishers overfish, reducing the overall resource base available to small-scale fishing communities. This hypothesis remains untested, and further work on the role that industrial vessels play in determining local resource availability is an essential next step. Third, the impacts of incidents at sea revealed within this research provided a momentary snapshot. As a cross-sectional study, it was unable to provide deeper insight into the deeper and more lasting effects of experiencing an incident at sea, and longitudinal studies of the consequences would be invaluable. Further, these studies would enable a greater understanding of the vulnerability or resilience of fishing households and communities to the shocks, and lend insight into potential solutions. The work presented here is intended as a starting point for this work, and the ultimate goal is the improvement of a challenge that affects the day to day lives of millions of fishers around the world.

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	9. Research vessel	
Accused's gear / Petitioner's gear	1. Set net 2. Top set net 3. Bottom set net 4. Trawl net 5. Shrimp trawl net 6. Ali-poli-Watsa 7. Drift Gill Net 8. Hook and line	9. Longline 10. Purse seine 11. Pole and line 12. Beach seine 13. Trap 14. Other gear 15. Unknown gear 16. No fishing gear
Number of people on petitioner's vessel	Numerical	
Interaction characteristics		
Field	Variables	Notes
Gear damage	Yes/No	
Vessel damage	Yes/No	
Fatalities	Yes/No OR numerical	Some numbers of fatalities were available for some cases, all others were coded for presence/absence due to uncertainties in the number in some cases
Injuries	Yes/No OR numerical	Some numbers of injuries were available for some cases, all others were coded for presence/absence due to uncertainties in the number in some cases
Pursuit type	1. Paddle 2. Sail 3. Small motor 4. Large motor	Variables are non-exclusive and more than one can be attributed to a given case
Encounter type	1. Cooperation 2. Attempted compensation 3. Compensation 4. Argument 5. Threatening 6. Violence 7. Abduction	Variables are non-exclusive and more than one can be attributed to a given case
Encounter location	1. Far from vessel 2. Vessel side 3. Tethered to vessel 4. On vessel 5. On land	Variables are non-exclusive and more than one can be attributed to a given case
Accused's response	1. Flee 2. Denial 3. Acceptance 4. Cover vessel identification	Variables are non-exclusive and more than one can be attributed to a given case
Notes	Character	All narrative information
Arbitration characteristics		
Field	Variables	Notes
Date settled	mm/dd/yyyy	
Estimated loss	Currency	
Amount compensated	Currency	

Table A-2: Distribution of petitioners' gears from Incident at Sea Database

Gear	Percent petitioners	No. petitioners	Gear class
Set net	37%	211	Passive
APW	29%	162	Both
DGN	19%	113	Passive
Hook & line	5%	29	Active
Trawl net	4%	23	Active
Purse seine	2%	12	Active
Beach seine	2%	11	Active
Other gear	1%	6	Both
Longline	0.3%	2	Passive
Trap	0.1%	1	Passive
Unknown	47%	501	Unknown

Table A-3: Crosstab analysis of accused sector and interaction type, with severity index and average severity score

		Accused sector									
		Artisanal	Industrial	Cargo	Oil	Research	Semi-Industrial	Tug	Unknown fishing	Total	Severity index
Interaction Type	Cooperation	0	59	20	7	1	22	2	2	113	1
	Compensation	2	44	8	4	0	0	2	2	62	2
	Attempted Compensation	0	96	3	0	0	6	0	3	108	3
	Argument	20	492	68	12	0	272	8	12	884	4
	Threatening	30	165	20	0	0	110	0	10	335	5
	Violence	66	222	12	0	0	132	0	0	432	6
	Abduction	7	49	0	0	0	14	0	7	77	7
Average severity		5.208	3.6018	2.729	1.917	1	4.0290	2.4	3.6		

Numbers represent counts of discrete interactions between vessels at sea (n=551), and multiple interactions are observed within individual cases. Shaded cells represent the assigned severity index and average severity of incidents with each accused sector.

Table A-4: Information for data layers included in spatial analysis

Layer	Data type	Data source	Projection	Geographic Coordinate System
EEZ	Polygon shapefile	VLIZ (2014). Maritime Boundaries Geodatabase, version 8. Available online at http://www.marineregions.org/ . Consulted on 2016-05-25.		GCS_WGS_1984
Village locations	Point shapefile	Created- Incident at sea database and Google maps (n=102)		GCS_WGS_1984
Village seaspace polygons	Polygon shapefile	Created- midpoints between villages village locations connected to a polygon buffer layer 50 nm from the coastline		GCS_WGS_1984
Bathymetry	Raster (30-arc second grid cells)	General Bathymetric Chart of the Oceans (GEBCO)		GCS_WGS_1984
30-meter depth contour	Line shapefile	Hen Mpoano project	Mercator	GCS_WGS_1984
Inshore exclusion zone (IEZ)	Polygon shapefile	Created- all area within 6 nm from shore and all area less than 30 m within Ghana's exclusive economic zone (EEZ)		GCS_WGS_1984

Table A-5: Characteristics of the artisanal fishing fleet

Size classification	Vessel length	Propulsion type	Number fishers onboard	Associated gear
Small canoes	4-5 meters	Paddle or sail	1-2	Hook and line, small gillnet, cast nets
Medium canoes	6-11 meters	Paddle, sail, and 8, 25, or 40 hp motors	2-11	Hook and line, set nets, drift gillnets
Large canoes	11-17 meters, 12-19.5 (FS 2004)	40 hp motor	10-25	Ali-poli-watsa, drift gillnet, beach seine

Adapted from (Doysi 1984, Finegold et al. 2010, Bampoe 2011)

Table A-6: Design and use of artisanal gears in Ghana

Class	Ali-Poli-Watsa			Beach seine	DGN	Line	Set net		Trap
Gear	Ali	Poli	Watsa	Beach seine	DGN	Line	Bottom set net	Top set net	Trap
Use	Active gears used to surround schools of fish and characterized by a purse line at the bottom which aids in closing the net			Active gear used to surround schools, set by a boat and pulled from shore	Passive nets that catch or entangle fish in mesh	Active gears using baited hooks at the end of line	Passive nets that catch or entangle fish in mesh	Passive that catch or entangle fish in mesh	Passive gears comprised of wood, netting, bamboo, palm, and metal
Design	drift gill net design, sometimes used as purse seine	purse seine	purse seine	seine	large mesh drift gillnet	Hook and line	Bottom-anchored gillnet	Surface or mid-water gillnet	Various designs
Target catch	round sardine, short sardine	anchovy, sardine, grunt	sardine, anchovy, chub mackerel	grunt, threadfin, anchovy, sardine, ilisha, scad	shark, manta, tuna, sailfish, swordfish	bream, grouper, dentex, shad, pandora, etc.	croakers, sole, bream, lobster, rays, snapper, croaker, jacks	threadfin, grunts, clupeoids,	shrimp, crab
Specs	450–650 m in length and 30–50 m in depth, 25-50mm mesh	450–540 m long and 35–45 m deep, 30m depth, 13-50mm mesh	400–500 m long and 35–50 m deep, 40m depth, 50mm mesh	Sm-150 m long and 6 m deep, Med-280 m long and 19 m deep, Lg-1,800 m long and 18–22 m deep	100–450 m long and 15–20 m deep	May be used singly or in large numbers. Traditional in Ghana.	180–350 m long and 2-3 m deep, 10-50m depth		
Types					Anifa-nifa	Hand line, trolling line, longline	tanga		
Capacity	10-12 fishermen	12-15 men	8-12 men	80 men	4-6 fishermen		2-4 fishermen		

Adapted from (Doyi 1984, Finegold et al. 2010, Bampoe 2011)

Table A-7: Binomial test of proportions for artisanal gears from incidents and fleet

Gear	Sample probability from incident cases	True probability from fleet composition	P value
Ali-poli-watsa	0.3111945	0.4295485	p-value = 2.603e-08
Beach seine	0.02087287	0.09004295	p-value = 1.283e-10
Set net	0.4003795	0.2972583	p-value = 5.014e-07
Line	0.05502846	0.1033388	p-value = 0. 0.0001044
Drift gillnet	0.2125237	0.05974588	p-value < 2.2e-16

Table A-8: Distribution of accused's sector from Incident at Sea Database

Sector	No. cases	Percent cases with data*
Industrial fishing vessel	440	43%
Semi-Industrial fishing vessel	353	35%
Cargo vessel	141	14%
Unknown fishing vessel	22	2%
Oil vessel	21	2%
Artisanal fishing vessel	18	2%
Tugboat	11	1%
Research	4	0.4%
Government vessels	3	0.3%
*85 cases (8% of all cases) had no information regarding accused's subsector		

Table A-9: Distribution of accused's gears from Incident at Sea Database

Gear	Percent cases with data	Number of cases	Gear class
Trawl net	53%	523	Active
Unknown	20%	192	Unknown
No fishing gear	19%	183	None
Purse seine	5%	47	Active
Hook and line	3%	27	Active
APW	0.2%	2	Both
DGN	0.2%	2	Passive
Longline	0.1%	1	Passive
Other	0.1%	1	Unknown
*85 cases (8% of all cases) had no information regarding accused's subsector			

Table A-10: Encounter and Interaction types and characteristics

Field	Variables	Notes
Gear damage	Yes/No account	
Vessel damage	Yes/No account	
Fatalities	Yes/No account	Although number of fatalities was available for some cases, we coded for presence/absence due to uncertainties in the number in some cases
Injuries	Yes/No account	Although number of injuries was available for some cases, we coded for presence/absence due to uncertainties in the number in some cases
Pursuit type	5. Paddle 6. Sail 7. Small motor 8. Large motor	Variables are non-exclusive and more than one can be attributed to a given case
Interaction type	8. Cooperation 9. Attempted compensation 10. Compensation 11. Argument 12. Threatening 13. Violence 14. Abduction	Variables are non-exclusive and more than one can be attributed to a given case
Interaction location	6. Far from vessel 7. Vessel side 8. Tethered to vessel 9. On vessel 10. On land	Variables are non-exclusive and more than one can be attributed to a given case
Accused's response	5. Flee 6. Denial 7. Acceptance 8. Cover vessel identification	Variables are non-exclusive and more than one can be attributed to a given case
Arbitration characteristics		
Field	Variables	Notes
Date settled	mm/dd/yyyy	
Estimated loss	Currency	
Amount compensated	Currency	

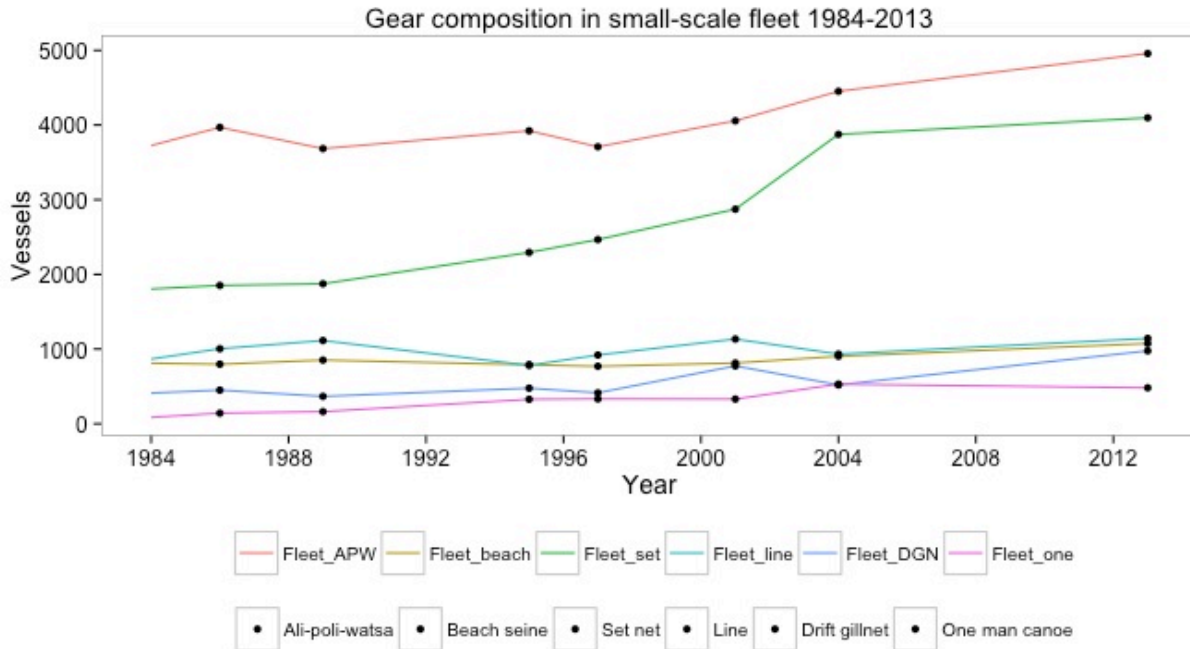


Figure A-1: Gear composition in the small -scale fleet, showing frame survey years and interpolation

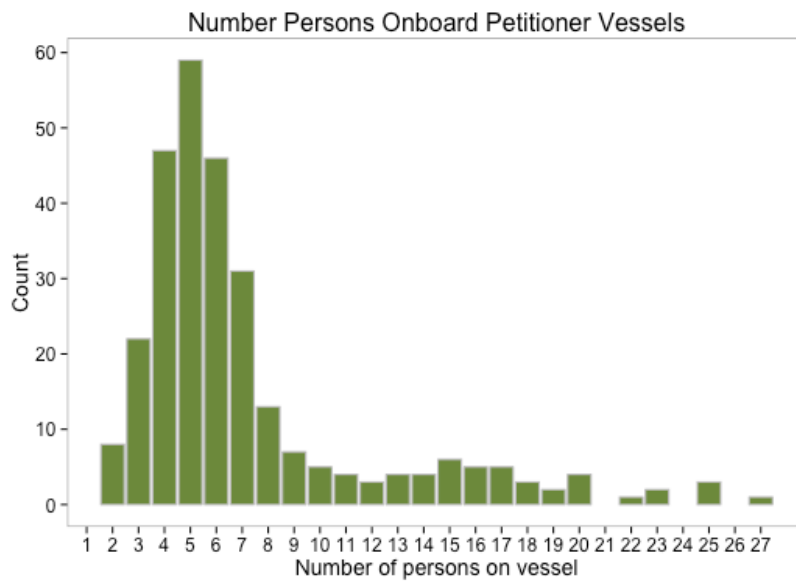


Figure 0-1: Histogram of incidents representing count of persons onboard the petitioner's vessel

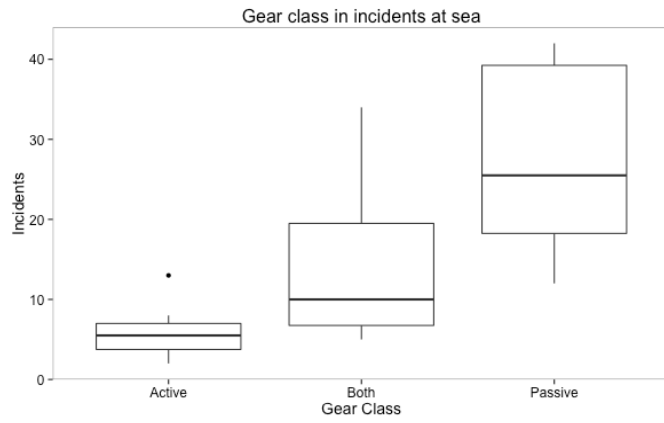


Figure 0-1: Generalized mixed model of gear class and incident prevalence

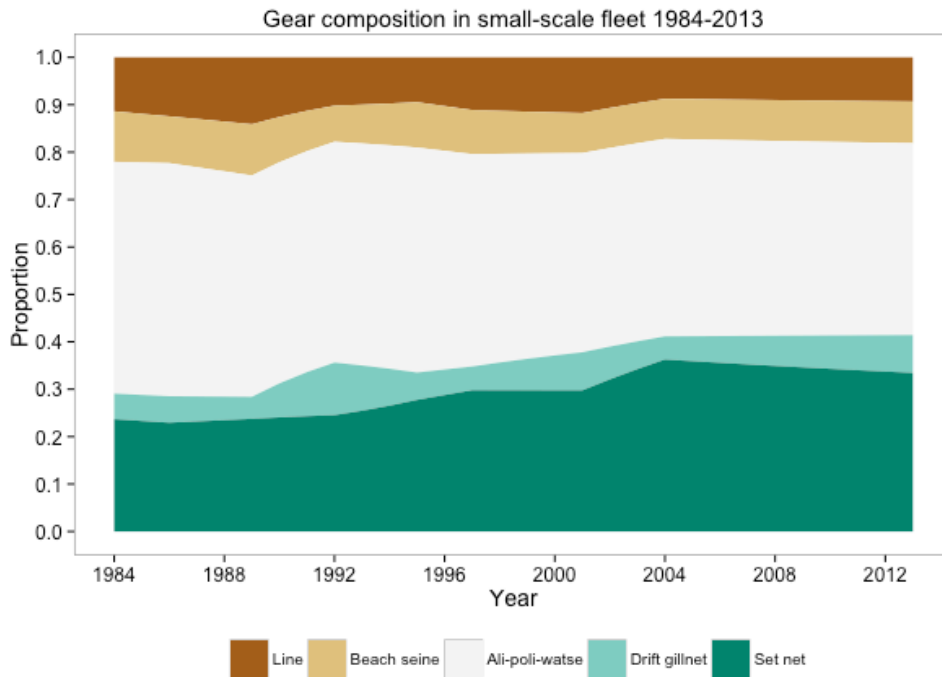


Figure 0-2: Proportion of individual gears in the small-scale fleet over time. Green scale gears are passive, brown scale gears are active, white indicate both passive and active

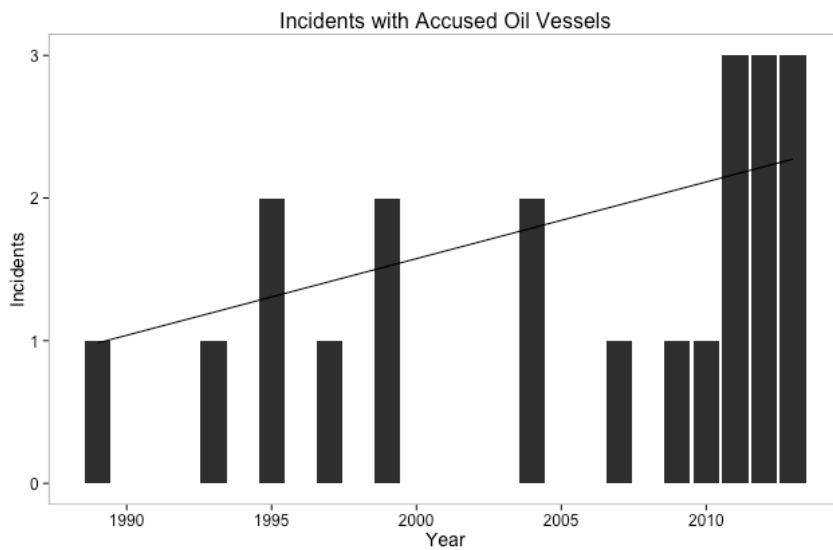


Figure 0-1: Incidents with accused oil vessels 1984-2013

B Appendix

Table B-1: Sample scheme for household surveys

	Village or town name	Region	Boat owner surveys	Fisher surveys	Female head of house surveys	Dates
1.	Aboadze	Western	17	27	41	Dec 2014-Jan 2015
2.	Abuesi	Western	14	20	32	Nov 2014
3.	Accra area	Greater Accra	15	40	36	Nov 2014- Jan 2015
4.	Adjoa	Western	16	26	28	Feb 2015
5.	Axim	Western	17	29	30	Feb 2015
6.	Cape Coast	Central	12	22	27	Feb-Mar 2015
7.	Dixcove	Western	14	26	25	Feb 2015
8.	Elmina	Central	6	23	21	Mar 2015
9.	Funko	Western	12	33	30	Feb 2015
10.	Kommenda	Central	15	22	26	Mar 2015
11.	Kpone	Greater Accra	13	40	31	Feb-Mar 2015
12.	Moree	Central	7	33	24	Jun 2015
13.	Ningo	Greater Accra	5	20	19	Apr 2015
14.	Prampram	Greater Accra	6	20	20	May 2015
15.	Sekondi	Western	18	29	39	Jan 2015
16.	Shama	Western	11	17	25	Nov 2014
17.	Takoradi	Western	20	24	42	Jan 2015
18.	Tema	Greater Accra	13	43	27	Nov 2014
19.	Teshie	Greater Accra	11	34	29	Jan-Feb 2015

Table B-2: Pairwise comparison of respondents' observations of decreased income between disturbance types within a logistic regression using Tukey's HSD (honest significant difference) test

	Estimate	Std. Error	z value	p-value
CLOS - AAS	-3.7883	1.1269	-3.362	0.00585
LOST - AAS	-1.7089	0.5456	-3.132	0.01282
OTH - AAS	-1.9966	1.4503	-1.377	0.61449
STL - AAS	-0.7438	0.8638	-0.861	0.90028
LOST - CLOS	2.0794	1.1667	1.782	0.35473
OTH - CLOS	1.7918	1.7795	1.007	0.83618
STL - CLOS	3.0445	1.3452	2.263	0.13967
OTH - LOST	-0.2877	1.4814	-0.194	0.99963
STL - LOST	0.9651	0.915	1.055	0.81158

Table B-3: Descriptive statistics comparing respondents' perceptions of the impact that different disturbance types had on household income, expenditures, and remittances received.

Fishing disturbance	Income decreased	Spent less money on basic goods & services	Remittances increased	Total households that experienced disturbance
AAS	75% (n=71)	24% (n=23)	6% (n=6)	92
LOST	45% (n=10)	14% (n=3)	0	22
STOLEN	66% (n=6)	11% (n=1)	0	9
CLOS	14% (n=1)	0	0	7
OTH	33% (n=1)	0	0	3

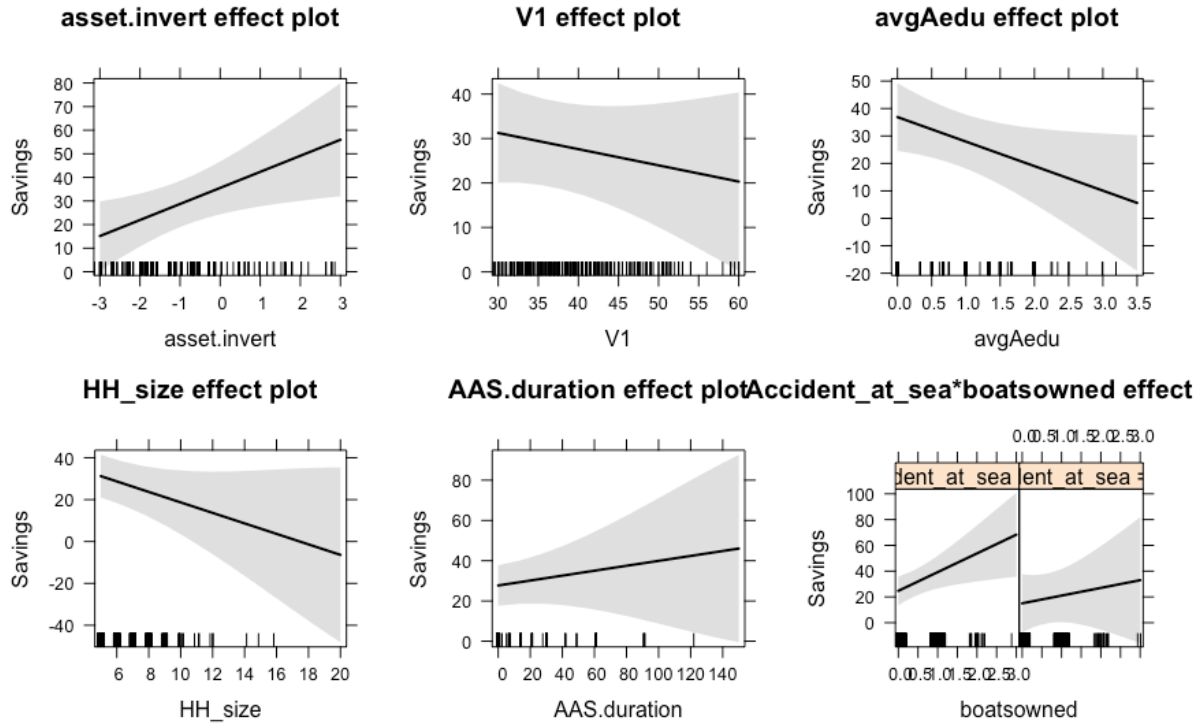


Figure B-1: Comparison of individual explanatory variables with the linear mixed effects model with household expenditures as outcome

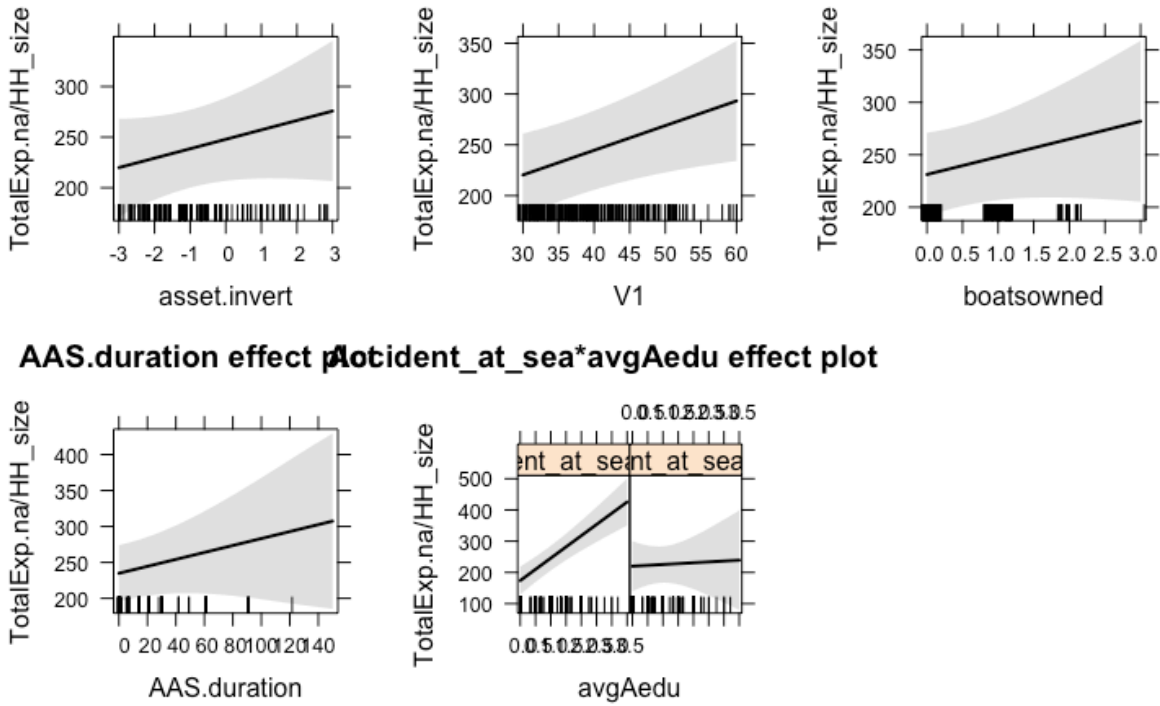


Figure B-2: Comparison of individual explanatory variables with the linear mixed effects model with household savings as outcome

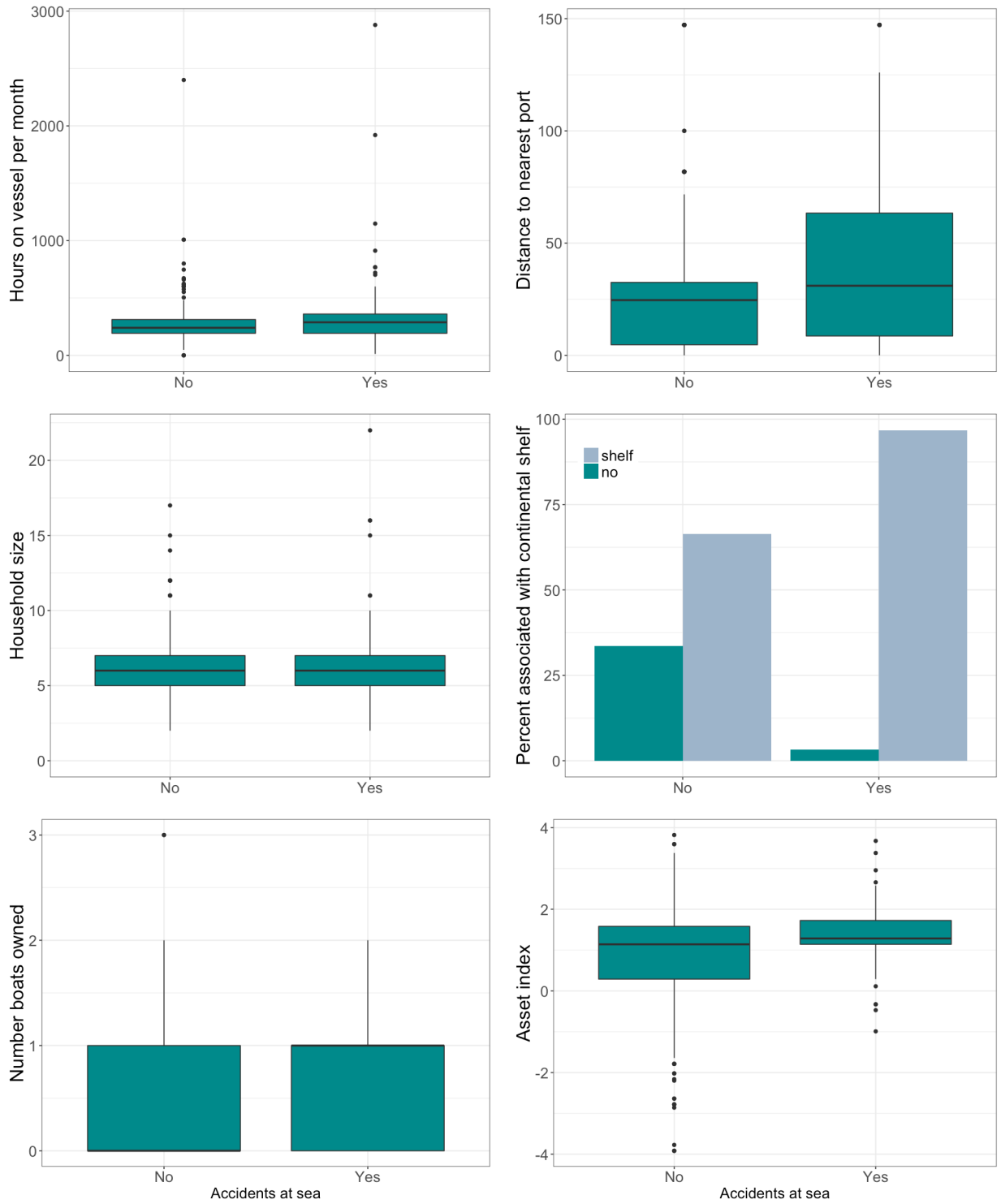


Figure B-3: Comparison of households that experienced an incident at sea to those that did not, along individual multinomial logistic regression variables