SOCIAL SHOCKS IN SOCIAL-ECOLOGICAL SYSTEMS: THE IMPACTS OF SEA CUCUMBER BOOMS FOR COASTAL COMMUNITIES IN MEXICO

by

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B.A., The University of Victoria, 2013

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Resources, Environment and Sustainability)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

November 2016

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Abstract

In a world of growing interconnectivity, global scale social processes drive local-level change at ever-faster rates, shaping the challenges and opportunities faced by communities. Yet, literature on vulnerability and adaptation within social-ecological systems (SES) scholarship has largely centred on climate change and associated biophysical stressors. Key theoretical shortcomings are twofold. First, in SES scholarship, there has been limited engagement with non-climate anthropogenic drivers of change and characterization of how other social drivers impact communities and the larger social-ecological system in which communities are nested. Second, there has been less consideration of the differing timescales of change, resulting in a scholarship that is under-theorized in terms of how communities experience and respond to shocks (e.g., hurricanes, volatility in international markets, military coups) versus trends (e.g., rising ocean temperatures, urbanization).

This thesis seeks to address these shortcomings by exploring the impacts of socially driven shocks in a coastal community, including implications for vulnerability and adaptation. Specifically, through a qualitative case study of a fishing community on Mexico’s Yucatán Peninsula, I investigate how a rapidly developed sea cucumber fishery, triggered by rising demand from international seafood markets, drives dramatic change in the social structure, functioning and feedbacks within the community. I demonstrate how the emergence of sea cucumber fishing has driven novel and rapid change in the community, introducing new stressors such as poaching and violent conflict, while exacerbating pressures from ongoing trends of population increase and overfishing of other commercially valuable species. Results suggest that
this spike in pressure on the social system has impacted vulnerability and challenged the capacity of local institutions to respond adaptively. This includes a decreased capacity to manage local resources and increased risks to livelihoods for fishers. By attending to social drivers of rapid change in coastal SES, this research contributes to scholarship on multiple stressors and their contributions to local vulnerability. Finally, by focusing on the impacts of change on the structure, functions and feedbacks of social systems, I provide a framework that aligns with existing SES thinking and language while creating space for a more robust engagement with the social dimensions of these linked systems.
Preface

The overall design of the research and research instruments, along with data analysis and the writing of the thesis itself was done by me with continuous direction and feedback from co-supervisors Nathan Bennett and Terre Satterfield. I collected the interview data with the help of a research assistant who also assisted with translation of the interview schedule. Chapter two was written as a stand-alone manuscript to be submitted for review and publication as an article co-authored by Drs. Nathan Bennett and Terre Satterfield. However, at the time of defence it had not yet been submitted for review.

The fieldwork conducted for this thesis was approved by UBC’s Behavioural Research Ethics Board with ethics certificate #H14-02357.
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Acknowledgements

The research presented in this thesis would not have been possible without the significant contributions of time and support from my mentors, colleagues, friends, and family. I would first like to express sincere appreciation to my thesis advisors Drs. Terre Satterfield and Nathan Bennett for the tremendous amount of thoughtful mentorship and practical support they have provided over the past two years. I feel incredibly fortunate to have had their continued guidance and encouragement. I am thankful as well to Dr. Grant Murray for serving as my third committee member.

I am thankful to Dr. Julia Fraga of CINVESTAV, Merida, for the many forms of support she offered throughout my experience in Mexico. I have been lucky to benefit from her many years of experience conducting ethnographic research on the Yucatán Peninsula and her generous guidance as I endeavored to better understand the community of Rio Lagartos. My gratitude is owed for the time, effort, and dedication of Victor Rejon Cruz, who worked thoughtfully and diligently as my research assistant throughout the fieldwork. I would like to thank the people of Rio Lagartos who so kindly shared with me their time, thoughts, experiences, and friendship. I would also like to acknowledge financial contributions by the Social Science & Humanities Research Council as well as Mitacs that made it possible to conduct the research presented in this thesis.

Thanks to my Father, stepmother, grandmother, and siblings for their ongoing love and support throughout this process.
Finally, I am deeply grateful to Barry Warren for over two years of the most patient ear, rejuvenating humour, and endless encouragement that a graduate student could ask for.
To my father, Mark, whose years of painstaking editorial effort gave me the tools to write this thesis, and to my mother, Margaret, who I know would have been so pleased to read it.
Chapter 1: Introduction

1.1 Situating the Research

1.1.1 Confronting Change in Coastal Communities

For coastal communities exposed to and engaged in the dynamics of both marine and terrestrial systems, the impacts of modern social and environmental change are particularly glaring (Bennett et al., 2015). Coastal zones face some of the greatest biophysical impacts of climate change, including myriad consequences of rising sea levels (e.g., coastal erosion and sea water inundation) and increased variability of storms, drought, and other extreme weather events (Bunce et al., 2010). A combination of stressors such as ocean acidification and unsustainable global fishing practices has meant that coastal communities increasingly confront challenges related to declining marine ecosystems, from decreased livelihood sustainability to food insecurity (Bennett et al., 2016). Such processes also impact intangible but important aspects of community life including identity, cultural values, and practices (Satterfield et al., 2013). For many smaller and more remote coastal communities, declines in coastal and marine livelihoods are resulting in aging populations, as younger generations leave to pursue employment and education opportunities in urban centers (Ommer, 2007). Conversely, more populated coastal zones are often sites of demographic, economic, and land-use change, driven by processes such as tourism development and urbanization (Bunce et al., 2010).

In small-scale fishing communities, participation in international seafood markets has been a significant source of opportunity and risk, with increasing vulnerability to global market fluctuations (Marshke & Berkes, 2006; Berkes et al., 2006; Christensen, 2011). With the
accelerated mobility of information, technology, labour, and capital, the speed of exploitation for internationally valuable marine species is unprecedented (Adger et al., 2009; Berkes et al., 2006; Eriksson et al., 2015b). This new rate of change can have unexpected consequences at the community level, with Bennett (2016a) noting that “as the globalization of seafood trade has become increasingly footloose and efficient, new pressures to harvest resources can manifest in local fishing communities so rapidly that governance institutions may not have time to adapt” (p.2). In the case of several invertebrate species, such processes increasingly result in fishery booms, where rising values in international markets trigger the rapid development or intensification of fisheries at local scales (Anderson et al., 2010, Eriksson, 2015b). Similar to terrestrial resource booms, rapid-onset fisheries can drive immediate change in local communities and the ecosystems on which they depend. This thesis characterizes the accelerated expansion of global sea cucumber fisheries as a particularly salient example of modern cross-scale social-ecological change and explores implications for vulnerability and adaptation in coastal communities.

1.1.2 Rapid Globalization of Sea Cucumber Fisheries

Sea cucumbers are slow-moving, tubular-shaped invertebrates that inhabit ocean floors worldwide (Eriksson et al., 2015b). Long valued as a delicacy within traditional Chinese cuisine, small-scale harvest and trade of sea cucumber, predominantly in the form of ‘beche de mer’, or ‘trepang’ (the dried sea cucumber body wall) have occurred amongst communities in the Indo-Pacific region for at least several hundred years (Anderson et al., 2010; Eriksson & Clarke, 2015). With a growing population of middle and high-income consumers, increased affluence in China particularly has led to growing demand for sea cucumber in international markets
(Anderson et al., 2010; Eriksson & Clarke, 2015). As a result, the sea cucumber has become a high-end global commodity, with top-valued species selling for over $1500 USD per (dried) kg in Hong Kong (Purcell et al., 2014). Soaring market demand has spurred sea cucumber fishery booms across the globe as fishers, importers and middlemen rush to profit from the ‘gold of the sea’ (Metado, 2015). Over the previous three decades, Hong Kong’s sourcing network for sea cucumber has expanded dramatically, and now includes countries spanning the majority of the world’s tropical coastlines (Eriksson et al., 2015b).

There are substantial differences between the social-ecological contexts of sea cucumber fisheries in the temperate oceans of the global north and those of the tropical south. Temperate northern fisheries tend to be single-species and industrialized, characterized by large vessels fishing in deep water. With high capital investment, operating costs, and exploitation capacity, fisheries in the global north are often managed through exclusive-access licenses. Conversely, tropical fisheries are primarily multi-species, small-scale, and near shore, with wading or diving (skin, compressor, or scuba) occurring in coral reefs, tropical lagoons, and inshore seagrass beds. These fisheries are typically open-access and characterized by minimal monitoring, management, and enforcement capacity (Purcell, 2010).

While both temperate and tropical fisheries face challenges regarding the sustainable management of sea cucumber stocks, it has proven particularly difficult to prevent resource depletion in tropical fisheries (Purcell, 2010; Eriksson et al., 2015a; Anderson et al., 2010). Purcell (2010), Anderson et al. (2010) and others suggest that this is the result of a combination of factors including the significant economic incentives for exploitation, the relative ease of
harvest compared to other species, low population replenishment, and limited governance and management capacities in areas where many fisheries are located (Purcell et al., 2014). Eriksson and Clarke (2015) note that these limitations are also “coupled with the dire economic circumstances that confront fishers in the tropics, which cause them to respond to declines in ways that expand and reinforce unsustainable rates of harvest” (p.170). Such management challenges are further exacerbated by limited scientific knowledge in terms of taxonomy, biology and ecology of commercially fished sea cucumber species (Friedman et al., 2011).

Hence, while global catch of sea cucumber has increased through the development of new sea cucumber fisheries, Anderson et al. (2010) and Eriksson et al. (2015b) have shown that the catch of many individual sea cucumber fisheries have followed boom-bust-ban patterns. Research by Anderson (2010) on the expansion of global sea cucumber fisheries showed that since the 1950’s the catch of many individual fisheries has been declining almost as quickly as it expands. The global impact of such serial depletion of sea cucumber stocks can be seen on the IUCN’s redlist, where seven species are listed as endangered, and nine as vulnerable (Purcell et al., 2014). In a 2010 FAO report Purcell notes that “the collapse of breeding stocks has led to recent moratoria (fishing bans) being placed in fisheries of Costa Rica, mainland Ecuador, India, Mayotte (France), Panama, Papua New Guinea, Solomon Islands, mainland Tanzania, Tonga, Vanuatu and Venezuela” (p.1).

Social consequences of the expanding global sea cucumber fishery have sparked concern and are as novel as their ecological counterparts. While social and cultural dimensions have been given limited attention in the growing body of research on sea cucumber fisheries, case studies
examining management challenges and the ecological implications of over-harvesting (Purcell et al., 2014; Eriksson et al., 2015a; Berkes et al., 2006) frequently reference social discord in communities experiencing sea cucumber booms. Sea cucumber booms increasingly occur in communities that did not harvest the species historically (Anderson et al., 2010), and research giving specific consideration to the social dimensions of these fisheries reveals trends of social conflict reflective of terrestrial resource booms (Bremner & Perez, 2002; Christensen, 2011). Case studies of the now infamous ‘sea cucumber war’ in the Galapagos Islands in the 1990’s demonstrate how uncontrolled fishery expansion, where growing numbers of fishers used credit to acquire an increasing number of boats, resulting in rapid overharvesting, and led to conflicts amongst fisher groups, and violent protests against conservation efforts by regulators (Celata et al., 2012; Eriksson et al., 2015a). Recently, sea cucumber fisheries have also received increased attention for the extreme health risks associated with diving practices (Eriksson et al., 2012). Risks that can accompany dive fisheries such as illness, disability, and death from decompression sickness are described as particularly problematic in sea cucumber fisheries, where high profits incentivize many fishers to dive for longer time periods and at greater depths than is physically safe (Eriksson et al., 2012).

Rapid-onset sea cucumber fisheries thus represent an important but understudied social mechanism of change in coastal communities, with heretofore-limited research into community-level impacts and responses. In boom fisheries, elucidating these dynamics requires engagement with both social and ecological dimensions of the communities in question. To this end, the following section presents a review of the literature that applies here, particularly that on understanding change in linked human-environmental systems.
1.2 Theoretical Context: Frameworks for Understanding Linked Human and Environmental Change

1.2.1 Social-ecological Vulnerability, Resilience & Adaptation

Social-ecological systems frameworks aim to provide a coherent lens through which to examine the complex dynamics of human and environmental relations in a given space (Turner et al., 2003). Conceiving of humans and the natural environment as interdependently coupled, social-ecological systems (SES) thinking is employed in scholarship and practice across a growing number of fields ranging from resource management, community development, and disaster planning to environmental psychology, political ecology, and beyond (Folke et al., 2010, Ommer et al., 2012). ‘Resilience’, ‘vulnerability’ and ‘adaptation’ make up three of the dominant theoretical frameworks through which research has examined how complex social-ecological systems experience and respond to change (Jansson & Ostrom, 2006). While emerging from various intellectual traditions, the literatures on resilience, vulnerability and adaptation share a broad interest in the ways in which SES respond to different shocks and stresses, including their capacity to adapt (Adger, 2006).

The resilience of a system is considered to be a function of its ability to persist through fluctuations of pressure or stress (Folke, 2006). Resilience thinking in the environmental sciences was first applied to the dynamics of ecological systems through the contributions of CS Holling (1973), representing a dramatic departure from conventional notions of stable, single-state ecosystems (Folke, 2006; Armitage et al., 2012). Though the initial development of resilience
theory focused on ecological systems alone (Lorenz, 2010), it was later applied to social-ecological systems in work by Berkes & Folke (1998), Walker et al. (2002), Carpenter et al. (2005), Ollson et al., (2004) and Janssen & Ostrom (2006). Extending theory on ecological resilience, a broadly accepted conception of a resilient SES is “one with the capacity to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks” (Walker et al., 2004 p.2). SES resilience has similarly been characterized as the amount of disturbance that can be absorbed before a critical threshold is crossed where the system shifts into an alternate, potentially undesirable state (Turner et al., 2003; Blythe, 2014). Investigation of such critical thresholds has thus become a substantial component of SES scholarship, including work on regime shifts (Nayak et al., 2015; Scheffeld & Carpenter, 2003), critical transitions (Scheffer, 2009), and tipping points (Renaud et al., 2013), all seeking to better understand and characterize points of substantial, long-term and possibly irreversible system change.

With roots in scholarship on hazards and risks as well as psychology, ‘vulnerability’ has generally referred to the degree to which a system, subsystem, or system component is susceptible to harm (Turner et al., 2003). In its application within SES thinking, vulnerability is typically considered to be the “the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt” (Adger, 2006 p.268) with key parameters being “the stress to which a system is exposed, its sensitivity, and its adaptive capacity” (Adger, 2006 p.270).
In these literatures, ‘adaptive capacity’ refers to the latent characteristics or attributes of a given system that enable it to respond adaptively in the face of stress, threats or perturbations (Engle, 2011; Smit & Wandel, 2006; Birk, 2014). Thus, adaptation, the way(s) a system reacts to change or stress either by preparing in advance or else by adjusting and responding to their effects (Engle, 2011; Adger, 2006) is a component of both resilience and vulnerability concepts. These concepts have been used to understand the ways in which social-ecological systems are susceptible to and respond in the face of different forms of stress. While much of the research in this area has examined the characteristics of individual stressors, or ranked the relative significance of stressors for a given system, recent studies have sought to understand how multiple stressors interact to influence local vulnerability contexts (McCubbin et al., 2015).

1.2.2 Vulnerability and Adaptation in the Face of Multiple Stressors

The external pressures to which SES are exposed are rarely driven from single sources alone (Bennett et al., 2016). Rather, multiple drivers of change interact at different spatial and temporal scales to influence vulnerability at the local level (Bennett et al., 2016; O’Brien & Licheinko, 2000; Bunce et al., 2010, McCubbin et al., 2015). Within SES scholarship, investigation of such drivers, also termed exposures (O’Brien & Licheinko, 2000), stressors (Turner et al., 2003), or trends (Bennett et al., 2016) has been heavily motivated by concerns for current and impending impacts of climate change (Smit & Wandel, 2006; Bennett et al., 2016; McCubbin et al., 2015). This research has examined the ways that impacts from climate change will interact with other forms of stress, such as disease epidemiology (Reid & Vogel, 2006) livelihood risks (Belliveua et al., 2006), or resource management policies (Bunce et al., 2010) to influence vulnerability in a given context. Theorizing how change at higher scales can manifest at local levels, Bennett et al.,
(2016) note that local impacts can be direct or interactive, explaining “interactive impacts result from interactions between drivers at higher scales, cascading effects of direct impacts from exposures, autonomous feedbacks between and among social and ecological components, and the feedbacks of adaptive responses to direct impacts” (p.3). In this way, complex and often difficult-to-see interactions between drivers -i.e. external forces of change and feedbacks -i.e. responses within the system- occur across scales and influence social-ecological vulnerability at the community level (O’Brien et al., 2009).

While providing growing insights on resilience, vulnerability, and adaptation in the face of multiple stressors, there are two key areas where literature on vulnerability could benefit from further theoretical development. First, research on social-ecological change continues to emphasize the role of biophysical stressors over socio-economic ones (Cote & Nightengale, 2012). The result of this, Armitage (2012) notes, is that “slow and fast ecological variables that shape social-ecological systems are better understood than their social counterparts” (p.8). In SES vulnerability scholarship, the focus on climate change and associated biophysical impacts provides only a partial appreciation of the factors influencing community vulnerability. This is particularly limiting for our understanding of coastal communities, where broad social processes forces like globalization, technological development, and neoliberalization play an ever-greater role in shaping local dynamics (Breslow, 2015; Hicks et al., 2016; Adger et al., 2009). Recently, however, there has been increased consideration of coastal communities in the multiple stressors literatures (e.g., Blythe et al., 2014; Bunce et al., 2010; McCubbin et al., 2015; Bennett et al., 2014; Schwartz et al., 2011; Birk, 2014) and work by Breslow (2015) and Hicks et al. (2016),
has called for greater attention to ways that contemporary social processes drive change in human and ecological elements of local coastal SES.

Second, there has been limited consideration of the differing timescales of various drivers of change. As globalization and technology produce growing interconnectedness between SESs at greater geographic distances, cross-scale change is driven at ever-faster speeds (Berkes et al., 2006). Thus, social and ecological processes at global scales increasingly emerge as ‘shocks’ for local systems, driving rapid and often surprising forms of change, distinct from and yet interacting with the impacts of slower ongoing trends. However, in focusing on vulnerability in the context of climate change, SES scholarship often assumes slow variables, seldom differentiating between faster and slower forms of change in regards to drivers or impacts (Armitage & Johnson, 2006). Much of the case-study research on multiple stressors investigates relatively gradual changes over time, for example, stressors such as increased drought, or land-use and livelihood changes that emerge over multiple decades (Birk, 2014). As a result, there has been little empirical work in this scholarship demonstrating how the timescales of stressors relate to community vulnerability.

Given the importance of temporal characteristics (rate of onset, duration, and frequency) in research on hazards and risk (Tobin & Montz, 1997), the lack of distinction between fast and slow drivers in scholarship on community vulnerability is striking. It further contrasts with theory on resilience in SES, where rapid, dramatic, and unforeseen spikes in system pressure
(shocks or perturbations) are typically differentiated from gradual and anticipated forms of change (stressors or trends) (Carpenter et al., 2012; Turner et al., 2003). It has long been intuitive that rapid and intense changes are more difficult for humans to cope with, and more likely to result in maladaptive outcomes (think, for example, of the lottery winners that find themselves in financial ruin a short time after receiving their fortune). Differentiating between fast and slow drivers of change is likely key to improved understanding of the dynamics of social systems in particular, where the timescales of change have differing implications for the ability of individuals, groups (Adger, 2012) and institutions (Berkes et al., 2006) to adapt to change.

In summary, this review has identified two shortcomings: 1) there has been a limited engagement with social drivers of change in SES research on vulnerability and adaptation to multiple stressors, and 2) the implications of faster versus slower forms of change are under-theorized in SES, vulnerability and adaptation research.

1.3 Research Objectives and Questions

In consideration of the above research shortcomings, this thesis has two broad objectives:

1. To empirically investigate the consequences of a rapid anthropogenic change for a local SES, and

2. To explore implications of these changes for social system vulnerability, adaptation, and adaptive capacity.

1 Again, nomenclature varies, with hazards referred to as either chronic or acute among risk scholars
Toward these ends, the research presented here investigates the local-level impacts of rapidly developed sea cucumber fishery through a qualitative case study of Rio Lagartos, a fishing town on Mexico’s Yucatán Peninsula.

Specifically, I examine the following questions:

1. What local social-ecological changes are associated with the rapid emergence of the sea cucumber fishery?
2. How are impacts from the sea cucumber fishery distinct from and how do they interact with slower ongoing trends? and;
3. How are these processes affecting aspects of social system vulnerability, including adaptive response?

By answering these questions, this research endeavours to improve our understanding of how coastal communities experience and respond to shocks in the context of ongoing social-ecological change. Specifically, I provide insights regarding the impact that boom fisheries can have on social system vulnerability, adaptation and adaptive capacity.

1.4 Context of the Study

1.4.1 Research Site

Rio Lagartos is a small fishing town located on the northeastern coast of Mexico’s Yucatán Peninsula. Together, the town of Rio Lagartos (pop~2000) and the neighbouring town of Las Coloradas (pop ~1000) make up the municipality of Rio Lagartos. Situated within the buffer zone of the Ría Lagartos Biosphere Reserve (RLBR), the local geography encompasses a
diversity of landscapes and ecosystems from wetlands, mangroves, estuaries, and marshes, to savannah, grasslands, coastal dunes, lagoons and multiple classifications of forest (UNESCO). Currently, 6,916 permanent residents live in the buffer zone of the RLBR, spread across Río Lagartos, Las Colorados, San Felipe, and El Cuyo. The area first came under protection as a Fauna refuge in 1979 for the protection of the rose flamingo populations that use it as wintering habitat and was designated as a Biosphere Reserve in 1999 (Fraga, 2006). The dominant livelihood in Río Lagartos is small-scale fishing, with secondary socio-economic activities including tourism, salt production, cattle ranching, and agriculture (Fraga, 2006). Fishers harvest octopus, spiny lobster, red grouper, snapper, and in the last several years, sea cucumber, as the main commercial species (Pedroza & Salas, 2011; Bennett, 2016a). Local mangrove estuary ecosystems provide habitat for juvenile fishes and crustaceans, which locals harvest for both household subsistence and commercial use.

During the first few decades of commercial fishing in Yucatán, the vast majority took place within cooperatives. From the 1940’s through the 1970’s, the state fishing sector developed slowly, with plentiful catch volumes that required travelling only few nautical miles (Pedroza & Salas, 2011). The 1980’s were a time of drastic transition in the fishing sector in Yucatán, characterized by deregulation, privatization and the dramatic expansion of fishing capacity. Pedroza & Salas (2011) note that several events and processes contributed to this, including the adoption of an exclusive economic zone (EEZ), the establishment of BANAPESCA, a state fisheries bank and other government programs to support sector growth, as well as new incentives in the international markets. The sector grew rapidly, with increases in fishers, intermediaries, infrastructure, and production (Pedroza & Salas, 2011).
The incursion of new participants brought increased demand among merchants and competition among fishers, to the detriment of fishing resources. Compounding these problems, the institutional arrangements reduced the capacity of managers to deal with an increase in fishing pressure" (p.44).

The result of increasing capacity and deregulation, fishing pressure continued to climb steadily and by the early 2000’s, four out of five of the main commercial species had peaked and were on decline (Pedroza & Salas, 2011). Further, the liberalization of state fisheries was accompanied by a decrease in support for cooperatives, leading to dramatic changes in the ratio of independent to cooperative fishers in Yucatán (Bennett, 2016a). For example, Bennett (2016a) notes that in the community of Celestún, cooperatives now represent only 2% of total fishermen, with the rest participating in patron-client relationships where independent permit holders (patrons) purchase fish privately from individual fishers. By comparison the transition from cooperative to independent modes of fishing has been much more gradual in Río Lagartos, where two main cooperatives, established when commercial fishing began, continue to account for around half of fishers (Bennett, 2016a).

1.4.2 Emergence of Sea Cucumber Fishing on the Yucatán Peninsula

Commercial sea cucumber fishing in Mexico began with the arrival of Chinese buyers to Baja California in the late 1980’s (Toral-Granda, 2008) whereas Mexico’s southeast coast was introduced to the global sea cucumber industry much more recently. Foreign buyers of sea cucumber first arrived to Yucatán’s two main fishing ports of Progresso & Celestún in the early 2000’s, and the National Fisheries Commission, CONAPESCA, began issuing permits for short
seasonal openings for two species of sea cucumber (Isostichopus badconotus and Holuthuria floridana) in 2010 (Bennett, 2016a). With the growth of Yucatán’s commercial fishing industry over the 80’s and 90’s, and then subsequent declines in key commercial species, the lucrative nature of sea cucumber harvesting represented a significant economic opportunity for fishers in the region (Bennett, 2016a; Pedoza & Salas, 2011). Indeed, the first years of sea cucumber fishing in Yucatán were characterized by huge economic profits for participating fishers. Newspapers reported a ‘gold fever’ spreading across the coast as fishers rushed to harvest as much product as they could (Hugo Michel, 2013).

In Río Lagartos, cooperatives and independent fishers received their first commercial sea cucumber permits in the spring of 2013 (Bennett, 2016a). While federal regulations for sea cucumber harvesting include limited access permits, quotas, and closed seasons, Bennett (2016a) suggests that “the limited presence of State authorities in fishing communities has meant that local fishing institutions are the primary moderating force of market pressures”, implementing their own 'de-facto' management of local fisheries. She notes that in communities such as Celestún, this process has led to what are essentially ‘open-access’ fishing regimes whereas in Río Lagartos, local cooperatives have taken efforts to monitor fishing activity and enforce formal regulations.

1.5 Research Approach and Methodology

1.5.1 Qualitative Case Study

This research employs a single case study approach using multiple qualitative methods and supported by reviews of relevant academic and grey literatures. Qualitative case studies allow for
detailed contextual analysis of the phenomena of interest within the specific boundaries of a case (Brown, 2008). They are described by Yin (1984) as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used” (p.23).

1.5.2 Data Collection and Analysis

Field data collection was conducted at the research site between July 2015 and October 2015 and consisted of two qualitative research methods: semi-structured interviewing and participant observation. Over August and September of this period, I lived in the case study community full time, accompanied by my research assistant Victor. We both lived during this period in the center of town to support daily engagement with community members, flexible interview scheduling, and continuous exposure to community life. Victor, born and raised in the State of Yucatán, had previously assisted in ethnographic research projects in the community and was invaluable to my ability to connect and communicate with interview participants as well as to navigate daily life in the community.

Before, during, and after the time of field data collection, academic literature reviews and ‘grey’ document analysis provided key sources of secondary data. This involved in-depth reviews of the fields of study highlighted in section 1.2 – including SES vulnerability, resilience, adaptation, and adaptive capacity. ‘Grey’ documents analyzed included governmental and non-governmental reports on issues related to the sustainable management of sea cucumber fisheries at regional
(Yucatán State), national (Mexico) and international scales, as well as regional and local news media.

1.5.2.1 Field Data Collection

Qualitative interviews with the community members allowed for direct engagement with individuals who are experiencing and responding to local social-ecological change. I used a semi-structured interview protocol (see Appendix A) designed to elicit a range of narratives regarding perceptions, knowledge, experiences, and feelings related to changes in local livelihoods, demographics, fisheries and their management, and any other topic of interest to people there. The protocol began by introducing Victor and myself, explaining a bit about the research project, and receiving permission to record audio of the interview. Participants were first asked open-ended questions about what it was like to live in the community, as well as about perceived changes over time and within the past 10-15 years. Once changes were mentioned, prompts were then used to initiate discussions of drivers, impacts (positive and negative), responses, and trajectories of change. The interview protocol was developed over several iterations with extensive feedback from my thesis supervisors Terre Satterfield and Nathan Bennett. It was also reviewed and adjusted extensively with the assistance of Victor, who advised on translation from English into Spanish including on nuances of sentence structure and terminology that would be socially appropriate, respectful, and understood within the community. Over the initial interviews, Victor and I worked together to continuously review and adjust the protocol for phrasing, terminology, and question order to ensure a structure that was at once methodologically effective, culturally appropriate, and conducive to an enjoyable social interaction between interviewees and the research team.
Selection of interview participants was done through convenience and purposive sampling to engage both men and women representing a broad range of ages and livelihood groups in the community. The goal of this sampling approach was to engage a diverse range of perspectives regarding local social-ecological changes, including the direction, drivers, and impacts of changes. Interview participants consisted of males (n=29) ranging from 22-81 years of age, and females (n=10) ranging from 22-68. Groups engaged included fishing (n=14), tourism, (n=15), municipal leadership (n=3) biosphere reserve staff (n=2), ranching (n=4) and store owners (n=1) (see Table 1.2). All interviews were conducted in Spanish, save for one conducted in a mix of Spanish and English, and ranged from approximately 30 to 90 minutes in length.

<table>
<thead>
<tr>
<th>Livelihood Group</th>
<th>Males (ages 22-81)</th>
<th>Females (ages 22-68)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-op Fisher (working)</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-op Fisher (retired)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meskil Gleaner</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Independent Permit Holder-Fisher</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>House wife</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>14</strong></td>
<td></td>
</tr>
<tr>
<td>Tourism</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-operative Guide (3 Co-operatives)</td>
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<td></td>
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</tr>
<tr>
<td>Independent Guide</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Restaurant/Hotel Owner</td>
<td>3</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Restaurant/hotel employee</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>15</strong></td>
<td></td>
</tr>
<tr>
<td>Municipal Leadership</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Mayor</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex-Mayor</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Livelihood Group</th>
<th>Males (ages 22-81)</th>
<th>Females (ages 22-68)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserve Staff</td>
<td>Technical operator</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Park guard</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Ranching</td>
<td>Rancher (Working)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rancher (Retired)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ama de Casa</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Store owners</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total Participants</td>
<td></td>
<td>29</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 1.1 Overview of Interview Participants

During interviews, Victor and I would take shorthand notes on our interview guides in Spanish and English and then compare them afterward for consistency. Beyond this, I also kept daily field notes in electronic format on my personal computer. Notes taken after interviews to summarize the key content were crucial for tracking emerging themes of interest throughout the weeks of interviewing. Audio recordings were later transcribed to accompany the hand written notes.

1.5.2.2 Data Analysis

Interview transcriptions and field notes were analyzed using NVivo (version 11.1.1), a qualitative data analysis program. Analysis of interview transcripts and field notes was done in multiple rounds. In the first round, initial open-coding (without pre-established categories) was done based on research questions to identify salient themes (Emerson, Fretz & Shaw, 1995). From these themes, codes were developed and used for a second round of tracking specific forms of social-ecological change, associated drivers and impacts, adaptive responses and trajectories of change. The narratives of key events, change processes, and outcomes were then analyzed
with more depth to build an understanding of the relationships between them, and characterized with the social systems framework presented in section 2.2.3.

1.5.3 **Strengths and Limitations of Research Methodology**

Broadly, limitations of the methods used in this research are those inherent to case studies and to research working with qualitative data and perceptions. With case studies, the ability to generalize beyond the case is limited—i.e.—the findings from one case cannot be presumed as consistent across other scenarios (Brown, 2008). Similarly, data gathered from a small number of individuals in a community should not be extrapolated as representative of the views held by all local actors. Moreover, qualitative data gained through semi-structured interviewing cannot be taken as objective or scientifically accurate depictions of ‘reality’ (Merriam, 2001). Rather, they are considered as they offer important dimensions of meaning as filtered through individual perspectives within a social setting (Bennett, 2016b). As such, perceptions often provide descriptions of social-ecological changes that can be later investigated in the event the drivers and impacts described are inconsistent with, and perhaps even contrary to, the results from more objective forms of measurement (Lyons et al., 2016).

Despite such limitations, the qualitative case study approach was chosen for its capacity to more completely derive and characterize the social experience of coupled social-ecological change within the bounds of a specific context (Merriam, 2001). As a goal of this research was to understand the social dimensions of changes driven by the new fishery, semi-structured qualitative interviewing was selected to allow for the combined use of organized lines of questioning as well as flexibility in pursuing different directions as they emerge with a given
respondent (Hammersely & Aitkenson, 2007). Broad, open-ended initial questions reduced the likelihood of ‘guiding’ respondents through my own framing, instead allowing interviewees to choose how to begin the telling of their story (Hammersely & Aitkenson, 2007). Critical for research on vulnerability in communities, this also provided an opportunity for respondents to highlight the practical concerns of everyday life. Finally, conducting interviews in a face-to-face format with one respondent at a time is generally considered to lead to more candid answers and comfortable discussion of sensitive topics in ways that can be prevented by the social dynamics of methods such as focus groups (Miller & Crabtree, 2004).

That said the methods used were constrained in a few practical ways. First, while I endeavoured to engage community members of diverse backgrounds, experiences, and identities, I did not speak with any non-local fishers who migrated to the community to harvest sea cucumber. This research is thereby missing a core voice in the story of social dynamics surrounding the new fishery. However, because my primary intent was to understand how local community members are experiencing and responding to local changes, this gap is not considered to compromise the value of my main results. Second, participant observation was hampered somewhat by linguistic barriers. While my ability to speak and understand Spanish improved immensely over my time in the field, data collection may have been enhanced were I to have had a stronger grasp of the language from the beginning.

1.6 Organization of Thesis

Chapter 2 was written as a stand-alone manuscript structured into 6 main parts. Part 2.1 introduces the rapid development of sea cucumber fisheries as a socially driven shock for coastal
SES around the world. Part 2.2 situates the research within literature on community vulnerability in the context of multiple stressors and presents a framework for understanding the impacts of change in social systems. Part 2.3 provides an overview of the research approach and methodology. In Part 2.4, results of interviews and participant observation are presented, demonstrating how the rapid onset of sea cucumber fishing has functioned as a shock amongst ongoing trends, driving fast and dramatic change in social system structure, function, and feedbacks. Part 2.5 discusses the differing impact pathways of shocks versus trends, implications of such differences for community adaptive capacity, and adaptation as well as for notions of feedbacks and threshold dynamics in social systems. Part 2.6 concludes with a brief summary of the case study and its contributions to research more broadly.

Finally, chapter 3 provides a brief synthesis of the primary contributions of the thesis as a whole and concludes by providing personal reflections and closing remarks.
Chapter 2: Catching Sea Cucumber Fever: Conceptualizing Shocks Versus Trends to Better Understand Vulnerability in Coastal Social-ecological Systems

2.1 Introduction

The impacts of modern social and environmental change are particularly salient for coastal communities (Bunce et al., 2010; Ommer, 2007; Bennett et al., 2016). As a result, understanding the dynamics of multi-scale, interacting social and environmental change presents a continuous challenge for researchers and decision makers engaged in researching vulnerability and adaptation in coastal communities (Bunce et al., 2010). While scholarship in this area has tended to focus on climate change (e.g., Cinner et al., 2015; Bunce et al., 2010; Julca & Paddison, 2010; Prno et al., 2011; Bardsley & Wiseman, 2013; Wise et al., 2014; O’Brien & Wolf, 2010) less attention in the SES scholarship has been given to understanding non-climatic anthropogenic drivers of change, such as broad demographic, socio-political, economic, cultural or technological processes of change and their cross-scale impacts (Breslow, 2015; Bennett et al., 2016). In addition, there has been little differentiation between the drivers and impacts of fast versus slower forms of change. Yet, anthropogenic drivers of rapid change play an increasing role in the opportunities and challenge that communities face (Hicks et al., 2016; Breslow, 2015), with distinct consequences for their ability to respond or adapt. Processes of economic globalization, as an example, have allowed for the rapid development of new markets for marine resources (Berkes et al., 2006) often coinciding with a neoliberalization of marine spaces that is
introducing significant change across fishing communities worldwide (Breslow, 2015; Hicks et al., 2016).

Rapid expansion of the global sea cucumber trade, triggered largely by growing demand in Asian luxury seafood markets, exemplifies such modern and impactful drivers of change. Over the past few decades, the increasing international value of sea cucumber products has sparked fishery booms, often in communities where commercial sea cucumber harvesting had not previously occurred (Eriksson et al., 2015b). In their work on the recent global spread of sea cucumber fisheries Eriksson et al. (2015b) show that in the 15 years between 1996 and 2011, Hong Kong’s sourcing network for sea cucumber expanded from 35 to 83 countries. Sea cucumber fisheries serving the Chinese market currently operate “within countries cumulatively spanning over 90% of the world’s tropical coastlines” (Eriksson et al., 2015b p.435). However, Anderson et al. (2010) have shown that despite a trend of increasing global sea cucumber catches, the catch of individual fisheries has followed a boom-and-bust pattern, “declining nearly as quickly as they expanded” (p.1). While boom and bust marine resource industries have occurred throughout history, the current speed with which markets for species of this and other echinoderms are emerging, supported by the accelerated mobility of information, technology, labour, and capital, has resulted in a rate of resource exploitation that is unprecedented (Adger et al., 2009; Berkes et al., 2006; Eriksson et al., 2015b). Eriksson et al. (2015b) note that “not only has exploitation developed more rapidly than local institutions can react to but it has also in some cases resulted in overfishing before the resource is perceived as threatened or has even been taxonomically described” (p.438).
While scholarship on sea cucumber fisheries has largely centered on the ecological implications of overharvesting and challenges for fishery management and governance (e.g., Purcell et al., 2014; Eriksson et al., 2015b; Berkes et al., 2006) such research work makes frequent mention of myriad forms of social conflict that accompany ‘boom’ sea cucumber fisheries. Research giving specific consideration to the social dimensions of these fisheries reveals themes of social discord reflective of terrestrial resource booms, including clashes between large numbers of migrating workers and local residents, as well as between user groups and conservation authorities and municipal governments (Bremner & Perez, 2002; Christensen, 2011). Rapid exploitation practices, combined with limited capacity for management within local governments, increasingly results in the sequential overexploitation of individual fisheries, with consequences for both human and ecological components of the coastal zones where harvesting occurs (Anderson et al., 2010; Eriksson et al., 2015b). Rapid-onset sea cucumber fisheries thus represent an important but understudied anthropogenic mechanism of fast change in coastal communities, with heretofore-limited research into the associated social impacts and responses. The research presented here investigates how a rapidly developed sea cucumber fishery has driven change in a local community through a qualitative case study of Río Lagartos, a fishing community on Mexico’s Yucatán Peninsula.

Using this case study, we aimed to:

1. Empirically investigate the consequences of a rapid anthropogenic change for a local SES, and second,
2. Explore implications of these changes for social system vulnerability, adaptation and adaptive capacity.
Specifically, we examined the following questions: What local social-ecological changes are associated with the sea cucumber fishery? How are rapid impacts from the sea cucumber fishery distinct from and interacting with slower ongoing trends? How are these processes affecting aspects of system vulnerability, including adaptation and adaptive capacity? We also situate this research and its questions within the literature on social-ecological resilience, vulnerability and adaptation in the face of multiple stressors. In so doing, we clarify the need to differentiate between the impacts of slow trends and rapid shocks by also proposing a framework for conceptualizing impacts to social systems in SES research.

2.2 Literature Review

2.2.1 Understanding Impacts and Response to Change in SES

The concept of a social-ecological system (SES) reflects an understanding that the human and biophysical components of a given landscape are inextricably linked, continuously influencing and responding to each other in a complex adaptive system (Adger, 2006; Berkes et al., 2006; Renaud et al., 2006). ‘Resilience’, ‘vulnerability’ and ‘adaptation’ make up some of the dominant theoretical lenses through which research has examined how these linked systems experience and respond to change (Gallopín, 2006). While specific definitions of these terms vary between traditions, the broadly accepted characterization of a resilient SES is “one with the capacity to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks” (Walker et al., 2002). This conception emerged from literature on ecological resilience, and specifically from the work of
CS Holling (1973). Holling’s research illustrated that ecosystems exist in multiple stability domains and that a defining characteristic of an ecosystem was its ability to persist through change, termed ecosystem resilience (Folke, 2006). Alternatively, vulnerability has been described as the “degree to which a system is susceptible to and is unable to cope with adverse effects” (Adger, 2006 p.269). Regarding SES, Adger (2006) has suggested that key parameters of vulnerability are “the stress to which a system is exposed, its sensitivity, and its adaptive capacity” (p.269). Through this theoretical lens, adaptive capacity is considered to represent the latent characteristics or attributes of a given system that enable it to respond adaptively in the face of stress, threats or perturbations (Engle, 2011; Smit & Wandel, 2006; Birk, 2014). Adaptive capacity is ‘realized’ through adaptive response, when a system reacts to change or stress either by preparing in advance or else by adjusting and responding to their effects (Engle, 2011; Adger, 2006).

Unifying points of interest between resilience, vulnerability, and adaptation research are the ways in which social, ecological or social-ecological systems experience and respond to different shocks and stresses, and their capacity to adapt (Gallopin, 2006). One of the most salient insights of this body of literature is that multiple drivers of social-ecological change interact at varying spatial and temporal scales to influence the vulnerability of individuals, communities, and ecosystems at the local level (Bunce et al., 2010; Bennett et al., 2016; Leichenko & O’Brien, 2008). Scholarship on multiple stressors, also termed exposures, has largely centered on community vulnerability in the context of climate change, investigating, for example, how multiple forms of climate stress interact with consequences of globalization (O’Brien et al., 2004), disease epidemiology (Reid & Vogel, 2006), livelihood risks (Belliveua et al., 2006), or
resource management policies (Bunce et al., 2010) in a given context. There is also increasing attention to how to incorporate multiple interacting exposures into adaptation plans (Bennett et al., 2016).

Given a preoccupation with adaptation to climate change and other biophysical stressors (e.g., O’Brien et al., 2004; Reid & Vogel, 2006, Birk, 2014; Bunce et al., 2010, Tschakert, 2007; Mccubbin et al., 2015), SES scholarship has paid less attention to the impacts of non-climatic anthropogenic drivers of change. Notable exceptions include recent work by Hicks et al. (2016) and Breslow (2015). Breslow (2015) points out that the absence of non-climate drivers of change is particularly significant for apprehending vulnerability across fishing communities, where broad social processes play an ever-greater role in shaping local dynamics. She offers examples of the global neoliberalization of marine resources, arguing that it is "severely straining and in some cases destructive of the livelihood-based identities, egalitarian and place-based cultural values, and the internal social structures that characterize small, rural, traditional, and indigenous fisheries and fishing communities” (Breslow, 2015 p.1). Such social processes are also intricately linked to local ecological change, with Hicks et al. (2016) demonstrating how distal social drivers (e.g., international markets) can escalate proximal social drivers (e.g., fishing pressure) to push marine ecosystems towards regime shifts.

SES scholarship often assumes slow variables (an imprint perhaps of the aforementioned climate change focus), seldom differentiating faster and slower forms of change in terms of their drivers or impacts. Despite frequent reference to the varying temporal scales at which drivers exert pressure on local systems (Bennett et al., 2016; Adger et al., 2012; Bunce et al., 2010), there has
been little empirical research demonstrating how the timescales of different interacting stressors relate to community vulnerability. Yet, as globalization and technology produce growing interconnectedness between SES across geographic scales, cross-scale change is driven at ever-faster speeds (Berkes et al., 2006). Social processes at global scales thus increasingly emerge as ‘shocks’ for local systems, driving rapid and often surprising forms of change, distinct from and yet interacting with the impacts of slower drivers (Armitage & Johnson, 2006).

It is also the case that social and ecological systems, while they are considered interdependently coupled, have inherent differences that carry implications for how we conceive of vulnerability, resilience, and adaptation (Davidson, 2010; Armitage et al., 2012; Cote & Nightingale, 2012). Agency, values, and power dynamics, as well as processes of human cognition differentiate social systems from their ecological counterparts and add layers of conceptual complexity to the ways in which humans experience, anticipate, and respond to stress and change (Armitage et al., 2012; Davidson, 2010; Cote & Nightingale, 2012).

However, the natural science heritage from which resilience and vulnerability thinking emerged has meant that the ecological dimensions of these systems have received far more theoretical attention than social ones (Armitage, 2012). For instance, conceptions of ecosystem structure, functioning, and feedbacks have been heavily theorized while their social counterparts have not benefited from the same level of effort within the SES literature. We note here that Cote & Nightingale (2012) caution against overemphasizing similarities between social and ecological dynamics, arguing that doing so “masks the necessity to include these normative factors to understand social change and governance issues within SES adaptive dynamics” (p.479). This is
particularly so in terms of system functions and feedbacks (Davidson, 2010; Cote & Nightingale, 2012). For example, Davidson (2010) posits that “while the structural complexity of both ecological and social systems can be conceived of in similar terms, the feedback processes associated with each are incomparable” (p.1142) because of the role that individual and collective agency play in social systems. Yet, much of SES theory relies heavily on the ecological terminology of structure, functions and feedbacks without elucidating how they may differ for social versus ecological dimensions of these linked systems. This lack of distinction represents a conceptual hurdle within a scholarship where “urgent questions remain about how to account for deeper social phenomena such as agency, structure, culture and power” (Parkins, 2013 p.529).

In summary, key shortcomings evident from the literature review are 1) there has been minimal engagement with the role of social drivers of change in SES vulnerability and adaptation research, 2) faster verses slower drivers of change are under-theorized in SES research, resulting in limited understanding of the impacts of rapid change on communities, including dynamics of social vulnerability and adaptation, and 3) there has been limited integration of the language and thinking of social-ecological systems with social dimensions. These considerations are particularly pertinent for understanding vulnerability and adaptation in coastal communities, as they increasingly experience novel and rapid change stemming from social drivers at different geographic scales. In the following sections we first explore differentiating drivers of faster versus slower change and then present a proposed framework for conceptualizing change in social systems.
2.2.2 Differentiating Fast and Slow Change

Timescales play an important role in the way that communities experience and respond to change (Lindsay & Boyd, 2010; Grothman & Patt, 2005). The role of temporal variation is, however, masked by a dependence on different terms, each used to characterize or represent sources of SES change including: stressors (O’Brien et al., 2004, Bunce et al., 2010), exposures (Obrien & Lecheinko, 2000), shocks (Schwarz et al., 2011), trends (Bennett et al., 2016), and perturbations (Gallopin, 2006). While some of these terms imply differing timescales or magnitudes of pressure, they are often used interchangeably (e.g., the use of ‘perturbation’ in Gallopin, 2006) and applied to both slower and faster forms of change.

For the purpose of the research presented in this paper, Table 2.1 provides useful definitions of shocks and trends, adapted from definitions found in Turner et al. (2003) and Walker et al. (2004 & 2012). We use the term ‘trends’ to represent external drivers of gradual, ongoing change that influence structure, function, or feedbacks in the social-ecological system in question. Examples of trends that might build pressure over time include rising ocean temperatures, soil degradation, or the opening of global commodity markets. Alternatively, ‘shocks’ are considered to be external drivers of rapid and dramatic change, affecting the system (e.g., natural disasters such as hurricanes, market crashes, military coups) (Turner et al., 2003). Where a trend represents gradually increasing pressure, typically within the range of normal system variability, shocks can be considered as spikes in pressure that are outside of the normal range of system variability (Turner et al., 2003).
**Trends**
External drivers of gradual, ongoing change that influence the structure, function, or feedbacks of a system.

**Shocks**
External drivers of rapid, dramatic change that influence the structure, function, or feedbacks of a system.

<table>
<thead>
<tr>
<th>Table 2.1 Proposed Definitions of Trends and Shocks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trends</strong></td>
</tr>
<tr>
<td>External drivers of gradual, ongoing change that influence the structure, function, or feedbacks of a system.</td>
</tr>
<tr>
<td><strong>Shocks</strong></td>
</tr>
<tr>
<td>External drivers of rapid, dramatic change that influence the structure, function, or feedbacks of a system.</td>
</tr>
</tbody>
</table>

While every social-ecological system undergoes change over time, individuals, groups, and institutions experience and respond to fast change differently than slow change (Vanclay, 2002). Gradual changes allow greater time for the development of adaptive responses—i.e. adjustments made in response to actual or expected stresses in order to prevent or mitigate negative impacts. In contrast, fast change can overwhelm the ability of institutions, formal & informal, to effectively reduce actual or potential harm from a stress (Berkes, 2006; Eriksson et al., 2015b). This is seen, for example, when resource governance systems function successfully until faced with a rapid change in actors, technology, or environmental units. Such has been the case in many sudden aquaculture economies, where development outpaces regulatory capacity and leads to both pollution and disease outbreaks (see case studies in Nayak et al., 2015). In terms of adaptive management, multiple stages of learning and response are slow. Time is necessary to gain an understanding of system changes of interest, to develop foresight around likely trajectories of change and anticipate necessary actions, and to share information across groups and through networks (Armitage et al., 2008). Adaptive institutional response is therefore challenged by acute, novel, and unexpected change (Berkes, 2006). This is also true for some social institutions, such as traditional ecological knowledge. Pearce et al. (2015) note that the “rapid changes associated with anthropogenic climate change, combined with the effects of socioeconomic changes, have made some historical adaptation efforts less plausible (e.g.,
shifting location to follow the migration of animals) and others more difficult” (p.243). In this way, a community, institution, or individual with high levels of what are conventionally considered determinants of adaptive capacity may be successful in mitigating negative impacts from an ongoing trend, but struggle to manage rapid-onset pressures (such as an economic shock).

Fast variables also provide less time for communities to adjust psychosocially (Vanclay, 2002; Lorenz, 2010). Alongside the forms of institutional adaptation discussed above, part of human resilience throughout history has been the ability to normalize changing social and environmental contexts by integrating new variables and adapting expectations of the social-ecological system in which they are a part (Lorenz, 2010; Vanclay, 2002). Through this process, gradual change can be absorbed by a society, becoming an unremarkable aspect of daily life among other norms (Papworth et al., 2009). Alternatively, fast social or environmental changes, such as dramatic changes in local demographics (e.g., rapid migration), markets (e.g., stock market crashes), or ecosystem health (e.g., oil spills), can be much more distressing than slower forms of change (Vanclay, 2002). Change that is perceived as ‘too different, too fast’ may also be felt more intensely than gradual change by conflicting with norms and expectations and thereby triggering feelings of insecurity (Vanclay, 2002). Regarding this Vanclay (2002) says:

“Cultures have well-developed systems that allow them to cope with a degree of change, provide survival mechanisms, and provide for the effective functioning of those societies. When change is too rapid, or when there are exogenous shocks with which the system cannot cope, there may be disregard for traditional cultural practices by members of society, which means that the culture does not provide the benefits it once did.” (p.199)
Vanclay (2002) refers to this as a “double blind”, saying that “there is an expectation by some members of the society that these systems should work, and because they were in place in the past, there are not alternative mechanisms to provide for those services in the present when those cultural practices are not adhered to” (p.199). For Alaskan native communities facing fast changing environmental conditions, Cunsulo Willox et al. (2014) and others (Turner & Clifton, 2009) posit that psychosocial and cultural impacts can arise where communities feel a sense of loss of the traditional knowledge and wisdom necessary for “predicting weather patterns, navigational strategies, and understanding conditions for safe travel to younger generations” (Cunsulo Willox et al., 2014 p.175).

2.2.3 Conceptualizing Change in Social Systems

Seeking a conceptual framework that better integrates social dimensions with social-ecological systems thinking and language, Table 2.2 presents our proposed description of core social system elements. In this framework we build from theory on ecological resilience (see Holling, 1973) and social-ecological resilience (found in Folke, 2006; Walker et al., 2004) with thinking on resilience in social systems (found in Cote & Nightengale, 2012; Armitage, 2012; Lorenz, 2010; Davidson, 2010) to provide categories and examples of social system structure, function, and feedbacks. In our corresponding framework, social system structure is represented by system components (e.g., actors and resources) that are organized into sets of interrelations in such forms as networks, institutions, livelihoods, and social hierarchies. Social system functions include the processes and outcomes of component interrelations. Specifically, ‘processes’ refer to actions and decision-making processes that take place within the social system, such as the management and allocation of resources. ‘Relational and psychological outcomes’ refer to the
resulting quality of relations between individuals and groups in the social system, such as levels of social cohesion versus social disintegration, and to psychological wellbeing, such as fears and aspirations and sense of agency. ‘Material and physical outcomes’ refer to material wealth, such as levels of income, food security, or access to resources, and to physical health, such as absence of disease or infirmity.

Finally, social system feedbacks are responses that influence the direction of a change in system structure or function. Building on Bennett et al. (2016), we suggest that feedbacks can be of three types: 1) stabilizing, where a response reduces or mitigates undesirable change in the system 2) amplifying, where a response exacerbates undesirable change, and 3) adapting, where a response drives desirable change in the system².

<table>
<thead>
<tr>
<th>Social System Structure</th>
<th>Definition/ description</th>
<th>Categories with Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Components of the system in a set of interrelations</td>
<td><strong>Components</strong></td>
</tr>
<tr>
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<td>Actors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resources (e.g., fish stocks)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Structure of interrelations</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Institutions</td>
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<td></td>
<td></td>
<td>Networks</td>
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<tr>
<td></td>
<td></td>
<td>Livelihoods</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Social hierarchies</td>
</tr>
</tbody>
</table>

² Characterizing “desirable” and “undesirable” change is of course dependent upon scale and perspective, or the question of ‘desirable for whom?’. For community level analyses, a desirable change may be considered as change that leads to a reduction in overall community vulnerability, with ‘undesirable’ change being that which increases community vulnerability over time. Thus the same change process may be desirable for a particular individual, group, or institution, but undesirable at the community scale.
<table>
<thead>
<tr>
<th>Social System Functions</th>
<th>Definition/description</th>
<th>Categories with Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>The processes, relations, and outcomes of component interrelations.</td>
<td>2.2.3.1.1 Processes</td>
<td>2.2.3.1.2 Management of resources</td>
</tr>
<tr>
<td>2.2.3.1.3 Decision making</td>
<td>2.2.3.1.4 Allocation of public goods and services</td>
<td>2.2.3.1.5 Community development</td>
</tr>
<tr>
<td>2.2.3.1.6 Relational and Psychological Outcomes</td>
<td>2.2.3.1.7 Social cohesion, trust, tension, conflict</td>
<td>2.2.3.1.8 Equity and gender relations</td>
</tr>
<tr>
<td>2.2.3.1.9 Sense of security, agency, empowerment, belonging</td>
<td>2.2.3.1.10 Cultural integrity/persistence vs. cultural marginalization</td>
<td></td>
</tr>
<tr>
<td>2.2.3.1.11 Material and Physical Outcomes</td>
<td>2.2.3.1.12 Food security and physical health</td>
<td>Wealth, income and assets</td>
</tr>
<tr>
<td>2.2.3.1.13 Community infrastructure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social System Feedbacks</td>
<td>2.2.3.1.14 Stabilizing</td>
<td>(Mitigative): Internal responses that reduce/mitigate undesirable change in system structure and function</td>
</tr>
</tbody>
</table>
Amplifying (Maladaptive):
Internal responses that drive further undesirable change in system structure and function

Adapting (Adaptive):
Internal responses that drive desirable change in system structure and function

Table 2.2 Conceptual Framework for Social System Elements

By characterizing social system as structure, functions and feedbacks, this framework aims to provide terminology and concepts for investigating social dimensions in a manner congruent with SES thinking and language thus enabling interdisciplinary scholarship. It can be differentiated from existing SES frameworks such as those found in Ostrom (2009) by creating space for analysis of the social subsystem of a given SES beyond the social institutional factors influencing the state of a resource (Cote & Nightingale, 2012). For example, by conceptualizing functional outcomes as related to dimensions of relational, psychological, material and physical wellbeing, this framework supports deeper engagement with insights from social theory on the manifold ways in which social-ecological change can impact communities. Further, as critical thresholds in SES are often defined as points of change in structure, functions, and feedbacks, we believe such a framework may assist in the investigation and characterization of thresholds in social and social-ecological systems. In the case study below we apply this framework to examine the social consequences of a rapidly developed sea cucumber fishery (i.e., a ‘shock’) as an example of how it might be used in other SES research.
2.3 Research Context and Methods

2.3.1 Research Site

The town of Río Lagartos (pop~2000) is located on the northeastern end of Mexico’s Yucatán Peninsula, in the State of Yucatán. Río Lagartos is situated, along with the communities of Las Colorados, San Felipe, and El Cuyo, within the buffer zone of the Ria Lagartos Biosphere Reserve (RLBR). The biosphere reserve, designated in 1999, covers 150,000 acres of important marine, coastal and terrestrial environments, including wetlands, mangroves, estuaries, marshes, savannah, grasslands, coastal dunes, lagoons and multiple classifications of forest (UNESCO Website). For the past 50 years, small-scale commercial fishing has made up the dominant livelihood of the region, with octopus, spiny lobster, red grouper, snapper, and most recently, sea cucumber as the key commercial species (Pedroza & Salas, 2011; Bennett, 2016a; Fraga, 2006). While cooperative models characterized the early decades of commercial fishing in Yucatán, deregulation and privatization of state fisheries over the 80’s and 90’s, including the removal of exclusive access rights for fishing cooperatives, resulted in dramatic growth in the private sector (Bennett, 2016a; Pedroza & Salas, 2011). In Río Lagartos, two long-standing cooperatives account for around half of the fishers in the community, while the rest participate in patron-client relationships (Bennett, 2016a).

Secondary and tertiary livelihoods include tourism, salt production, cattle ranching, and agriculture (Fraga, 2006). Eco-tourism in particular is a growing sector for the community, with national and international visitors arriving throughout the summer months for boat tours to see the pink flamingos that inhabit the estuary.
2.3.2 Data Collection and Analysis

A qualitative case study approach was chosen to allow for detailed analysis of perceived social-ecological change within the boundaries of a local context (Merriam, 2001). Field data was collected through two qualitative research methods: Semi-structured interviewing and participant observation. ‘Grey’ document analysis, including governmental and non-governmental reports on the management of sea cucumber fisheries at regional (Yucatán State), national (Mexico) and international scales, as well as online news media, provided key sources of secondary data.

Field data collection took place between July 2015 and October 2015. Over August and September of this period, the first author lived in the case study community full time and was accompanied by a Yucatecan research assistant. For this approach, living in the community allowed the first author to engage community members in relationship building, informal
conversation, and participant observation that were crucial to the collection and analysis of data used.

<table>
<thead>
<tr>
<th>Livelihood Group</th>
<th>Description</th>
<th>Males Ages 22-81</th>
<th>Females Ages 22-68</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishing</td>
<td>Fishers (co-op &amp; independent), their wives, and women gleaners.</td>
<td>10</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Tourism/Hospitality</td>
<td>Guides (co-operative and independent), restaurant &amp; hotel owners and employees</td>
<td>13</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Municipal Leadership</td>
<td>Current &amp; Past Mayors</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Reserve Staff</td>
<td>Technical Operator &amp; Park Guard</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Ranching</td>
<td>Ranchers (working &amp; retired) and their wives.</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Small Business</td>
<td>Store Owner</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total Participants</strong></td>
<td></td>
<td><strong>29</strong></td>
<td><strong>10</strong></td>
<td><strong>39</strong></td>
</tr>
</tbody>
</table>

Table 2.3 Summary of Interview Participants

Selection of interview participants was done through both convenience and purposive sampling to engage community members from a range of demographic groups (see Table 2.3). This included men (n=29) and women (n=10), ages 22-81, representing a diversity of experience within the fishing (n=14), tourism/hospitality (n=15) and ranching sectors (n=4), as well as staff of the biosphere reserve (n=2), and municipal leadership (n=3). Interviews were conducted with a semi-structured protocol and ranged from 30 to 90 minutes in length. All interviews were conducted in Spanish, save for one that was conducted in a mix of Spanish and English.

Interview participants were first asked open-ended questions about life and livelihoods in the community, and perceived changes over time (see Appendix A). Once participants mentioned observing a particular change, prompts were used to initiate discussions of the perceived drivers, impacts (positive and negative), local responses to, and the future trajectory of the change.
Notes taken by both the research assistant and first author during interviews were written onto interview guides and later compared for consistency. Audio recordings were transcribed to accompany the hand written notes. Interview transcriptions and field notes were analyzed with NVivo (version 11.1.1). This software was used first to organize the open coding of data and then to track themes of interest and categorize perceived social-ecological changes, associated drivers and impacts to the social system (in terms of structure, functions and feedbacks), adaptive responses, and trajectories of change.

Key limitations of the methods used in this research are those inherent to case studies and to research using self-reported qualitative data. Engaging local perceptions of change, the methods used in this research do not produce results that should be considered objective measurements or scientific determinations of cause and effect (Miller & Crabtree, 2004). With a small and diverse sample size of interview participants, results cannot be extrapolated as statistically representative of the views held by all local actors, or all members of a certain demographic (Miller & Crabtree, 2004). A further limitation is that the research did not engage fishers who migrated to the community to harvest sea cucumber, thereby leaving a substantial and undoubtedly interesting side to the story of the sea cucumber fishery as a driver of local and regional change. However, the qualitative case study approach was deemed appropriate for its ability to gather rich and nuanced data about the social experience of coupled social-ecological change in a local context (Lyons et al., 2016).
2.4 Results: A Changing System

2.4.1 Gradual Changes in the Community

Interview participants reported (unprompted) a consistent set of changing socio-economic and biophysical conditions in the community over different timelines. Regarding changes occurring in last 10-50 years (see Table 2.4) participant observations were mostly linked back to several consistently identified drivers of change that have emerged slowly over time, such as population growth, urban development, and a growing tourism industry associated with the Ria Lagartos Biosphere Reserve (RLBR). Some of the new conditions resulting from these drivers were considered to bring desirable outcomes for the community, such as the economic benefits and livelihood options derived from tourism demand and related development. Other trends, such as a gradual decrease in fish catches, or increasing housing pressure, represented mounting challenges. Bounded in by the RLBR, the community of Río Lagartos is unable to acquire new land on which to expand its stock of housing. As the population grows through both natural increase and immigration, it has become more and more difficult for newly married couples to acquire land on which to build their own homes. Despite such challenges, most respondents spoke about the biosphere reserve in a positive or neutral manner, noting that reserve programming has created positive outcomes for the community by way of eco-tourism development, environmental conservation efforts, and environmental education outreach.

<table>
<thead>
<tr>
<th>Change</th>
<th>Sample Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreasing Fish Catch</td>
<td>“Fishing has diminished significantly, twenty years ago there was a lot of fish but in the last twenty years the truth is it has decreased a lot. If we talk about the 80’s, the 90’s, there was a lot of fish…”</td>
</tr>
<tr>
<td>Fishers becoming Tour Guides</td>
<td>“Some (fishers) have changed from fishing to tourism… They prefer tourism because it is less dangerous, and it’s faster money.”</td>
</tr>
</tbody>
</table>
### Table 2.4 Summary of Reported Change Over Time

Community members have responded to these changing social and environmental conditions in a variety of ways. In response to declines in multiple commercially valuable species since the late 1990s, fishers reported increasing fishing effort, diversifying or changing livelihoods, and seeking short-term support through social networks and local organizations. Local entrepreneurs are actively cultivating a local eco-tourism industry by leveraging the attraction of the biosphere reserve, with a growing number of fishers now giving ‘eco-tours’ part or full-time. Responses to housing pressure included youth moving to different towns, the illegal construction of homes within the mangroves and coping by living with in-laws or grandparents (a situation that respondents described as highly undesirable in the long-term). Over time the community has developed a range of responses to mitigate the economic impact of seasonal fluctuations in fishing and tourism industries, such as shrimping in the estuary and accessing loans from fishing
cooperatives. In these discussions, the two local cooperatives were often referenced as key assets in times of crisis, such as supporting the families of fishers who were unable to work as a result of illness.

2.4.2 Sea Cucumber Fishing: A Shock Amongst Trends

In stark contrast to ongoing trends described above, the local sea cucumber fishery emerged as a salient driver of rapid, dramatic and predominantly undesirable change over the past 1-4 years. Changes associated with sea cucumber fishing represent a significant amount of attention across the interview transcripts, with five of the six top-mentioned local change processes reported as either introduced or dramatically exacerbated by the start of the fishery. Below, we demonstrate how the sea cucumber fishery has driven and continues to drive changes in structure, functioning and feedbacks in the social system.

2.4.2.1 Changes in Social System Structure

Similar to Yucatán’s other port towns, the first few years of sea cucumber fishing in Rio Lagartos were characterized by dramatic changes in actors, fishing livelihoods, and resources.

Fishing livelihoods: The initial wave of sea cucumber harvesting in brought huge profits to participating fishers, with daily earnings that were double or triple what they could make fishing other commercially valuable species such as lobster. Local news media described the entire coast

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3 These were: decreasing fish catch, increasing numbers of non-local fishers, a developing hospitality and tourism industry, increased housing pressure, increasing community conflicts, and an increasing occurrence of illegal fishing activity.
of Yucatán as struck with a ‘gold fever’ (Hugo Michel, 2013) as people rushed to benefit from local sea cucumber stocks.

“Of the sea cucumber it is true that the early days had a lot of profits in the thousands of pesos. There were those who earned 30 thousand pesos (~USD1628) in a day of fishing, 3 days of 40 thousand pesos...” (Housewife, Fishing household)

"A few years ago the sea cucumber (fishery) started and people actually managed to make some money, they did well, there are people who bought more boats, there are people who built new homes, the patrons had more money, created, bought more boats, bought new vehicles... It brought more profit to the fishermen... But also brought with it a number of problems, it brought many problems." (Tour guide)

**Actors:** The sudden spike in profitability drew an influx of fishers, buyers, patrons and poachers to the State. So while the first sea cucumber openings in Río Lagartos meant rapidly increased revenue for local fishers, they also triggered an inpouring of non-local fishers and middlemen.

Respondent (R): “…It’s been 4 years since the people started coming.”
Interviewer (I): “And why 4 years, do you know?”
R: “Because we discovered another product that was here, the sea cucumber. That attracted the people.” (Fisher)

Interview participants frequently mentioned the increase in patrons (independent permit holders), present in the community over the past few years. Working separately from the local cooperatives, patrons contract individual fishers to land catches with them, often providing fishers with the use of boats and gear as well as loans (Bennett, 2016a). With the profitability of initial sea cucumber harvests, patrons brought increasing numbers of non-local fishers to work their boats.

4 In comparison, fishers harvesting spiny lobster typically earn about USD150 from a day of fishing.
“If normally there are 150 boats from one cooperative and 100 from the other, that’s already 250 boats. In the sea cucumber season- 400 boats come just from el Cuyo!” (Past/present Political Leadership)

The sea cucumber fishery is likewise attributed with recent incursions of poachers who illegally harvest sea cucumber as well as other local fish stocks.

“The biologists saw that there aren’t any (sea cucumber)- it’s already fished out, it’s necessary to wait three years for the biomass to increase to capture it again. But people from Dzilam and Celestún, still they go fishing. You do not know, you’re sleeping and they are fishing at night and sometimes during the day, you do not know, they are fishing. That’s never going to stop, the (foreign) people are going to fish. We respect (the closures) but they do not.” (Tour guide)

**Resources:** Increased harvesting pressure from the growing number of fishers, including poachers, was described as having a tangible impact on sea cucumber stocks.

“It’s already been quite some time and the sea cucumber has not recovered. We have (sea cucumber) but little by little we are running out of it because the poachers (will) continue fishing every day until it runs out how it ended in Progresso, they stopped fishing.” (Fisher)

The recent spike in non-local fishers was also connected to declines in other marine species, including grouper and crustaceans. For example, the gleaners interviewed reported that the amount of blue crab they could harvest had decreased drastically over the past two years as a result of harvesting by “fishers from away”.

### 2.4.2.2 Change in Social System Functions

When discussing the significance of the recent and dramatic changes described above, respondents concerns focused on current and future implications for local resource management, safety and security, social cohesion, and fisher health.
Management of local resources: For fishing cooperatives, the increases in patrons and outside fishers has resulted in dramatically increased competition and a reduced ability to manage fishing pressure. Without exclusive fishing rights for cooperatives, the changing ratio of independent versus cooperative fishers has hindered the ability of cooperatives to control harvesting through collective enforcement mechanisms used in the past. Co-operative members described feeling overpowered by the influence of independent permit holders, who are seen to have financial and political capability to get away with fishing outside of the legal openings.

“They (patrons) are growing and cooperatives are down because we are affiliated under the laws and not allowed to grow. They as permit holders, as individuals, as independents, they grow when they want (saying) "I put a boat (on the water) and nobody can tell me anything” (Fisher)

For locals, illegal sea cucumber harvesting and the problems it brings are supported by corruption in the state government. Illegal fishers, often described as mafia or ‘narco-pepineros’ to reflect an association with drug traffickers, are considered to have influence over if not partnerships with corrupt authorities and decision makers.

“We have brought them (illegal fishers) before the authorities and nothing ever happens; Why doesn’t anything happen? Because it is a permit holder who has a lot of influence…” (Fisher)

Material/economic wealth: As increasing participation in the fishery exacerbates the pressure on already overexploited stocks there was concern amongst respondents about the future of fishing livelihoods. While a few interviewees were optimistic that there would be a solution to the problem of overexploitation, many suggested that the future of fishing, particularly for younger generations, was bleak.

"You no longer harvest enough, sometimes you only recover enough for gasoline... As a fisherman you do not make enough, but you know that you're not going to leave your family without their income... But they (the authorities) are never going to understand that part, that we (cooperative fishers) depend on the sea. The patrons don't depend on the sea, they fish and they
Day by day the (private) businesses are increasing, this generates more fishers and less fish; and our sons are going to have to go double the distance than us to be able to fish." (Fisher)

**Fisher health:** Pursuit of profit maximization during very short fishery openings has led many fishers to dive more than is physically safe, increasing their vulnerability to health complications from decompression sickness. Fishers described harvesting sea cucumber, in comparison to other dive fisheries such as lobster, as particularly difficult and physically exhausting work.

“With the cucumber (the boat) goes, you don’t return (to the surface). You don’t leave (the ocean floor) because once you fill a bag of 50 kilos of cucumber you are pulled along the bottom...they throw out a buoy with another bag... and you keep working there and it’s very deep where they are... now they are diving cucumber for like 20 miles and it’s a really great depth.” (Fisher)

Temporary sickness, long-term disability and death from decompression are described as increasingly common, especially for newer divers and those without adequate training.

**Conflict, (in)security and social cohesion:** The start of sea cucumber fishing triggered a wave of violent confrontations between fishers across the Yucatán coast, with some news media referring sea cucumber fishing as the “center of conflict between Yucatecans” (Diario de Yucatán, May 12, 2013). Disputes in and around Río Lagartos have been primarily between local cooperative fishers and outside fishers found harvesting or attempting to harvest sea cucumber illegally- either without permit or outside of the legal openings. In Río Lagartos, tales of violent conflict, of fishers being kidnapped, murdered, and thrown into the sea are woven into the ways in which locals discuss the fishery. This was described as a form of violence never before seen in the small fishing community.

R: “*There was between San Felipe and Dzilam, among the mangroves along the coast, an illegal camp for boiling and processing sea cucumber*”.
I: “*When was that?*”
R: “*That was last year. Then the authorities knew that and went along the coast and there was shooting between police and (illegal) fishermen from Dzilam. Shots were fired and we were*”
Beyond specific confrontations between poachers and locals, non-local fishers are associated with rising levels of local violence more generally, as well as deviant behaviours such as drug use, prostitution, and theft. As a result, interviewees described the influx of “outsiders” as causing an increased sense of insecurity regarding physical safety and the security of property.

“...Before, we didn’t have to worry about anything, but those people started coming, but now we’re being careful a lot, especially those with young children, because we do not know what habits that have. Recently they even beheaded someone nearby, and we are not used to this because people here are very peaceful, they are not aggressive people.” (Housewife, Ranching Household).

One respondent talked about the increase in theft and resulting changes in local behaviour and way of life, saying:

“They started to rob motors too. Two fishers, they took their boat and motor. It’s new, it came with the sea cucumber problem. It began when they started to fish sea cucumber because they had never stolen engines and boats... People already started putting cameras in front of the seawall to their boats, and hired a guard to walk on the boardwalk, to watch the boats... And the people were afraid because they are stealing boats and that had never happened here, it was quiet” (Tour guide)

Concerns over increased inflow of non-local people were also described in terms of impacts on aspects of social cohesion. At the beginning of interviews, when participants were asked about life in the community many responded by describing how friendliness and strong social relations were valued aspects of living in Río Lagartos. A commonly expressed sentiment was that locals did not want their community to become like the nearby fishing town of Celestún or the tourist hub of Cancun, because of the way that rapid increases in immigration and fisher competition in the former and tourism development in the latter led to reduced social cohesion. Such sentiments
seemed to re-emerge in discussions of the sea cucumber fishery and the associated spike in “outsiders”, as participants brought up concerns about how their presence is or may yet impact levels of trust, friendliness and shared values in the community.

“Río Lagartos, in the sense that it is now no longer quiet, already you cannot walk at night, as I was telling you, because people are coming from other places. There are many people from Veracruz, Chiapas, many foreign people are coming and we do not know their way of life, if they are calm people. While there is tranquility there is no problem. I imagine that (the community) is going to change in many aspects, they are building some hotels on the waterfront, like how it is in Cancun, and we don’t know what is going to happen” (Rancher)

In many of the circumstances described above, the negative social impacts associated with the fishery are the result of its rapid amplification of stressors or threats that had previously existed at a level that was more tolerable. In the past, fishers from other communities had come to fish local species, but this was considered acceptable because they were smaller in number, their stay was shorter, and they were known if not related to the local families. The start of sea cucumber fishing has resulted in a much greater number of participants in the local fishery, and incoming fishers are considered to be unconnected to the community and seen, unlike locals, to have no incentive to fish sustainably. While myriad social conflicts had occurred in the community, as in any, the spike in intensity and frequency of violent conflict was referred to as a disturbing shift in norms. In reference to the change in violence one woman said:

“Here there are fights but at the most it is insults, a punch and that’s it, they don’t take a knife or gun, people are not armed but fishermen from outside, yes, from Veracruz, Tabasco. We had a murder last year, the first murder in the history of Río Lagartos, it was a young man in the doorway of a bar and he died of a gunshot wound or stab wound, I do not remember.” (Housewife, Fishing Household)

A general sense that the sea cucumber fishery marks a dramatic change in ‘life-as-we-know-it’ is captured in this quote:
“You'd never heard of brawls and shootings at sea or something like this situation with the cucumber. The cucumber, I believe it was more like a drug, like cocaine... the cucumber is more valuable than cocaine. That there are pirates in the sea, they are going to take the fish that you have, they rob you and they take it, they fire shots, they burn boats. It has become something.” (Restaurant Owner)

2.4.2.3 Change in Social System Feedbacks

As the sea cucumber fishery drives changes in community structure and function, interviewees mentioned several forms of response by locals, at both individual and group scales. These included increased fishing effort, vigilance by cooperative members, organized protest, as well as simply bearing the effects and hoping for improvement.

**Increased fishing effort:** As mentioned above in Section 2.4.1, fishers have been responding to declining fish stocks through fishing longer hours further from shore. While increasing fishing effort can function as a coping mechanism in the short term, it is often characterized as ‘maladaptive’ behaviour in the long term because of the increased likelihood of pushing stocks to a point of collapse (Boonstra & Hanh, 2015). For sea cucumber harvesters, this response represents an increase in both ecological and physiological risk: With continued overexploitation of sea cucumber populations, divers are venturing farther from shore to harvest at increasing depths. As seasonal openings are short, and competition growing, divers are inclined to work longer hours for more consecutive days than are safe and increase their likelihood of decompression illness or death.

“For the cucumber they come to us to give courses and all but the people, let’s call it greed, that if I’ve got 200 kilos of cucumber and it’s early, I’m going to go back and get another 100 kilos because that’s a little more money, but that trip sometimes causes decompression. Now several have died here from decompression.” (Fisher)
**Vigilante justice:** With ineffective fisheries governance at the state level, the local fishing cooperatives have attempted to take on elements of regulation, monitoring and enforcement in what can only be described as vigilante in method. As local fishers take action against encroaching poachers, through physical confrontations and boat burning, the continued conflict contributes to furthering the sense of insecurity.

“*About a year ago we went out to take care of pepineros (illegal sea cucumber harvesters), along with those (fishers) of San Felipe, together we burned their boats.*” (Fisher)

While the efforts of cooperatives stemmed the influx of poachers initially, poachers soon returned better armed and in larger groups.

“*They began to come (back) armed, and grabbed one (fisher from) San Felipe and burned their boats too... almost killed them, it got hard.*” (Fisher)

**Protest:** In response to the presence of illegal fishers, cooperative fishermen of Rio Lagartos have on multiple occasions created blockades at the town entrance, demanding action from state authorities. One such blockade occurred during the time of field research. For a full day, fishing activity was halted so that cooperative fishers could blockade the highway into town. Locals hoped that it would prompt state authorities to take action on poaching. Though government representatives did not show up during the protest, it did result in challenges for tourism and hospitality groups, who had busloads of disgruntled tourists waiting to get in or out of the town.

“Well the most difficult (issue), where I see that there are lots of problems is that sea cucumber. I believe you already know that they (protesting fishermen) closed the highway... If you arrive and you are with your family, and you have a reservation in Cancun and you can’t leave with your car, imagine it. This is what I have experienced that is really bad, it never happened here (before)” (Tour Guide)
**Bearing the effects:** After relatively ineffective attempts to bring poachers to justice, and the physical risk that comes with efforts to monitor and defend local fishing grounds, some fishermen expressed a sense that the only option was to allow the poaching and bear its effects until sea cucumber stocks were completely overfished.

“It is something that cannot be solved because it's like you're messing with the mafia. They are armed, there is a risk that they will hit you with a bullet.” (Fisher).

For many respondents, the perception that government corruption, apathy and lack of action create a favourable environment for illegal fishing makes this challenge seem all the more daunting.

Below, Table 2.5 presents a summary of the changes in system structure, functions, and feedbacks mentioned by respondents.

<table>
<thead>
<tr>
<th>Aspect of Social System</th>
<th>Changes Associated with the Sea Cucumber Fishery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure</strong></td>
<td><strong>Fishing Livelihoods</strong></td>
</tr>
<tr>
<td></td>
<td>New income opportunities within the sea cucumber fishery</td>
</tr>
<tr>
<td></td>
<td>Increased competition</td>
</tr>
<tr>
<td></td>
<td>New risks associated with fisher-fisher conflict</td>
</tr>
<tr>
<td><strong>Actors:</strong></td>
<td>Introduction of migrant fishers, independent patrons, regional buyers &amp; poachers</td>
</tr>
<tr>
<td><strong>Resources:</strong></td>
<td>Declines in sea cucumber, increased pressure on other commercial and subsistence species</td>
</tr>
<tr>
<td><strong>Functions</strong></td>
<td><strong>Management of Local Resources</strong></td>
</tr>
<tr>
<td></td>
<td>Decreased ability of cooperatives to manage harvesting pressure and prevent illegal fishing activity</td>
</tr>
</tbody>
</table>
## Functions

<table>
<thead>
<tr>
<th>Changes Associated with the Sea Cucumber Fishery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economic/Material Wealth</strong></td>
</tr>
<tr>
<td>Decreased profitability of fishing</td>
</tr>
<tr>
<td><strong>Fisher Health</strong></td>
</tr>
<tr>
<td>Increase in decompression illness and death</td>
</tr>
<tr>
<td><strong>Conflict, Sense of Security, and Social Cohesion</strong></td>
</tr>
<tr>
<td>Rapid increase in ‘others’ with different values and habits</td>
</tr>
<tr>
<td>Increase in violent conflict and deviant behaviour</td>
</tr>
</tbody>
</table>

## Feedbacks

<table>
<thead>
<tr>
<th>Changes Associated with the Sea Cucumber Fishery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Increased Fishing Effort</strong></td>
</tr>
<tr>
<td>Increase fishing distance and hours to make up for declining stocks</td>
</tr>
<tr>
<td><strong>Vigilante Justice</strong></td>
</tr>
<tr>
<td>Confront poachers at sea, attempt to dissuade or bring to police</td>
</tr>
<tr>
<td><strong>Protest</strong></td>
</tr>
<tr>
<td>Set up road blockades at entrance to town to call attention of regulators and government</td>
</tr>
<tr>
<td><strong>Bearing the effects</strong></td>
</tr>
<tr>
<td>Change nothing, wait until sea cucumber is extirpated or government steps in</td>
</tr>
</tbody>
</table>

### Table 2.5 Changes to Social System Associated with the Sea Cucumber Fishery

#### 2.5 Discussion

The results presented above illustrate how the recent emergence of commercial sea cucumber fishing on the Yucatán Peninsula has driven fast and dramatic changes in the community of Río Lagartos. The rapidly developed fishery has triggered a gold-rush style influx of new actors, new livelihood opportunities (and risks) with accompanying shifts in harvesting pressure and institutional power dynamics. In this discussion, we explore a few of the key insights of this
research in greater depth, focusing on the differing impact pathways of shocks versus trends, the implications of such differences for community adaptive capacity and adaptation as well as for conceptions of feedbacks and thresholds in social systems.

2.5.1 Impact Pathways of Shock Versus Trends

By tracking the drivers and impacts of the top-mentioned social-ecological changes we were able to compare the impact pathways of the sea cucumber fishery to the impact pathways of slower trends (see Figure 2.2). From this, four key distinctions emerge. First, while social-ecological changes that were observed to be taking place over ten or more years were linked to drivers such as the establishment of the biosphere reserve, regional development, and population growth, the majority of recent and rapid local changes were connected to the start of commercial sea cucumber fishing. A second distinction is in perceptions of impacts on community functioning. Slower drivers (trends) were associated with changing conditions that caused both positively and negatively perceived impacts on community functioning. In contrast, fast changes attributed to the sea cucumber fishery were consistently described as having negative impacts on community functioning. The host of new issues and challenges that has emerged with sea cucumber fishing resulted in several respondents referring to sea cucumber as the key problem that the community faced, and a case of the social and ecological costs to the community outweighing the potential profits for participating fishers.
Figure 2.2 Impact Pathways of Shock Versus Trends

In this figure, the circles represent social and ecological changes, both drivers and impacts as mentioned in the interviews. Spatial scale is represented on the X-axis from global to local and temporal scale is represented on the Y-axis from faster to slower. Red circles demarcate changes that respondents linked back to the sea cucumber fishery. Blue circles show changing conditions that were associated with other drivers, and purple circles are changing conditions that were mentioned as contributed to by both the sea cucumber fishery and other drivers. Green boxes represent examples of community functions that were affected through changing conditions.

Third, changes driven by the fishery have exacerbated the negative impacts of several ongoing trends, such as declines in commercially important fish stocks. As migrant fishers harvest local species other than sea cucumber, the development of the fishery has amplified the harvesting pressure on species such as lobster and grouper that have been declining since the early 2000’s (Pedroza & Salas, 2011). Finally, it is also of note that compared to trends, a large portion of the local changes mentioned across interviews were connected to the sea cucumber fishery. The substantial attention that respondents gave to impacts of the rapid-onset fishery aligns with the literature on social impacts presented in section 2.2.2. This suggests that fast and dramatic

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change tends to be more noticeable, disturbing and, indeed ‘shocking’ than slower forms of change (Vanclay, 2002).

2.5.2 Implications of Shocks for Adaptive Capacity and Adaptation

What do the results tell us about how adaptation and adaptive capacity might be differentiated in regards to shocks versus trends? To the extent that they are novel and unforeseen, shocks afford limited opportunities for proactive adaptation. As well, the more acute the change at onset the less time local institutions have to develop response options that effectively mitigate impacts (Berkes, 2006; Eriksson et al., 2015b). Particularly telling is the rate of increased illegal fishing activity triggered by the fishery boom, as it has overwhelmed the capacity of local cooperatives to respond effectively. These dynamics suggest that greater adaptive capacity may be required for successful institutional response to shocks compared to trends. Such observations align with work by Carpenter et al. (2012) where they posit, “extreme events that are unusually intense or extensive require a more all-purpose kind of resilience” (p.3250). They suggest that novel, unforeseen and dramatic change often presents a formidable challenge for institutions as disturbance both “erodes capacity to organize and respond, and induces new feedbacks that tend to keep the system in the disturbed state” (Carpenter et al., 2012 p.3250). In situations of rapid-onset disturbance, swift action may be crucial but quick-fix responses that do not adequately consider longer-term consequences can lead to decreased resilience in the long run (Carpenter et al., 2012).
Observations made by most interviewees also indicate that there is a smaller range of response options available for community members to mitigate the impacts of shocks compared to trends. For example, in response to gradual stock declines, fishers have been diversifying their sources of income (e.g., participating in tourism) and advising younger generations to pursue education and training toward alternative livelihoods. In contrast, the local responses to dramatic changes driven by the fishery, such as vigilante efforts by cooperatives to enforce fishery closures, were described as ultimately ineffective for mitigating negative impacts. Other responses, such as increasing fishing effort, may in fact contribute to increased vulnerability over time by exacerbating the overexploitation of fish stocks.

Results also suggest that the psychosocial dimensions of adaptive capacity and response may vary between shocks and trends. For example, empowerment and agency are fundamental to effective adaptation (Lindsay & Boyd, 2010) while feeling overwhelmed by a change to the extent that it causes a reduced sense of agency can impact whether and how people choose to adapt (Grothman & Patt, 2005). For many respondents, the rate of increases in legal and illegal fishing pressure represented considerable challenges for fishery regulators and local cooperatives. Perceptions that government corruption, apathy and lack of action create a favourable environment for illegal fishing make this challenge seem all the more daunting. ‘Perceived adaptive capacity’, the extent to which people perceive themselves as having the ability to adaptively respond to a change or threat (Seara et al., 2016), may therefore vary in the face of dramatic and unforeseen change compared to gradually changing conditions.
2.5.3 Shocks & Social Thresholds

In SES scholarship, shocks (or perturbations) have been of particular concern because of their potential to push a system over a critical threshold into a less desirable state (Folke et al., 2010). Much of the thresholds research in SES has focused on conceptualizing and locating thresholds in ecological systems where “crossing over” can result in significant changes in ecosystem structure, function, and feedbacks (Walker et al., 2004). A smaller but growing body of work has broadened SES threshold scholarship by investigating the role of social and institutional threshold dynamics (Armitage et al., 2012; Nayak et al., 2015; Blythe, 2014; Christensen & Krogman, 2012). This includes conceptions of thresholds as points of change in social-ecological system identity (Blythe, 2014; Cumming et al., 2005) and thresholds at which there is a loss of capacity to learn and adapt (Renaud et al., 2013). Yet, current threshold characterizations are limited in their ability to conceptualize and communicate threshold effects that are significant in terms of social impact. For example, a threshold in social-ecological system identity that is defined by points of change in a resource or livelihood (e.g., fishers shifting into ranching livelihoods) may tell us little about the positive or negative social impacts that result from such a change process.

The social system framework presented in this paper may assist in identifying social thresholds that better elucidate the social impacts of system changes. For example, results from our case study highlight how rapid changes in components (e.g., new actors and new livelihoods) can overwhelm the capacity of institutions (e.g., cooperatives) to maintain desired social functions. Thus, a threshold might be understood as the point(s) at which pressure from a change is great enough to result in a loss of desired community functions, such as the ability to access or manage
local resources, or a sense of social cohesion. A second conception of thresholds might focus on feedbacks. In the ecological resilience literature, system thresholds are often considered to be the point where new feedbacks begin to reinforce the direction of change toward an alternate (undesirable) domain of attraction, or system state (Davidson, 2010). In social systems, a feedback-threshold might be defined as a point at which actors or institutions begin responding to change in ways that are predominantly ‘maladaptive’—i.e. result in increased vulnerability in the long run. A third area where social thresholds may be identified is through the perceptions of local actors who may experience a significant enough change in the quality of life, wellbeing, ability to adapt or social cohesion to feel they are in a different community. Finally, we also stress that there is a distinct difference between social thresholds and social-ecological thresholds—where the former refers to changes within the social system itself and the latter refers to a fundamental change in the nature of the relationship between social and ecological components of the system (e.g., as represented by level of impacts, types of activities, benefits from harvesting, or values towards nature).

2.6 Conclusion

The research presented here illustrates how rapid-onset sea cucumber fisheries, triggered by rising international demand, can emerge as ‘shocks’ in local social-ecological systems, driving fast and often unforeseen forms of change. Interview results demonstrate how the new fishery has driven dramatic changes in the community by sparking an influx of new actors, new livelihood risks and opportunities, and creating new pressures on local environmental resources. Such dramatic changes in structural components of the social system (the community) have combined with ongoing stressors to negatively impact aspects of community functioning,
including the ability to manage local marine resources, sustainability of fishing livelihoods, social cohesion, and sense of security.

By investigating a social driver of rapid change in coastal SES, this research contributes to broadening scholarship on community vulnerability and adaptation to include social stressors, while also highlighting the need to better differentiate the impacts of stressors at varying timescales (i.e. shocks and trends). Our social systems framework may support future efforts to identify the community level impacts of different trends and shocks. Further, this research contributes a rich empirical investigation of the social consequences that can occur during the ‘boom’ stage of rapid fishery development. Yet our understanding of the implications of and how to actually respond to these types of rapid changes remains limited. Accordingly, this study highlights the need for further research on the following: Additional case studies that differentiate the impacts of shocks versus trends; research that examines how to improve planning for and adapting in the face of social shocks; and continued efforts to improve understanding of social thresholds.

As novel forms of environmental and social change occur at unprecedented rates, shocks, both social and biophysical in origin, are likely to continue to have significant real world consequences. In this context, efforts to support thriving coastal communities and the ecosystems upon which they depend require improved understanding of how these communities experience and respond to such modern change.
Chapter 3: Synthesis and Conclusion

3.1 Summary of Contributions

This thesis has explored the impact that social shocks in the form of boom fisheries can have on coastal communities, including associated consequences for local vulnerability and adaptation. The case study presented in Chapter 2 demonstrates how the rising international value of and demand for sea cucumber products has triggered rapid change in a local social system, creating new challenges while exacerbating the stresses caused by slower ongoing trends. In doing so, this thesis makes several contributions to research on change in linked human and environmental systems.

First, by investigating the role of social drivers this thesis contributes to a recent body of work that broadens vulnerability and adaptation literature beyond its conventional climate change focus (see Breslow, 2016 and Hicks et al., 2015). While climate change research is and will continue to be essential for understanding community vulnerability in coastal zones, climate is far from being the only driver of change affecting these communities today. Indeed, many coastal communities face much more immediate forms of stress to which they must respond.

Second, by illustrating distinctions between the impact pathways of and local response to shocks versus trends, this thesis highlights the importance of differentiating the timescales of stressors in scholarship on social-ecological systems. Toward this end, the conceptual framework for social systems presented in Chapter 2 may better elucidate the social impacts of different drivers of change. By characterizing social system elements as structure, functions and feedbacks, this
framework provides language that is congruent for engaging social system impacts across the SES literatures. Moreover, by conceptualizing social system functions as the processes and outcomes (relational, psychological, material and physical) resulting from interacting system components, we have created conceptual space for deeper engagement with the social dimensions of SES. This thesis thus supports recent efforts by others to bring insights from social sciences to SES frameworks, including concepts of power, agency, values and social wellbeing (Armitage et al., 2012; Cote & Nightingale, 2012; Brown, 2013; Davidson, 2010; Murray et al., 2016).

This study also makes empirical contributions to scholarship on the social impacts of ‘boom and bust’ marine resources. While much of the research in this area has focused on community-level consequences during or following the decline of a given resource (see Hamilton et al., 2012; Milich, 1999; Zeigenhorn, 2000), Chapter 2 provides rich empirical descriptions of the impacts that can occur during the boom stage of such processes. Further, this thesis presents one of relatively few case studies to date specifically examining the social dimensions of the expanding global sea cucumber fishery.

3.2 Directions for Future Research

In conducting this investigation, a number of potential avenues for future research have become apparent. First, scholarship on multiple stressors would benefit from continued efforts to understand the role of broad social processes in driving change at the community level. Second, there is a need for further case studies characterizing differentiated impact pathways of shocks and trends and the implications of their differences for how and whether adaptive forms of
response take place. As a growing number of communities experience social-ecological change driven from the international seafood market, questions could be asked about whether and how aspects of vulnerability and adaptation have varied between communities with newly created versus pre-existing fisheries. Regarding sea cucumber fisheries, insights might be gained through comparative case studies of social impacts and adaptive response in communities that have experienced rapid-onset sea cucumber fishery development (such as Río Lagartos) and those that have a longer history of harvesting sea cucumber for both local and international markets (such as Palau).

Finally, the growing body of research on psychosocial (Turner & Clifton, 2009; Evans et al., 2016; Cunsulo Willox et al., 2015), cultural (Adger, 2012) and cognitive (Grothman & Patt, 2005; Kuruppu & Liverman, 2011; Ung et al., 2015) dimensions of climate change adaptation could be broadened to consider social drivers as well as give explicit consideration to different speeds of change. In light of results presented in this thesis, questions arise as to how human dimensions of adaptation differ in the context of rapid, dramatic and unexpected change compared to gradual trends. For instance, understanding the ways in which perceived adaptive capacity may differ in the face of trends versus shocks would provide useful considerations for targeting adaptation policy. Differentiation of trends and shocks may also engender better understanding of critical social thresholds at which substantial system change can occur.

3.3 Personal Reflections on the Research Process

One of the many valuable opportunities provided to me through this research project has been direct experience with qualitative field research methodologies. As a new researcher, this was an
exciting challenge, one that has involved countless moments of confusion, reflection, and learning.

During my time in the field, I used an interview protocol designed to elicit rich and candid narratives about key social-ecological changes observed by community members. Using broad and open-ended questions about how the community has changed over time, as well as the ‘ups and downs’ of daily life at individual and household levels, I aimed to draw out the ways in which different drivers of change were interacting to create new challenges, risks, benefits, and opportunities for locals. My hope was that such methods would result in an investigation of changes that were more locally relevant than changes that were pre-determined before entering the research context.

However, pursuing such a methodological approach required a large amount of in-field flexibility, including selecting which drivers of change would be the focus of the case study. Before heading into the field, I had presumed that more interview respondents would mention impacts associated with the local biosphere reserve, either immediately or when prompted. At that time I thought the research might focus on how changes driven by the biosphere reserve had interacted with other drivers of change to influence community vulnerability and resilience. However it soon became apparent through initial interviews that for most respondents the biosphere reserve, including its policies, programs, and staff, played a fairly innocuous role in community dynamics overall. Conversely, ongoing analysis of preliminary interview data showed that other issues such as increased housing pressure, new social conflicts, changes in fishing livelihoods and of course, the recent start of sea cucumber fishing, were given much
greater attention by respondents. So while I continued to include original prompts that focused on changes connected to the biosphere reserve, I also pursued emerging themes. Having had the ability to adapt my investigation to the local context has, upon reflection, only enhanced my appreciation for the capacity of ethnographic field methods to capture the type of nuanced social data required to illuminate local experiences of social-ecological change.

3.4 Concluding Remarks

Understanding how people experience and respond to modern forms of social and environmental change is a critical part of supporting resilient coastal communities and sustainable marine and coastal resource management. Without adequate attention to social dimensions, public sector resource management initiatives risk creating policy and programme interventions that exacerbate rather than reduce the impacts of stressors on communities. Yet, thoughtful and coherent integration of social and ecological systems remains a challenge both in theory and in practice. For research in the field of environmental change, this necessitates continued broadening of vulnerability and resilience paradigms beyond their initial ecological scope to include insights and assessment methodologies from the social sciences. Increased focus on social phenomena such as values, perceptions, and agency, will be essential for elucidating how and why some forms of change are more socially impactful than others, as well as the types of feedbacks they can trigger. Toward that end, I hope this thesis may provide some insights.
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## Appendices

### Appendix A  Sample Interview Schedule

**Checklist of points to cover before questions**
- Thank them for agreeing to the interview
- Review project & researchers
- We have about 15 questions to ask
- Reminder that there are no right or wrong answers- all thoughts and opinions appreciated
- Typically takes about 45 minutes but they should please take all the time they need
- Ask permission to record the conversation
- Let them know we will also be taking notes throughout

<table>
<thead>
<tr>
<th>English</th>
<th>Spanish</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic Profile</strong></td>
<td></td>
</tr>
<tr>
<td>1a. OK so let’s start with the basics- what is your name and age?</td>
<td>1a. Bueno, vamos a empezar con lo básico: ¿Cuál es su nombre y su edad?</td>
</tr>
<tr>
<td>1b. What do you do for a living and for how long?</td>
<td></td>
</tr>
<tr>
<td>1c. How long have you lived in Rio Lagartos?</td>
<td></td>
</tr>
<tr>
<td><strong>Community &amp; Change &amp; Drivers</strong></td>
<td></td>
</tr>
<tr>
<td>2a. Can you tell us a bit about living here?</td>
<td>2a. ¿Puede contarnos un poco acerca de la vida aquí?</td>
</tr>
<tr>
<td>2b. What do you like about Rio Lagartos? What is good/easy about living here? What is a bit bad/difficult?</td>
<td>2b. Que le gusta sobre Rio Lagartos- sobre viviendo acá? que es un poco malo/difícil?</td>
</tr>
<tr>
<td>2c. Have these things changed over time?</td>
<td>2c. Esos cosas han cambiado a través del tiempo?</td>
</tr>
<tr>
<td>3a. Can you tell us about what changes have occurred in Rio Lagartos over time? -What about in the last 10-15 years?</td>
<td>3a. ¿Puede contarnos sobre que cambios ha habido en Rio Lagartos a través de tiempo? -Y en los últimos 10-15 anos?</td>
</tr>
<tr>
<td>3b. What things have changed since you have lived here?</td>
<td>3b. ¿Qué cambios ha vivido durante el tiempo que ha estado aquí? ¿En su trabajo? -Podrían haber cambios sobre cómo vive la</td>
</tr>
</tbody>
</table>
-These could be changes in how people live
-what about changes in the environment
-or the economy?

3c. Why did this happen?

3c. ¿Cómo ocurrió esto?

### Impacts- Responses to Change -Adaptive Capacities

<table>
<thead>
<tr>
<th>Question</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4a. How do these changes affect life here for you and your family?</td>
<td>4a. ¿Cómo estos cambios afectan o afectaron su vida y la de su familia?</td>
</tr>
<tr>
<td>-Did the changes make life easier, more difficult? Why/how?</td>
<td>-Estos cambios hacen la vida aquí más fácil, difícil? Como?</td>
</tr>
<tr>
<td>4b. What about for other members of the community?</td>
<td>4b. Y para los otros miembros de la comunidad?</td>
</tr>
<tr>
<td>5a. How do you and your family adapt/deal with these changes?</td>
<td>5a. ¿Cómo usted y su familia lidian con estos cambios?</td>
</tr>
<tr>
<td>5b. And the other people in the community? How do they deal with that change?</td>
<td>5b. Y la otra gente en la comunidad, como lidia con eso? ¿Cómo viven aquí con ese cambio?/¿Cómo se ha adaptado la gente de Río Lagartos a eso,</td>
</tr>
<tr>
<td>5c. Are there things that make it easier to deal with it?</td>
<td>5c. Hay cosas que hacen que sea más fácil lidiar con eso? (cambios que ha mencionado?)</td>
</tr>
<tr>
<td>6a. For the other challenges that you have mentioned- How do you and your family deal with those challenges?</td>
<td>6a. Y los otros desafíos que mencionó - ¿Cómo usted y su familia sobreviven cuando esto pasa?</td>
</tr>
<tr>
<td>-How do you cope during times of…</td>
<td>-¿Cómo sobrevive durante el tiempo de…</td>
</tr>
<tr>
<td>-What do you do when…</td>
<td>-¿Qué hace usted y su familia cuando…</td>
</tr>
<tr>
<td>6b. And the rest of the community? How does the community deal with these difficulties?</td>
<td>6b. ¿Y el resto de la comunidad? ¿Qué hace fuerte a esta comunidad para enfrentar todas estas dificultades/ desafíos?</td>
</tr>
<tr>
<td>6c. Do people in the community help each other?</td>
<td>6c. ¿Se ayudan unos a otros en la comunidad? Como?</td>
</tr>
<tr>
<td>7a. Are there people or organizations that help community members in deal with these</td>
<td>7a. ¿Hay personas u organizaciones que ayudan a los miembros de la comunidad con este tipo de</td>
</tr>
<tr>
<td>biosphere reserve impacts</td>
<td>biosphere reserve impacts</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>ok, now i’d like to talk a bit about the biosphere reserve.</td>
<td>bueno, ahora vamos a platicar un poco sobre la reserva (ahora me gustaría platicar un poco sobre la reserva).</td>
</tr>
<tr>
<td>8a. do you know there is a biosphere reserve?</td>
<td>8a. ¿ya sabe que hay una reserva?</td>
</tr>
<tr>
<td>8b. within the park are there different rules for the people who enter?</td>
<td>8b. Dentro del parque- ¿existen diferentes reglas para los que entran ahí?</td>
</tr>
<tr>
<td>9a. can you tell us how this area is protected?</td>
<td>9a. ¿puede decirnos como ve que esta área esté protegida?</td>
</tr>
<tr>
<td>9b. how do you see the relationship between the people who work in the reserve and the community?</td>
<td>9b. Como es la relación de la gente que trabaja en la reserva con la comunidad?/¿Cómo conviven las personas que trabajan en la reserva con el área natural y con la gente de la comunidad?</td>
</tr>
<tr>
<td>9d. have these relations changed over time?</td>
<td>9c. ¿esos relaciones han cambiado a través del tiempo?</td>
</tr>
<tr>
<td>10a. what kinds of changes have occurred in relation to the biosphere reserve?</td>
<td>10a. ¿qué tipos de cambios han ocurrido relacionados con la reserva?</td>
</tr>
<tr>
<td>-what changes have happened in terms of environmental, or social, or economic?</td>
<td>- ¿qué cambios han habido con respecto al medio ambiente, o sociales, o económicos?</td>
</tr>
<tr>
<td>11a. what have been the main advantages of this biosphere, for you or your family?</td>
<td>11a. ¿cuáles son las principales ventajas de la reserva, para usted o su familia?</td>
</tr>
<tr>
<td>11b. for the rest of the community?</td>
<td>11b. ¿para el resto de la comunidad?</td>
</tr>
<tr>
<td>12a. are there disadvantages? what have been the main disadvantages for you and your family?</td>
<td>12a. ¿hay desventajas?/¿cuáles han sido las principales desventajas para usted y su familia?</td>
</tr>
<tr>
<td>12b. what about for the rest of the community?/ are there any disadvantages that the community is inside the reserve?</td>
<td>11b. ¿y para la comunidad?/ ¿hay alguna desventaja de que la comunidad esté en la reserva?</td>
</tr>
<tr>
<td>13a. how do people deal with that/those (the disadvantages)?</td>
<td>13a. ¿cómo superan estas desventajas en la comunidad?</td>
</tr>
<tr>
<td>13b. what about for you or your family?</td>
<td>13b. ¿y usted y su familia qué hacen?</td>
</tr>
<tr>
<td>help/hinder to adapt-</td>
<td></td>
</tr>
<tr>
<td>14a. is there anyone/any program that helps</td>
<td>14a. ¿hay alguien/algún programa que ayude a</td>
</tr>
</tbody>
</table>
### Wrap up

Ok I believe that is all of my questions. But before ending - Is there anything else that you would like to tell us? Something that you think we should know a bit more or that you would like to clarify?

Thank you very much for all your answers. We could not have success here without people like you sharing their opinions and experiences.

---

<table>
<thead>
<tr>
<th>the community deal with/resolve (that disadvantage?)</th>
<th>la gente de la comunidad a resolver estas desventajas?</th>
</tr>
</thead>
<tbody>
<tr>
<td>14b. In what ways does the biosphere reserve- it’s programs or staff help community members to adapt/ deal with the types of changes you have mentioned? / How does the biosphere reserve help community members?</td>
<td>14b. ¿De qué manera los programas o trabajadores de la Reserva ayudan a los miembros de la comunidad a adaptarse/ lidiar a los tipos de cambios que mencionaste? / ¿En qué ayudan los miembros de la Reserva a la comunidad?</td>
</tr>
</tbody>
</table>

### Potential for improvement

<table>
<thead>
<tr>
<th>15a. How could the biosphere reserve better support the community in dealing with the various changes and challenges that you have mentioned?</th>
<th>15a. Si estuviéramos a cargo de la Reserva, que harías diferente para ayudar a la comunidad para lidiar con esos cambios y retos que mencionaste?</th>
</tr>
</thead>
</table>

---

Bueno, creo que es el final de mis preguntas. Pero antes de terminar- ¿hay algo más que le gustaría decirnos? ¿Algo que piensa que deberíamos saber (compartirnos) o que le gustaría aclarar?

Muchas gracias por todas sus respuestas, no podríamos tener éxito aquí sin gente como usted que nos comparta sus opiniones y experiencias.