Bloom and Bust: A Political Ecology of Jellyfish Fisheries on the Miskitu Coast of Nicaragua

By

Matthew Fahrenbruch
M.S., University of Southern Mississippi, 2013
B.S., University of North Dakota, 2011
A.S., Dixie State College of Utah, 2007

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Chair: Peter H. Herlihy

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Stephen L. Egbert

____

Shannon O'Lear

____

Brent E. Metz

____

James H. Thorp

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The dissertation committee for Matthew L. Fahrenbruch certifies that this is the approved version of the following dissertation:

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Chair: Peter H. Herlihy

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ABSTRACT

The environment, economy, and culture of the Caribbean (Miskitu) Coast of Nicaragua have been fundamentally shaped, since the colonial period, by boom-and-bust extractive natural resource industries. Coastal residents, many of whom are indigenous or Afro-descendant, have historically had little influence over these industries. In 2003, however, the Nicaraguan government passed a new Communal Property Law (Law 445) that created 23 indigenous and Afro-descendant territories and initiated a multi-level natural resources governance regime that promised a role for these groups. A new extractive industry emerged shortly after the passage of Law 445. A foreign jellyfish processor arrived in the indigenous fishing village of Tuapi in 2008 looking to build a jellyfish processing facility (JPF) to make salted jellyfish for Chinese consumers. The venture failed; however, between 2013 and 2015, several processors arrived on the coast, and at least nine new JPFs were built. The JPFs employed hundreds of seasonal workers and processed millions of kilograms of jellyfish collected by local fishermen; however, production quickly fell after 2015. By 2018, most of the JPFs were abandoned or had re-tooled to process other species. In this dissertation, I use a political ecology approach to elucidate the multi-scale biophysical, political-economic, and cultural-historical factors that contributed to the boom and bust of the jellyfish fishery in order to contextualize it with past boom-and-bust extractive industries and the objectives of Law 445. I demonstrate that the fishery shared many characteristics with past boom-and-bust industries and that many challenges of the past still haunt natural resource governance on the coast. This dissertation provides essential documentation for the short-lived jellyfish fishery on the Miskitu Coast and a valuable case study for the growing body of literature on multi-level governance regimes and their operation on the ground, especially regarding indigenous territorial jurisdictions, implementation gaps, non-traditional resources, and Nicaragua's Law 445.

RESUMEN

El medio ambiente, la economía y la cultura de la costa caribeña (miskitu) de Nicaragua han sido moldeados fundamentalmente, desde el período colonial, por una serie de industrias extractivas de recursos naturales en auge y caída. Sin embargo, los residentes de la costa, muchos de los cuales son indígenas o afrodescendientes, históricamente han tenido poca influencia sobre estas industrias. En 2003, sin embargo, el gobierno nicaragüense adoptó una nueva Ley de Propiedad Comunal (Ley 445) que creó 23 nuevas jurisdicciones territoriales indígenas y afrodescendientes e inició un régimen de gobernanza de recursos naturales multinivel que prometía un mayor papel para estos grupos. Poco después de la aprobación de la Ley 445, surgió una nueva industria extractiva. Un grupo de procesadores de medusas extranjeros llegó al pequeño pueblo pesquero indígena de Tuapi en 2008 con la intención de construir una planta de procesamiento de medusas para hacer medusas saladas para los consumidores chinos. La empresa fracasó; sin embargo, entre 2013 y 2015 llegaron a la costa varios procesadores nuevos y se construyeron al menos nueve plantas nuevas. Las plantas emplearon a cientos de trabajadores estacionales y procesaron millones de kilogramos de medusas recolectadas por los pescadores locales; sin embargo, la producción cayó rápido después de 2015. Para 2018, la industria estaba en quiebra y la mayoría de las plantas fueron abandonadas o se habían modificado para procesar otras especies. En esta tesis, utilizo un enfoque de ecología política para dilucidar los factores biofísicos, político-económicos y culturales-históricos de múltiples escalas que contribuyeron al desarrollo, auge y caída de la pesquería de medusas para contextualizarla con las industrias extractivas pasadas y los objetivos de la Ley 445. Demuestro que la pesquería compartió muchas características con las industrias de auge y caída del pasado y que muchos desafíos del pasado todavía acechan la gobernanza de los recursos naturales en la costa. Esta disertación proporciona documentación esencial para la

pesquería de medusas de vida corta en la costa Miskitu y un valioso estudio de caso para el creciente cuerpo de literatura sobre regímenes de gobernanza multinivel y su operación sobre el terreno, especialmente en lo que respecta a jurisdicciones territoriales indígenas, brechas de implementación, recursos no-tradicionales y la Ley 445 de Nicaragua.

ACKNOWLEDGMENTS

The following dissertation is about jellyfish fisheries and multi-level natural resources governance. Suppose you are from a region outside of East or Southeast Asia. In that case, you may be thinking, “Why would anyone want to fish for jellyfish” and “what do jellyfish fisheries have to do with indigenous people in Nicaragua?” You are by no means alone, and by the end of this dissertation, I hope you will be able to answer these questions. In this section, however, I would like to give you an understanding of how my path in life led me to live for eight months on the Miskitu Coast of Nicaragua, primarily in rural fishing villages, studying jellyfish fisheries. I would also like to recognize those friends, family members, advisers, academics, and governmental officials who guided me along this path and made this investigation possible.

This dissertation results from a longstanding interest in natural resources, globalization, and Latin America that began when I was an undergraduate geography major at the University of North Dakota (UND). As a student scholar with the Ronald E. McNair Post-Baccalaureate Achievement Program at UND, I was allowed to work closely with my faculty mentor Dr. Bradley Rundquist on research projects. Early on, I focused on biogeography, geographic information systems (GIS), and remote sensing. In my first project, I used high-resolution aerial imagery to estimate the distribution of invasive common tansy (*Tanacetum vulgare*) in a U.S. Fish and Wildlife prairie recovery site in northwest Minnesota. This project led to my first professional conference poster presentation at the 2010 annual meeting of the Great Plains/Rocky Mountain division of the American Association of Geographers at the University of Kansas. It was at the meeting that I also met my future Ph.D. adviser, Dr. Peter Herlihy.

Between my junior and senior years at UND, my interests began to evolve. I was becoming more interested in globalization and the human aspects of natural resources as well as developing

a regional interest in Latin America. That summer, I worked as a vegetation monitoring intern for the Student Conservation Association in the Moab, Utah field office of the U.S. Bureau of Land Management. During an interview with the field office manager, I asked her what challenges the BLM was facing in terms of natural resource management. The manager related that demographic and cultural change, including a growing Hispanic population, was changing how the community was using natural resources. The specifics of this conversation are lost to my memory now, but the conversation planted a seed in my mind and marked an inflection point in my academic path.

When I began researching graduate schools, I sought out faculty interested in natural resources and Latin America. One faculty member I connected with was Mathew Taylor at the University of Denver. Dr. Taylor operated a field station in southwest Nicaragua, and he encouraged me to visit the area. In 2011, in my last semester at UND, I sacrificed a minor in biology to embark on a month-long *voluntourism* trip to the community of San Juan del Sur, Nicaragua. I lived with a local family, volunteered with a sustainable tourism NGO, and attended Spanish language classes. Through this immersive experience, I learned about the community's history as a fishing and shipping port and its recent meteoric growth into one of Nicaragua's preeminent beach and retirement tourism destinations. I also learned that a tsunami had hit the community in 1992 and that the Mid-America Trench subduction zone near the coast had a history of tsunami events. This caused me to wonder what would happen, given the fundamental changes to the community's economy since 1992, if a tsunami were to strike again. I carried this question forward into my Master's degree at the University of Southern Mississippi (USM).

At USM, I studied Latin America's physical and cultural geography, tourism development, and natural hazards, and I was introduced to political ecology. For my thesis research, I conducted six weeks of fieldwork in San Juan del Sur during the summer of 2012. I adapted a sustainability-vulnerability framework of geographer and Latin Americanist Billy Lee Turner to assess 18 variables that took into account the physical, socioeconomic, cultural, and political factors that would impact the community's exposure, sensitivity, and resilience to a tsunami event. I was fascinated by how the community was being affected, through tourism, by global political, cultural, and socioeconomic forces.

I was guided in this work by my adviser David Cochran and committee members Mark Miller and Bandana Kar. Dr. Miller's qualitative methods class provided me with the essential skills to collect and evaluate survey and interview data. Dr. Kar, a student of renowned hazards researcher Susan Cutter, provided valuable feedback on my methodology and approach to hazards research. Dr. Cochran, a Latin Americanist himself, provided the insight, leadership, and stability that helped me plan, execute, and write my thesis, and publish my first academic article in the *Journal of Latin American Geography*. Dr. Cochran also encouraged me to pursue a doctorate with his Ph.D. adviser Dr. Peter Herlihy.

A doctoral dissertation is a significant investment of time, energy, and resources, and I would not have been able to complete it without the generous support of those around me. I am most grateful to the Department of Geography and Atmospheric Science faculty at the University of Kansas for many years of financial support and instruction. I am particularly thankful to my Ph.D. adviser, Dr. Peter Herlihy, for his strong commitment to my education and tireless support during the editing and revision process of this dissertation and countless job letters and grant applications. I especially enjoyed Peter's seminar on the Columbian Exchanges. The course exposed me to several important works, including Alfred Crosby's seminal book, *The Columbian Exchange: Biological and cultural consequences of 1492*. The course and book have had a tremendous impact on my view of historical globalization and the jellyfish trade that I discuss below.

I would like to also extend my gratitude to Dr. Herlihy and Dr. Jerome Dobson. They provided me with substantial support as a Research Assistant on their prestigious U.S. Department of Defense Minerva Initiative project, *Central America Indígena.* My work on the project allowed me to develop my GIS and cartography skills, learn about indigenous land movements in Central America, and to amass over five months of valuable and immersive on-the-ground experience in the region. I first learned about jellyfish processing in the region on my first CA Indígena project trip to the Honduran Muskitia in 2014. Without this generous support, I would likely have not written this dissertation.

I would also like to thank Dr. Laura Hobson-Herlihy and the KU Center for Latin American and Caribbean Studies (CLACS). CLACS provided me with generous support throughout my time at KU, including a 2015 Robert Oppenheimer Memorial Scholarship that helped me to attend Dr. Hobson-Herlihy's Language and Culture in Nicaragua study abroad program in 2015. It was during this program that I first learned about jellyfish processing on the Miskitu Coast. In 2016, CLACS awarded me a Tinker Foundation Field Research Grant that allowed me to conduct an additional three weeks of preliminary fieldwork on the Miskitu Coast. During both of these trips, Dr. Hobson-Herlihy was invaluable in her ability and effort to help me network with individuals in and around Bilwi (Puerto Cabezas). Finally, in 2017, CLACS awarded me its prestigious Charles Stansifer Fellowship. In addition to my Fulbright U.S. Student Research Grant, the fellowship allowed me to conduct my fieldwork on the Miskitu Coast between August 2017 and April 2018.

Thank you to the Institute for International Education and the Fulbright U.S. Student Program for their grant support. Fulbright initially selected me as an alternate for the 2017 competition, and I am forever grateful that they ultimately chose me to receive an award. Thank you to the KU review committee, my adviser Dr. Herlihy, and KU Fulbright Coordinator, Dr. Rachel Sherman, who helped me develop my successful proposal. I am also indebted to Maya Andelson of the Institute for International Education, and Lisa Swenarski, Mirna Cisneros, Vanessa Harper, and Maira Vargas of the Bureau of Cultural Affairs in the U.S. Embassy in Managua. These individuals helped me with logistical support throughout my fieldwork, including straightening out my stipend distributions, helping me when I was stuck in Panama awaiting a yellow fever vaccine, and helping me book travel and accommodations during my two evacuations. I appreciate their concern for my safety and well-being, and their help was essential to the success of my time in Nicaragua.

In Nicaragua, I would like to thank the residents of Tuapi, Krukira, Bismuna, and Haulover, who shared with me their experiences of the jellyfish fishery. I would especially like to thank Facundo Johnson, Eduardo Bans, and Fabio Richinal and their respective families for the help and hospitality they afforded me during my stay in Tuapi. Thank you to Facundo and family for renting me a room and putting up with my sometimes tentative travel schedule. Thank you to Eduardo for his months of work and travel with me as my research assistant, Miskitu translator, and traveling companion, and thank you to Fabio for arranging my stay in the community and answering my many questions about communal governance and the jellyfish fishery in Tuapi. I would also like to thank Keith Narvaez in the Office for External Cooperation and Lenin Green in the Institute for Natural Resources, the Environment, and Sustainable Development at the University of the Autonomous Regions of the Caribbean Coast of Nicaragua. Their support before and during my Fulbright grant period was essential to the success of this dissertation. Thank you also to Javier Álvarez-Tello for corresponding with me about his experience with the jellyfish fisheries in Mexico and Nicaragua and providing me with an understanding of the early development of the fishery.

Finally, I would like to thank my colleagues and friends. During my years at KU, I had the opportunity to meet and know some exceptional individuals who brightened my life and helped me through good and challenging times. Thank you to Dr. John Kelly and his wife Sangeetha for their friendship and several wonderful dinner parties. Thank you to Dr. Aida Ramos and Dr. Brent Metz for their friendship that included many birthday parties, brunch dates at Wheatfields and First Watch, softball games, and loads of baby clothes and toys for Isabelle. Thank you to Taylor Tappan and his wife Sylvia for their friendship and the great firepits. Thank you to Kiera Smith, Diana Restrepo, Marisela Chávez, and Maged Noshi for making my experience at KU memorable and for becoming my family in Lawrence. Finally, thank you to my wife Melissa and daughter Isabelle. Balancing a doctoral program's demands is difficult enough for one person alone without having to account for a new baby and a wife earning her Master's Degree. Thank you to Melissa for the constant personal support and understanding over the last decade, especially during the many months that I was away from home. Isabelle, thank you for being a good eater and sleeper and for being adaptive to changing circumstances, be they changes in schedules caused by Covid-19 or chaotic moves to new homes in new cities.

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GLOSSARY OF SELECTED TERMS

Cannonball Jellyfish (*Stomolophus meleagris*): An edible syphozoan jellyfish exploited in the Americas and the only verified member of the stomolophus genius. Individuals are relatively small with a maximum bell diameter of between 20 and 25 cm, and a maximum weight of 1 to 2 kg. Coloration varies from white/translucent with brown borders or purple/red spots on the bells to a homogenous blue pigment (Figure 10, Chapter 3). They are wide ranging and have been reported from the Northeastern U.S. to Brazil in the western Atlantic, Gulf of Mexico, and the Caribbean Sea, from southern California to Ecuador in the eastern Pacific and from the Sea of Japan to the South China Sea in the western Pacific.

Cayuco: An open-air hand paddled boat similar to a canoe that is carved out of a tree trunk by artisanal boat makers. They are sometimes augmented with small sails and additional wood to increase the height of the gunwale.

Chinese Luxury Seafood Commodities (CLSC): A class of seafood commodities defined by their high price, significance in social practices, and use in Chinese traditional medicine. Examples include sea urchin, lobster, sea cucumber, fish maw, live reef fish, seahorse, geoduck, and jellyfish.

Communal Assembly (*Asamblea Comunal*): The Communal Assembly is the highest authority in the communal government and includes all adult members of the community. The assembly convenes to debate, approve/decline potential projects, or other actions being proposed by the *Junta Directiva*. Traditionally the communal assembly was called to a session to elect the members of the Junta Directive; however, in some communities, this practice has been replaced by secret ballot voting.

Council of Elders: A group of elders in the communal government that are chosen to advise the Junta Directiva.

Indigenous Territorial Jurisdiction (ITJ): Territories jointly administered by state and indigenous authorities under "sovereignty regimes" with functional and legal expressions for providing indigenous territoriality within the context of modern states (Herlihy and Tappan 2019, 69).

INPESCA: Nicaraguan Fisheries and Aquaculture Institute (Instituto Nicaraguense de la Pesca y Acuicultura). Created in 2007, INPESCA replaced and assumed the powers of the National Administration of Fisheries and Aquaculture and the General Directorate of Natural Resources over the nation's fisheries and aquaculture operations. The mission of the agency is to manage the use of Nicaraguan fisheries and aquaculture resources, contributing to sustainable development with environmental, economic, and social equity.

JPF: A Jellyfish processing factory is a facility that is designed and dedicated to the transformation of raw jellyfish into salted jellyfish.

***Junta Directiva*:** The junta directive serves as the executive branch of the communal government and is composed of the sindico and wihta(s) who are elected by the Communal Assembly.

Panga**:** An open-air fiberglass boat typically eight-meters or more in length built in a factory and imported into the region; they use gas-powered, outboard, two-cycle motors typically of 70-75 horsepower or greater, making them seaworthy.

RACCN/RACCS (RAAN/RAAS): The Northern and Southern Autonomous Regions of the Caribbean Coast (*Región Autónoma de la Costa Caribe Norte and Sur*). Prior to 2014, these regions were referred to as the Northern and Southern Autonomous Regions of the Atlantic Coast (Región Autónoma de la Costa Atlántica Norte and Sur.

SERENA: Secretary for Natural Resources (*Secretaría de Recursos Naturales*). SERENA is a regulatory body within both the Northern and Southern autonomous regional governments and is responsible for natural resources management in the regions.

Sindico**:** The sindico is an elected member of the *Junta Directiva* of the communal government. The sindico handles the business of the community, including negotiating and administering contracts for the sale of natural resources, soliciting development projects, and ensuring the protection, conservation, and sustainable use of the community's territory and natural resources. Communities typically have one Sindico that is elected by the communal assembly for a term of one or more years.

Scyphozoan Jellyfish: Scyphozoa are one of four classes of the Phylum cnidarian along with corals, sea anenomies, sea fans, and hydras. Syphozoa are known colloquially as 'true jellyfish' due to their symmetrical design. The majority of edible jellyfish species, including the cannonball jellyfish, belong to this class.

Wihta**:** A wihta is an elected member of the *Junta Directiva* of the communal government. They serve as justices of the peace and are responsible for litigating disputes within the community according to traditional customs. Communities can have more than one wihta, depending on their size. Wihtas are elected by the Communal Assembly for terms of one or more years, depending on community tradition.

YATAMA (***Yapti Tasba Masraka Nanih Aslatakanka*****):** A regional indigenous organization that formed in 1987 in the final years of the Sandinista-Contra war and became a major political force on the Miskitu Coast. Many consider YATAMA to represent traditional indigenous values, while the FSLN represents broader mestizo-Nicaraguan values.

CHAPTER 1: INTRODUCTION, METHODS, AND LITERATURE

INTRODUCTION

On March 2, 2008, a group from Moon International, a Mexican-Korean fishing company, arrived in the small Indigenous fishing community of Tuapi on the Caribbean (Miskitu) Coast of Nicaragua accompanied by officials from the Nicaraguan Institute for Fisheries and Aquaculture (INPESCA) and the regional government. Residents, mostly community leaders, fishermen, and their family members, gathered in the community's Moravian Church to hear the group's proposal to build a factory in the community to process cannonball jellyfish (*Stomolophus meleagris*) for export to consumers primarily in China. Although the residents were perplexed at the thought of eating a jellyfish—a trash species and common nuisance to local fishermen—the community embraced the project and anticipated the jobs it would create. Unbeknownst to them, the community was entering into a multi-million dollar global jellyfish trade driven by fundamental changes occurring on the other side of the world.

China is one of the fastest-growing export markets for Latin American commodities. In 1990, it consumed about one percent of Latin American exports; today, this number is closer to 10 percent (Kotschwar 2014). China's growing economy and consumer culture have fueled the growth of commodities like agricultural and mining products, seafood, and petroleum (Cesarin, 2004; Jenkins, Peters, and Moreira 2008; Kotschwar, 2014; Bebbington 2015). The meteoric growth of the Chinese middle-class (projected to reach 600 million by 2022) is disrupting the centuries-old global economic hegemony controlled by Western consumers' tastes (Barton, Chen, and Jin 2013; Bu et al. 2017). The consumption of animal proteins, as well as animal-based medicinal products, is seeing booming demand amongst Chinese consumers and is prompting the development of new and sometimes non-traditional extractive industries (Barton, Chen, and Jin

2013; CAPLOG, EDFM 2014; Laurance 2017). From the Himalayan caterpillar fungus, to the illegal African and Asian ivory trades, to the booming Latin American and African donkey skin trades, and even to the jellyfish boom on the Miskitu Coast, the cultural tastes of Chinese consumers are impacting peoples and environments worldwide and challenging natural resource governance (Clarke 2004; Barton, Chen, and Jin 2013; Shrestha and Bawa 2013; Page 2015; Joyce 2016; Purvis 2017; Laurance 2017; Runk-Velazquez and Vardeman 2018).

The Miskitu Coast jellyfish fishery officially began in late 2008 when Moon International established an experimental jellyfish processing factory (JPF) in Tuapi. Despite good production, the venture failed, and the JPF closed at the end of the year. Residents were disappointed, and for five years, the JPF sat dormant. In 2013, however, new jellyfish processors began arriving on the coast. Between 2013 and 2015, the Tuapi JPF was reopened, and at least nine new JPFs were established on the coast. Over this period, fishermen landed millions of kilograms of jellyfish, and the JPFs employed hundreds of seasonal workers to process them. However, as quickly as the fishery boomed, it busted. Production fell precipitously after 2015, and by 2018, most of the JPFs were abandoned, shuttered, or had re-tooled to process other marine species like scaled fish, conch, and sea cucumber. In less than a decade, the cannonball jellyfish was transformed from trash to treasure and back to trash again, leaving many residents wondering what happened.

The residents of the Miskitu Coast are not unaccustomed to such boom-and-bust natural resource extraction. Since the colonial period, the region has experienced a series of boom-and-bust extractive natural resource industries that have fundamentally shaped its environment, economy, and culture (Nietschmann 1973, Nietschmann 1979; Helms 1971; Offen 2004b; Pineda 2006). Despite this history, the residents of the region, many indigenous Miskitu or Afro-descendant Creoles, have historically had little influence over extractive industries (Hale 1996;

Offen 2004b; Baracco 2011). However, legislation enacted by the Nicaraguan government in recent years points to a shift in indigenous and Afro-descendant rights.

In 2003, the Nicaraguan government adopted Law 445: the Communal Property Regime of the Indigenous Peoples and Ethnic Communities of the Autonomous Regions of the Atlantic Coast of Nicaragua and of the Bocay, Coco, Indio, and Maíz Rivers (*Ley 445: Régimen de propiedad comunal de los pueblos indígenas y comunidades étnicas de las regiones autónomas de la Costa Atlántica de Nicaragua y de los ríos Bocay, Coco, Indio y Maiz*) (Asamblea Nacional de Nicaragua 2003). The Act provided the judicial basis for the titling of 23 indigenous and Afro-descendant territorial jurisdictions on the coast and initiated a multi-level governance system that promised the "full recognition of communal property ownership rights, the use, administration and management of traditional lands and their resources…" (Asamblea Nacional de Nicaragua 2003, Ch.1, Ar.2; Larson and Lewis-Mendoza 2012; Gonzáles 2016). This policy shift is one of several that have occurred in Latin America in recent decades as central governments have attempted to balance the need to develop natural resources with the rights of indigenous and ethnic minority citizens who are impacted by the development (Ortega 2004; McNeish 2012; Haarstad 2012).

The broad goal of this dissertation is to use a political ecology approach to elucidate the multi-scale biophysical, political-economic, and cultural-historical factors in the development, boom, and bust of the jellyfish fishery on the Miskitu Coast and to compare the fishery to past boom-and-bust extractive industries and the objectives of Law 445. I demonstrate that the jellyfish fishery shares many broad characteristics with past boom-and-bust industries and that many of the challenges of the past still haunt natural resource governance on the coast today. I contextualize this study within the nature-society, and political ecology literature to provide an in-depth ethnographic account of a jellyfish fishery, a type of fishery that is quickly growing worldwide.

This dissertation also provides essential documentation for the short-lived jellyfish fishery on the Miskitu Coast, and it is a valuable case study for the growing body of literature on multi-level governance regimes and their operation on the ground, especially regarding Law 445 in Nicaragua.

A note on definitions

I must define several terms for the sake of clarity in this dissertation. First, I use the term Miskitu Coast. The Miskitu Coast is a vernacular region in eastern Nicaragua that generally corresponds with the Northern and Southern Autonomous Regions of the Caribbean Coast (*Región Autónoma de la Costa Caribe Norte and Sur:* RACCN, RACCS). Before 2014, these regions were known as the Northern and Southern Autonomous Regions of the Atlantic Coast (*Región Autónoma de la Costa Atlántica Norte and Sur*: RAAN and RAAS). The official name change occurred in 2014 (in Chapter 11 of Law 854: Partial reform to the political constitution of the Republic of Nicaragua, *Ley 854: de reforma parcial a la constitución política de la república de Nicaragua*). This name change recognizes the coast's geographic location adjacent to the Caribbean Sea and almost 2,500 km from the Atlantic Ocean. Readers should realize that the Miskitu Coast is often referred to as the Caribbean or Atlantic Coast or as the Northern or Southern Autonomous Regions in official documents. Bilwi, the RACCN capital, is also often referred to as Puerto Cabezas.

Second, this dissertation analyzes a multi-level natural resources governance regime, sometimes also referred to as a co-management or participatory management regime (e.g., Armitage 2008; Armitage, Berkes, and Doubleday 2010; Schröter et al. 2014; Bixler, Dell'Angelo, Mfun, et al. 2015). The terms natural resource governance and natural resource management are often used synonymously. The difference between governance and management can be ambiguous but tends to break along the lines of ownership rights, comprehensive strategic planning, and day-to-day operations. In this dissertation, the term governance refers to the power to establish general visions or missions and policies, guidelines, and regulations that define stakeholders, territorial ownership rights, and to direct management activities related to natural resources extraction. On the other hand, I define management as the day-to-day operations and the planning and execution of actions to achieve the goals of those who have governance authority and ownership rights.

Third, I use the term *artisanal fisherman*. the Nicaraguan government defines artisanal fishermen as those fishermen who use boats of 15 meters or less in length, do not use mechanized fishing equipment (not including boat motors), and typically operate within lagoons, bays, or within three miles of the coastline and 25 miles of adjacent keys (INPESCA 2008; Asamblea Nacional de Nicaragua 2003, Art. 33; Asamblea Nacional de Nicaragua 2004, Art 12). I use this definition, in this dissertation.

Fourth, in this dissertation, I broadly define an extractive industry as an industry that is composed of firms whose business models are based on the systematic extraction, processing, and sale of raw materials from nature, including fishing (Scott 1962, 70). In contrast, I define an extraction-based economy as a national or regional economy chiefly dependent on extractive industries' activities. On the Miskitu Coast, I consider the jellyfish fishery to be an industry composed of several different businesses (JPFs) dedicated to the extraction and processing of jellyfish, which along with other extractive industries like lobster and shrimp fishing, mining, and lumber, have contributed to the coast's historically extractive economy.

Fifth, geographers and other social scientists have long been interested in boom-and-bust natural resource exploitation, and many have studied it from the standpoint of 'boomtowns' and boom-and-bust landscapes (Hostetter 2011, Billon and Good 2016, Jacobsen and Parker 2016).

When I use the term boom-and-bust extraction, I am not referring to these topics. The influx of persons from surrounding areas during the jellyfish season did create a carnival-like atmosphere in Tuapi; however, this atmosphere dissipated after the season ended. Tuapi and the other communities that participated in the jellyfish fishery were not boomtowns in the traditional sense. The communities did not exhibit the typical patterns of rapid infrastructure development and population gain that are characteristics of boomtowns based on stationary resources that can be exploited year-round, like timber or minerals (Hostetter 2011). In this dissertation, I elucidate the multi-scale human and biophysical processes that prompted the development, boom, and bust of the jellyfish fishery in an area where there was no previous history of jellyfish exploitation.

Finally, the term jellyfish processing factory, abbreviated as JPF, is used in the literature on jellyfish fisheries, and I use it here to provide continuity with this literature (e.g., Nishikawa, Thu, Ha, et al. 2008). The term jellyfish processing plant is also sometimes used in the literature; however, both terms allude to a facility that is designed and dedicated to the transformation of raw jellyfish into salted jellyfish, as discussed below.

Objectives of the Dissertation

This dissertation has three research objectives:

1) It documents the jellyfish fishery's operational area and its spatial distribution on the Miskitu Coast of Nicaragua. Working with Miskitu community authorities, local academics, and government natural resource management officials, I mapped the movement patterns of fishermen and JPF workers in the community of Tuapi, and the locations of JPFs along the Miskitu Coast. I identified the locations of the JPFs through field visits to JPF communities, and conversations with past jellyfish fishermen and government officials. I assessed the movement patterns of fishermen and plant workers during past seasons through a question on the Tuapi household survey that asked respondents to identify the origins of any non-local workers and fishermen that they encountered during their participation in the jellyfish fishery.

2) It identifies and profiles the different actor groups that formed the jellyfish fishery's operational and administrative structure. Actors include the National Fisheries and Aquaculture Institute (INPESCA), the office of the Secretary for Natural Resources (SERENA) of the autonomous regional governments, indigenous territorial and communal authorities, jellyfish processors, fishermen, and JPF workers. A profile includes documenting and understanding the actors' roles in the fishery and specific behaviors necessary to perform these roles. This also meant understanding the general biology of scyphozoan jellyfish and the observed behavior of cannonball jellyfish on the coast as reported by local fishermen. I accomplished this through household surveys, interviews, and a focus group in Tuapi; interviews with national, regional, territorial, and communal government authorities in Bilwi, Tuapi, Krukira, Haulover, Pearl Lagoon, Bismuna, and Managua; interviews and listening sessions in other JPF communities, and interviews with past JPF administrators, as detailed below.

3) It documents the relationships among the different actor groups that formed the jellyfish fishery's operational, administrative, and governance structure. These relationships are analyzed to compare the fishery to past extractive industries on the coast and explain how it developed, boomed, and ultimately busted. I document how the movements of fishermen, jellyfish, and plant workers between jurisdictions was governed, the roles of the INPESCA and SERENA in the governance of the fishery jellyfish fishery; the relationships between the JPF firms and their host communities, workers, and fishermen; and finally, the relationship between humans and the cannonball jellyfish. Although jellyfish were not 'active' participants in the operation or governance of the fishery, I reviewed the literature on the biology of the cannonball jellyfish and scyphozoan jellyfish in general, as well as the literature on other jellyfish fisheries, to contextualize the challenges faced on the Miskitu Coast.

METHODS

Participant Observation

This research was conducted between August 2017 and April 2018 on the Miskitu Coast of Nicaragua, with two additional preliminary visits in 2015 and 2016. I lived the majority of this time in the RACCN, residing in the small fishing community of Tuapi and the regional capital of Bilwi. I made research visits to the national capital Managua, the JPF communities of Krukira and Bismuna in the RACCN, and the JPF community of Haulover in the RACCS (Figure 1). JPFs were also reported to exist in the communities of Awastara, El Bluff, and Monkey Point; however, I did not have the opportunity to visit those communities.

I rented a room from a local family during my residence in Tuapi, allowing me to develop relationships that helped open doors in the community. I made observations through my participation in daily community life. I bathed in the river and drank and ate local food and water. I helped search for cows when they got out of their enclosures, I attended services at the Moravian Church, I helped haul aggregate for the church's new kitchen, I taught a few English classes in the evening, and nearly every day I walked out to the beach to observe and participate in the day's fishing activities. Unfortunately, the jellyfish fishery was not in operation during my field work, I was not able to achieve my original goal of actively participating in the jellyfish fishery; however, by living in Tuapi and participating in daily activities, as well as conducting interviews, household surveys, and a focus group, I gained an understanding of the jellyfish fishery and the general dynamics of making a life in a Miskitu fishing community.

Figure 1: A Map of Nicaragua and the Autonomous Regions of the Caribbean Coast, including selected communities and topographic features mentioned in the text as well as the principal roads connecting the Caribbean and Pacific coasts (grey lines). The Miskitu Coast is a vernacular region in eastern Nicaragua that generally corresponds with the Northern and Southern Autonomous Regions of the Caribbean Coast (Región Autónoma de la Costa Caribe Norte and Sur: RACCN, RACCS).

Household Survey, Interviews, Focus Groups, and Listening Sessions

The primary survey instrument was a three-part questionnaire that collected general data on individual and household demographics and economics, household member participation in the jellyfish fishery, and residents' opinions of the fishery (Table 1; Appendix),

Individual Variables		
Sex, Age, Ethnicity	Marriage Status	Relations to Head of Household
Profession and Education	Role(s) in the Jellyfish Fishery	Years the Individual Participated in the Jellyfish Fishery
General Household Variables		
Number of Persons in the Household	Age, Construction Material, and Style of the house	Number of Rooms and Structures in the House
Sources of Household Sustenance	Subsistence Activities that Support the Household	Economic (cash earning) Activities that Support the Household
Other Jellyfish Fishery Variables		
Estimated Weekly Household Income from Jellyfish Fishery	Type of Boat and Equipment Used and Ownership Status	Origins of Non-local Fishermen and JPF Workers
Likert Scale Opinions of Fishery		
JPF-Community Relations	JPF and Environmental Damage	Benefits from the Fishery

Table 1: Household Survey Variables

At the survey time, Tuapi had a total of 128 houses, and the goal was to survey each one. A team of four research assistants and I conducted the surveys over a week in December 2017 (the recruitment of the field assistants is discussed below). The field assistants worked in teams of two, and after each day's work, we met together to transfer the completed surveys, record hours of work, and plan the next day's activities. Following the daily meeting, I entered the surveys into Microsoft Excel. The team completed 119 surveys; five homes were not occupied at the survey time, and four households abstained.

In addition to the household surveys, I interviewed local actors in the jellyfish fishery, including communal and territorial authorities and various jellyfish fishermen and JPF workers in Bilwi, Tuapi, Bismuna, Krukira, and Haulover. I also met with fisheries managers and officials with INPESCA and SERENA in Bilwi and Managua. These interviews were semi-structured and focused on the interviewee's professional opinions, the role of their agencies in the development, operation, and governance of the jellyfish fishery, or both. In this dissertation, I use officials and professionals' names as these individuals are generally considered to be public figures serving in a public role. However, in the case of individual fishermen and JPF workers, I omit their names to avoid privacy concerns.

In addition to interviews, I also conducted a focus group in Tuapi and a listening session in the communities of Haulover and Bismuna. The Tuapi focus group occurred in December 2017 and included key participants in the jellyfish fishery, including communal leaders, prominent fishermen, and JPF workers (Figure 2). The focus group's goal was to understand the development and operation of the fishery in Tuapi and the local lived experiences of fishermen and JPF workers who participated. Follow-up interviews with many of these persons and some survey respondents were conducted following the household survey and focus group. Listening sessions were also held in the communities of Haulover and Bismuna in March 2018. Anyone was welcome to attend, and it was more of an open forum with the goal of gaining an understanding of the development and operation of the JPFs and the local lived experiences of fishermen and JPF workers who participated. The focus group and listening sessions all had between 10 and 15 participants each.

Figure 2: Photo of the Tuapi jellyfish fishery focus group, including select fishermen and former JPF workers (Source: Author 2017).

Field Assistant Recruitment

I conducted this research in collaboration with the Institute for Natural Resources, Environment, and Sustainable Development *(Instituto de Recursos Naturales Medio Ambiente y Desarrollo Sostenible:* IREMADES) in the Bilwi campus of the University of the Autonomous Regions of the Nicaraguan Caribbean Coast (*Universidad de las Regiones Autónomas de la Costa Caribe Nicaragüense*: URACCAN), as well as with the community of Tuapi. Two students were chosen by the sociology faculty at URACCAN to work with me as research assistants; the school does not have a geography program. The sociology students participated in the Tuapi focus group in December 2017, but because of a lack of support, chronic miscommunication, and concerns about their attitudes toward residents and their interest in the project, they did not participate in the household surveys.

I recruited four field assistants to help conduct the household survey from Tuapi. The selection of the assistants was done in coordination with the community justice of the peace/mayor, called *wihta* in Miskitu, and other elders. Requisites for the field assistants included their voluntary participation (without coercion), reading and writing skills, and being respected community members. They made a commitment to the work for about one week to complete the survey. A mutual agreement was made that assistants would be paid 25 Córdobas/hour (the equivalent of US$ 0.83) for this work. Of the four assistants chosen by the community, one was male, and three were female. The man was an elder and former fisherman; one woman was a student of cultural heritage conservation at URACCAN; another was a teacher at the Tuapi primary school, and the fourth was the wife of a local taxi driver. The survey was administered in the community by me and the four paid assistants. I reviewed the questions with the assistants to make sure that the questions were clear and that they understood what to do. The surveys were written in Spanish, so I needed to confirm that they could be translated by the investigators into Miskitu if necessary. All surveys were conducted in either Spanish or Miskitu, door-to-door, and in individual homes.

Government and Non-Governmental Documents and Reports

I used annual fisheries reports provided by INPESCA, as well as the UN Food and Agriculture Organization (FAO) data on world seafood production, trade, and consumption. All data on fisheries activities in Nicaragua (landings, production, and exports) are drawn from annual fisheries reports available on the INPESCA website (www.inpesca.gob.ni). The most recent annual report available from INPESCA is for the year 2018. Assertions made about the decline of the jellyfish fishery are based on personal observation and testimony from informants. Additional INPESCA policy documents are also referenced to provide context for the agency's actions in the development of the jellyfish fishery. I performed all Spanish to English translation of government documents and interview transcripts.

Data on food imports and consumption from the FAO is available through 2013. Data on global jellyfish production is available from the FAO through 2016, as is data from the World Bank on urbanization and GNI growth in China. All weights are reported in metric tons (MT) or kilograms (kg). All prices are reported in United States (U.S.) dollars unless preceded by the Nicaraguan Cordoba symbol (C). At the time of this research in 2017-18, the Cordoba/USD exchange rate range was about 30:1, and at the height of the jellyfish boom in December 2014, the exchange rate was approximately 27:1 (U.S. Department of the Treasury n.d.). Where possible, I pair historical currency figures with inflation-adjusted values, in 2020 U.S. dollars, to provide context.

Fisherman Cost/Benefit Analysis

For this dissertation, I conducted two cost-benefit analyses, based chiefly on technical data from interviews, household surveys, and boat/motor manufacturers, to demonstrate the importance of boat type and distance for determining fishermen profitability and fishery sustainability. Other than the processors, fishermen were the actors who participated the most in the fishery. Fishermen were the conduit through which the processors gained access to their raw materials. Many of the conflicts highlighted by community members had to do with a fishermen's ability to make an acceptable profit. I specifically discuss the impact of distance on fisherman resilience to fluctuations in jellyfish abundance and dock price and why the JPFs in Tuapi were more successful than the others on the coast.

I make several assumptions in my analyses about the fishermen and their operation within the jellyfish fishery. I assume that fishermen only earned cash income from the sale of jellyfish.

Fishermen are generalists who typically catch a variety of fish and other aquatic life. Larger fish are often sold for cash, while smaller fish are consumed within the household, providing sustenance that would otherwise need to be purchased at the market. As locals do not consume jellyfish, the cost-benefit analysis is based solely on the assumption that fishermen will not catch jellyfish if they cannot realize an acceptable cash profit.

Defining an acceptable cash profit is difficult and is likely an extremely personal question that will vary from fisherman to fisherman according to their individual contexts. However, C500 (~US $17) was identified by many fishermen I talked to as the bare minimum acceptable profit for a day's work. I assume that an expected profit above this level would generate increased interest in the jellyfish fishery, while an expected profit below this level would lead to a decrease in interest.

Estimated profits from a boat trip collecting jellyfish are calculated by subtracting expenses from gross income. After operating expenses are paid, profits are typically divided equally among the fishermen, with an additional share for boat maintenance. I assume that most participating fishermen used eight-meter long fiberglass *pangas* with 70 or 75 horsepower two-cycle outboard engines (a common setup on the coast) (Figure 3). The greatest operating expense incurred by an owner-operated panga crew is fuel and oil. Outboard engines are typically of two-cycle design and require a mixture of gasoline and oil to operate. This fuel mix was estimated to cost around C150/gallon in Tuapi during the jellyfish boom (Tuapi Focus Group, December 2017). While fuel costs varied somewhat along the coast, I use this figure as standard in all calculations.

Figure 3: Examples of panga style boats in Tuapi. (Source: Author 2017)

A typical panga set up with a good running 70 to 75 horsepower motor would burn about 7.3 gallons of fuel per hour at wide-open throttle (WOT) and about 0.5 gals/hr. at idle (Lee 2013; Yamaha Corporation n.d.). According to Carlos Downs, science technician and panga operator with URACCAN, an eight-meter panga with the above setup and a crew of four can do a maximum speed of about 45 kph unloaded at WOT, and about 30 kph loaded when sea conditions are calm (Downs 2017). Assuming calm sea conditions and a properly operating engine, this works out to an empty WOT burn rate of 0.16 gal/km (7.3 gals/hr. ÷ 45/kph) or a fuel cost of about C24/km at C150/gallon. The loaded WOT burn rate would be 0.24 gal/km or a fuel cost of C35/km, and the idle burn rate of 0.5 gals/hr. would equate to a fuel cost of about C73/hr. Based on my observations, I assume that fishermen want to maximize their time fishing and travel at or near WOT to get to and from the fishing area, but that they will minimize fuel burn during collection by operating at or near idle as much as possible. According to jellyfish fishermen, collection times varied from a half-hour to a couple of hours, depending on how abundant the "blooms" were.

An eight-meter panga has a maximum capacity of between 50 and 60 baskets of jellyfish (2,000-2,400 kg). One “basket” (a plastic container originally designed for beer) holds around 100 jellyfish and weighs 30 to 40kg; in this calculation I use a 40kg basket weight. To determine the cut-off between one and two trips, I use 60 baskets, assuming that fishermen will want to maximize their boats' limits. Anything up to 60 baskets is considered one trip, and anything above 60 baskets would be caught on a second trip.

I assume a best-case scenario where seas are calm and do not hinder travel, blooms are close (about a kilometer) to shore and abundant enough to fill a panga in one hour. Also, of course, this assumes that engines are in good working condition, and the crew can maneuver at or near idle speed while jellyfish are collected. It should be noted that any changes in the parameters, including a higher desired minimum profit, poor sea conditions, weak blooms, longer collection times, and a malfunctioning or worn engine, would all adversely impact the profits that fishermen realize. Likely, in everyday practice these conditions were not optimal, but by keeping them constant, it is easier to compare the situations in Tuapi with those in Krukira, Haulover, and Bismuna. With these variables controlled, the key variables of analysis are:

1. The number of baskets delivered per trip;
2. The dock price in C/basket received from the JPF;
3. The distance, and thus fuel cost, traveled on a fishing trip (Figure 4).

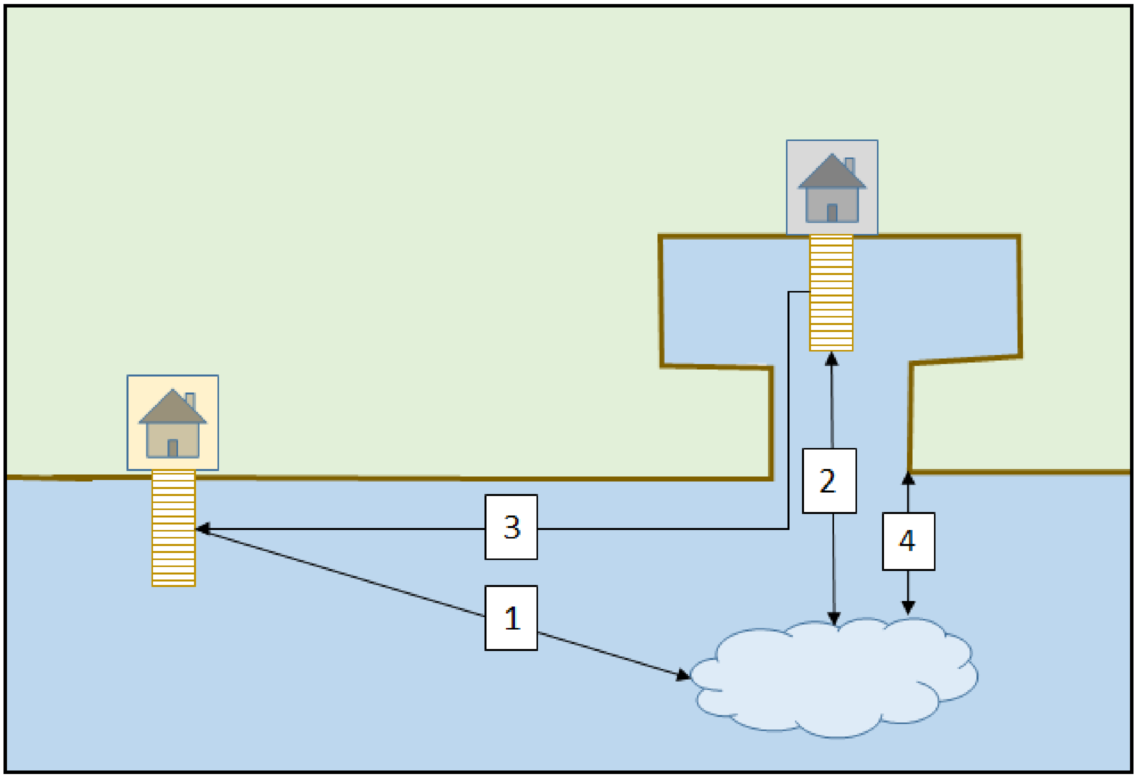

Figure 4: A simplified diagram of fisherman trip legs for jellyfish collection. Fishermen need to travel several legs on a jellyfish collection trip, including an empty leg between the home community dock and the fishing area (1), a loaded leg between the fishing area and the JPF (2), and an empty leg between the JPF and the home community dock (3). A second trip/collection adds an additional empty leg from the JPF to the fishing area and a loaded leg from the fishing area to the JPF.

Travel distances were estimated using the Google Earth path tool (Table 2). These are the estimated distances that a panga crew would need to travel on a fishing trip. Travel legs included an empty leg from the home community to the fishing area (Figure 4-1), a loaded leg from the fishing area to the JPF after collection (Figure 4-2), and an empty leg from the JPF back to the home community (Figure 4-3). The distance between the home community and the fishing area is measured from the community dock (the pier in Bilwi) to the fishing area. I define the fishing area as an area approximately 1 km off the coast adjacent to the river's mouth or waterbody that leads to the JPF (Figure 4-4). A second trip to the fishing area for collection would add an empty return leg to the fishing area from the JPF and a second loaded leg to the JPF from the fishing area. For all Tuapi estimations, I use the Poza Verde JPF because it is the closest to the sea and would be the best-case scenario for fishermen. Estimated travel distances, fuel usage, and fuel costs are reported in Table 2. These figures are used in the fisherman cost-benefit tables in Chapter 6, and the table cells that represent crew profit are calculated using the following formula.

$$\boldsymbol{Profit} = (\boldsymbol{BD}) - (\boldsymbol{35L} + \boldsymbol{24E} + \boldsymbol{0.5C})$$

B = # of Baskets of Jellyfish Sold to the JPF
D = Dock Price/Basket of Jellyfish
L = Kilometers Travelled Loaded
E = Kilometers Travelled Empty
C = Collection Time in Hours (1 hour/trip)
35 = Fuel Cost in C/km when Loaded
24 = Fuel Cost in C/km when Empty
0.5 = Fuel Cost in C/hr. when Idling

JPF	Distance (km) Empty/Loaded (1 Trip)	Distance (km) Empty/Loaded (2 Trip)	Est. Fuel Use (gal.) (1 Trip/2 Trip, inc. 1 hour collection time/trip)	Est. Fuel Cost @ C150/gallon (1 Trip/2Trip)
Tuapi: Poza Verde				
Tuapi	8/2	10/4	2.3/3.6	339/534
Pto. Cabezas	15/2	17/4	3.4/4.7	507/702
Krukira	33/2	35/4	6.3/7.6	939/1134
Krukira	6/6	12/12	2.9/5.8	435/870
Haulover	12/12	24/24	5.3/10.6	795/1590
Bismuna	14/14	28/28	6.1/12.2	915/1830
Way-Station	27/1	28/2	5.1/6.0	759/894

Table 2: Travel distances, fuel use, and fuel cost for panga fishermen from selected communities. This table includes the estimated distance and fuel burn by the number of trips, destination JPF, and origin community. Distances were estimated using the Google Earth path tool for the trip legs described above in Figure 4. Fuel use and fuel cost are based on the empty 0.16 gal/km burn rate (C24/km at C150/gallon), the loaded burn rate of 0.24 gal/km (C35/km), and the idle burn rate of 0.5 gals/hr (C73/hr). These figures are used in the calculation of the fisherman cost-benefit tables presented in Chapter 6.

RELEVANT LITERATURE

The Political Ecology Approach

Political ecology emerged in the 1970s and 1980s and combined cultural ecology and political economy (Bryant and Bailey 1997; Robbins 2004; Biersack and Greenberg 2006). This dissertation is theoretically rooted in the nature-society area of geographic scholarship. It uses a political ecology approach to assess the boom-and-bust of the Miskitu Coast jellyfish fishery. Political ecology is an especially useful framework for analyzing complex and multi-scale nature-society relationships, including the governance and exploitation of natural resources.

Within geography, political ecology can trace its roots back to renowned geographer Carl O. Sauer and the Sauerian School of cultural-historical geography (Steward 1955, Grossman 1977:132, Leighly 1987). At the turn of the 20th century, efforts to bridge human and environmental geography were defined by environmental determinists like Ellen Semple and Ellsworth Huntington, who applied the evolutionary theories of Darwin to argue that racial characteristics and sociocultural development were determined by physical environmental factors such as latitude and climate (Peet 1985). In response to environmental determinism, two schools of thought emerged that would define nature-society geography through mid-century (Zimmerer 2010). A group of self-defined 'human ecologists' formed around Harlan Barrows at the University of Chicago and became known as the 'Chicago School', and a separate group of cultural-historical geographers formed around Carl Sauer at the University of California at Berkeley (Zimmerer 2010). Both groups sought to explain the areal differentiation of humanity's adaptation to the environment, and both rejected environmental determinism; however, they had fundamental differences. Barrows and his students generally focused on human adjustment to environmental conditions, especially regarding natural hazards, while Sauer and his students focused on how humans alter the environment to suit their needs (Barrows 1923; Zimmerer 2010).

Sauer and his students criticized human ecology for focusing too much on human behavior and failing to address the wider cultural and historical contexts, as well as man's immense impact on the earth (Liverman 1990; Watts 1983; Zimmerer 2010). In his 1925 essay, "The Morphology of Landscape," Sauer (2007[1925]) defined a human agent-centered model of geography. To Sauer, geography was the cultural-historical study of how humans change the earth's surface and create landscapes to fit their material needs, termed "human geomorphisis" (Sauer 2009 [1931], 139).

Sauer and his students used historical evidence, ethnography, and methods from the natural sciences to interpret landscapes as artifacts of human expression, especially in rural Latin America (Sauer 1950; West 1948; Parsons 1954; Parsons 1955a; Parsons 1955b, 1962; Denevan 1961, 1966, 1971, Johannesen 1963; Nietschmann 1973; Leighly 1987). However, this approach was criticized for overgeneralizing and overemphasizing culture and not taking into account place-specific dynamics and socioeconomic and political power relations within cultures and the impacts of outside forces acting upon them (Brookfield 1964; Duncan 1980; Zimmerer 1996). This critique led to alternative approaches like cultural ecology and political ecology.

In cultural ecology, culture was considered to play a largely functionalist role in connecting humans and the environment. Settlement, agriculture, technology, and even social structures were considered human adaptations to the environment (Butzer 1989). Under the influence of the systems and adaptive dynamics approaches, cultural ecologists developed a heavy focus on energy flows, ecological equilibrium, and subsistence systems analysis at local scales (Zimmerer 2010). The economies of rural and subsistence-oriented cultures were heavily studied as they were perceived to provide a closer relationship between nature and society (Butzer 1976; Parsons and

Denevan 1967; Carneiro 1960; Aschmann 1959; Netting 1968). Cultural ecology, however, largely ignored the fact that, in an increasingly interconnected world, local-level cultural and ecological communities were embedded within larger political and socioeconomic structures (Bryant 1998).

The term "political ecology" was first coined by the anthropologist Eric Wolf in a brief article in a 1972 special issue of *Anthropological Quarterly* on the "Dynamics of Ownership in the Circum-Alpine Area" (Wolf 1972; Biersack 2006). In the article, Wolf posits the historical multi-scale political-economic chains of structural causation that help explain settlement and agricultural patterns in the Alps. Geographers made analogous observations in the 1980s and 1990s as 'chains of explanation' and 'networks' were explored to understand how human-environment relationships were affected by global development and conservation initiatives, structural adjustment programs, capitalist economic markets, international aid and financing programs and, pertinent to this dissertation, multi-scale politics of the environment and natural resources (Blaikie 1985; Blaikie and Brookfield 1987; Bryant and Bailey 1997; Robbins 2004).

For almost 30 years, political ecology has been an expansive and contested approach that geographers and other social and environmental scientists have used to explain human-environment relations (Zimmerer and Bassett 2003; Robbins 2004; Neumann 2014). There are now a variety of theoretical approaches, but there are common threads. Political ecology, as a methodological framework, carries forward the traditions of historical, ethnographic, and ecological analysis of cultural-historical geography and cultural ecology; however, it is distinguishable from these approaches by its incorporation of political economy and multi-scale analysis (Blaikie 1985; Blaikie and Brookfield 1987; Offen 2004a; Neumann 2014). Political ecologists subscribe to the idea that multi-scale political, economic, and biophysical processes, nested within cultural-historical context, define human-environment relationships at different levels (Zimmerer and Basset 2003, Offen 2004a, Robbins 2004). Notwithstanding critiques questioning political ecology's asymmetrical leaning towards either the biophysical or the political-economic (Pete and Watts 1996; Walker 2005), political ecologists seek to bridge the social and natural sciences to understand how human processes impact the environment, but also how biophysical processes impact humans. This dissertation also seeks to build such bridges as the jellyfish was not an exploited resource on the Miskitu Coast until a combination of biophysical and local, national, and international human 'chains of causation' linked together to make it so (Zimmerer and Bassett 2003; Neumann 2014).

Boom-and-bust Natural Resource Exploitation.

Geographers and other social scientists have long been interested in boom-and-bust natural resource exploitation and in elucidating the multi-scale biophysical and human factors that cause it. Two ways that boom-and-bust natural resource extraction is characterized in the literature provide insight into the boom-and-bust of the Miskitu Coast jellyfish fishery. The first shows how changes in demand or supply can be caused by changes in cultural tastes, and the political, social, and economic landscapes that suppliers and consumers operate in, and the second illustrates how changes in supply can be caused by localized degradation or depletion of the natural resource base.

In *Personal Narrative of Travels to the Equinoctial Regions of America, During the Years 1799-1804*, Alexander Humboldt and Aime Bonpland provided one of the earliest accounts of a boom-and-bust resource industry in the Americas, the pearl oyster fisheries of Venezuela. First identified by Columbus on his third voyage in 1498, pearl-producing oysters were abundant around the islands of Cubagua, Coche, and Margarita off the northeast coast of Venezuela, and it did not take long for word to reach Spanish traders. Pearls were in high demand in Europe, and by the 16^{th}

century, the pearl fisheries of Venezuela were celebrated on the level of the famous fisheries of the Persian Gulf and Sri Lanka (von Humboldt and Bonpland 2012 [1818]).

Exploitation was tempered in the early years of the fishery. The production of pearls relied on the willingness and ability of indigenous Guayaquer divers (also known as the Guayaquil), who lived on the island of Margarita, to collect and trade the pearls (Romero, Chilbert, and Eisenhart 1999). By 1519, however, the area was a booming frontier, and as more Europeans arrived, the demand for pearls and the abuse of the Guayaquer increased (Romero, Chilbert, and Eisenhart 1999, 63). Attempts to enslave the Guayaquer resulted in a short-lived rebellion in 1520; however, this did little to quell the demand for the pearls (Romero, Chilbert, and Eisenhart 1999).

In 1528, as demand increased for the pearls and the tax revenue they generated, the intensity of exploitation and degradation increased. The use of dredges was authorized by the Spanish government, and exploitation increased significantly; the oysters began to be exploited year-round without rest (von Humboldt and Bonpland 2012 [1818]). Furthermore, the increasing popularity of cut diamonds and Venetian imitation pearls in Europe decreased the demand for natural pearls, while overexploitation was degrading the fishery and making it less profitable (von Humboldt and Bonpland 2012 [1818]). The Spanish attempted to regulate the fishery, but these efforts were ineffectual, and by 1535, pearl production had collapsed. Rampant consumer demand in Europe and weak development/tax-minded regulations fueled the boom, but overexploitation and degradation of the fishery ultimately led to its bust when demand declined.

In his article, The Making and Unmaking of a Natural Resource: The Salt Industry of Coastal Southeastern Massachusetts, geographer William Meyer (2013) described the rise and fall of a different boom market in the Americas, the sea salt industry on Cape Cod. Before the American Revolution, seawater was not exploited on Cape Cod. However, this changed during and after the war because of a combination of natural, political-economic, and cultural forces. State subsidies and tariffs, high salt prices during and after the war, and Cape Cod's poor soils for agriculture and lack of economic opportunities for retired seamen all helped precipitate a boom in the development and expansion of small-scale salt-works on the Cape (Meyer 2013). Eventually, however, the tariffs were phased out and imports of cheaper mined salt flooded the market which reduced the profitability sea-salt and busted the boom. In Meyer's words, "It was not a natural but a political fact that was principally responsible for the making and unmaking of saltwater as a profitable resource in southeastern Massachusetts." Unlike Venezuela's pearl fishery, Cape Cod did not run out of saltwater, but it did run out of the subsidies and tariffs that made sea-salt making profitable.

In his book chapter, How Sushi Went Global, Anthropologist Theodor Bestor discusses the making of the lucrative bluefin tuna fishery in New England and the rise of sushi consumption in North America (Bestor 2003). Before the 1970s, the bluefin was a sport fish in New England, valued for their 'fight', but to commercial fishermen, they were a trash species sold for "cat food" when possible and trashed when not (Bestor 2003, 288). However, the tuna's trash status changed in the 1970s when fishing laws and environmentalist pressures suppressed the Japanese tuna fishery and brought Japanese buyers to the docks of New England. Driven by booming Japanese demand, trash was transformed into treasure within a few years, and U.S. bluefin production increased 61 percent between 1984 and 1993 (Bestor 2003).

In the 1990s, Japan's economy stagnated, however, and the demand for New England bluefin collapsed. However, the impact on the New England fishery was mitigated by a cultural shift in North America. Before the 1970s, sushi consumption in North America was rare. Still, the emergence of Japan as a global economic power, and a rejection of "red-meat American fare" in the 1970s, led to a boom in sushi consumption; what was culturally disgusting and even unpatriotic in the years following World War II became exotic and hip (Bestor 2003, 287). The introduction of a market from Japan, promoted by overexploitation and changing regulations, made the bluefin an exploitable resource in New England. Still, cultural changes and increased domestic consumption maintained the demand even after the original market busted.

These three accounts demonstrate that natural resources are dynamic constructions of human and biophysical processes that shift over time and space; what is an exploitable resource in one time and place is not necessarily so in a different time and place. Without high demand, weak regulations, and a plentiful oyster stock, Spanish traders would have had little incentive to compete with the established pearl fisheries of the Persian Gulf and Sri Lanka. Without wartime tariffs and subsidies, making sea salt on Cape Cod would likely never have been profitable. Without overexploitation and regulation in Japan, Japanese tuna buyers may have never landed on New England docks ready to pay top-dollar for cat food, and without a strong cultural shift in the U.S., neither would Americans.

The second approach to boom-and-bust natural resource exploitation considers changes in supply caused by localized degradation or depletion of the natural resource base. Natural resources are the basic material input and the final product of any extractive industry. Without plentiful pearls, saltwater, and tuna, the resource extractors highlighted above would have had nothing to sell regardless of demand and political environment. Furthermore, if it was not for the degradation of the pearl stocks, the Venezuelan fishery may have been able to weather the downturn in European demand, and it was in part overexploitation of Japanese fisheries that prompted a geographic shift to North American waters. It is this geographic pattern of boom-and-bust natural resource extraction, and destruction, which has particularly interested geographers.

In two 1938 essays, geographer Carl Sauer heavily criticized the predatory nature of capitalist-industrial natural resource exploitation that 'recklessly glutted resources for quick profit' (Sauer 1938, 767; Sauer 2009[1938]). He highlighted examples of an expansive geographic pattern of natural resource exploitation that he termed "destructive exploitation", including industrial agriculture (specifically tobacco) and the hunting and trapping of wild animals for what he called the "China trade."

> "The westward movement of Virginians was conditioned largely by the destruction of the land through tobacco. The development of the China trade via Cape Horn and the Chinese demand for furs and other animal products led quickly to the spoliation of pelagic mammals from the Falkland and South Orkney Islands to the Bering Sea" (Sauer 1938, 767-768).

> "We have accustomed ourselves to think of ever expanding productive capacity, of ever fresh spaces of the world to be filled with people, of ever new discoveries of kinds and sources of raw materials or continuous technical progress operating indefinitely to solve problems of supply…Land has been a cheap commodity... It has been most profitable to use up the land and reinvest the profits in new land, there to repeat the process of [destructive] exploitation…men have not settled on the land expecting to build their permanent homes [and] to have their children's children enjoy the acres which they brought under cultivation. The first wave move on to newer fields. The residuary legatees increasingly have had left to them the problem of living in economically devastated areas" (Sauer 2009[1938], 245-247).

Although Sauer does not use the term explicitly, in these examples, he is describing a boom-and-bust geographic pattern of exploitation (boom), exhaustion (bust), and expansion to new areas. Similar destructive patterns have been described for the forests in the U.S., Southeast Asia, and the Amazon (Hurst 1990; Williams 1991; Bryant, Rigg, and Scott 1993; Rodrigues et al. 2009); river turtles in the Amazon and the U.S. (Coker 1906; Smith 1974; Parks 2019); Amazonian rubber trees (Barham and Coombes 1994a;b); Caribbean sugar plantations (Moore 2010a; Moore 2010b); Malaysian cacao (Clough, Faust, and Tscharntke 2009); tuna, cod, and oyster fisheries (Innis 1940; Romero, Chilbert, and Eisenhart 1999; Campling 2012); and many resources in Nicaragua that will be discussed in the next chapter. 'Sequential exploitation', a recent term use in the ecology and fisheries literature, has also been used to describe a similar pattern of destructive exploitation of fisheries around the world (Berkes et al., 2006; Huitric 2005; Scales, Balmford, Liu, et al. 2006; FAO 2009; Anderson et al. 2011).

In the cases above, resource extraction emerged and boomed in response to market demand but eventually busted. In the case of the Venezuelan pearl fisheries, Humboldt and Bonpland blamed reduced demand in Europe but also degradation of the fishery and increasing production costs for precipitating the bust. In many cases, market demand for commodities does not necessarily bust, only the ability of a specific place to supply the desired commodity. The foreign-based traders that drive these boom markets typically hold little vested interest in the localities they exploit and seek only to extract as much as they can before moving on to the next location, much as Sauer described in 1938 (Berkes et al., 2006; Scales, Balmford, Liu, et al. 2006; FAO, 2009).

Geographers have more recently attempted to theorize these expansive exploitation patterns through commodity frontier theory. Much as Sauer argued in 1938, proponents of commodity frontier theory argues that capitalist-industrial natural resource exploitation is predicated on the continuous appropriation of nature by expanding commodity frontiers away from mature, less profitable, frontiers and into richer, less exploited frontiers[1] (Moore 2010a; Moore 2010b; Baglioni and Campling 2017). As with any frontier, pioneers and speculators drive frontier expansion by accepting high risk in hopes of high reward (profit). At first, conditions in a newly expanded commodity frontier are conducive to capitalist-industrial natural resource exploitation. The 'pioneers' find natural resources that are plentiful and cheap to extract, and by arriving first, they face low competition. A frontier 'matures' as more persons and companies move in, as regulations are established, and as resources are depleted. Maturation decreases risk, but it also decreases rewards as the pioneers now have to share a reduced resource base with the latecomers and the government in the form of increased regulation and competition (Moore 2010a, Moore 2010b; Baglioni and Campling 2017). Maturation can cause a crisis of profitability for extractors that drives them to expand commodity frontiers into new areas with less competition, more resources, and less oversight (Moore 2010a, Moore 2010b; Baglioni and Campling 2017). In this dissertation, I argue that the development of the Miskitu Coast jellyfish fishery is an example of commodity frontier expansion driven by high demand and the maturation of traditional fisheries in China and more recent fisheries in Mexico.

[1] The term commodity frontier here represents a geographic area with high surpluses of un-tapped or under-exploited natural resources such as virgin forests, untilled soils, and unexploited wild animal populations that are coming under commercial exploitation (Moore 2000; 2010a). These areas do not have to be geographically connected to areas previously exploited. The expansion of the commercial tuna market from Japan to the U.S. is an example of an expanding commodity frontier even though the expansion was thousands of miles from the Pacific Ocean to the Atlantic. In this case, the Japanese traders hopped from one resource pool to the next.

The Problem of Nature

Natural resources are both the basic material input and the final product of extractive firms. Although the social value of natural resources is a human construction, they are nonetheless physical and biological entities/materials and have inherent biophysical characteristics that extractive firms must contend with (Boyd, Prudham, and Schurman 2001; Bridge 2009; Baglioni and Campling 2017; Boyd and Pudham 2017). These biophysical characteristics are a major source of conflict as extractive firms engage in a never-ending struggle to control for uncertainty through the standardization and simplification nature's production (Moore 2010a; Moore 2010b; Baglioni and Campling 2017; Boyd and Pudham 2017). The literature refers to this conflict as the “problem of nature” (Boyd, Prudham, and Schurman 2001, 556; Boyd and Pudham 2017).

For some natural resources, such as agricultural and aquacultural commodities, control of production has been achieved to a large extent. Although uncertainty still exists, a rancher or fish farmer can control many factors of production. A rancher knows how many cows he has, how many of his heifers are pregnant, and how many calves he can expect in the spring. Through the use of guard dogs, enclosures, medications, and insurance, the rancher can reduce unexpected losses. Similarly, a fish farmer knows in advance what fish he is going to raise, what his input costs will be, and what yield he can expect (Boyd, Prudham, and Schurman 2001; Boyd and Pudham 2017).

For wild animals, there is an innate difficulty in economically controlling, or manipulating their biophysical characteristics, and the hunters and fishermen that supply these ‘uncontrollable’ resources face significant uncertainty. Extractors of these, and other resources, have had to adapt to a variety of unpredictable processes such as natural schedules of (re)production, natural quantities and distributions, the subsequent challenges of in-situ production including operating in harsh and often remote conditions, and the physical characteristics of the resources like perishability (Boyd, Prudham, and Schurman 2001; Boyd and Prudham 2017). One of the most extreme examples, fishing, is defined by relatively unpredictable ocean conditions, an 'invisible,' and mobile stock, and sometimes great seasonal variation (Marchack et al. 1987; Apostle and Barrett 1992; Boyd, Prudham, and Schurman 2001; Boyd and Pudham 2017). These challenges have also characterized the Miskitu Coast jellyfish fishery and will be considered further below.

Multi-Level Natural Resource Governance

As highlighted above, capitalist-industrial natural resource exploitation is predicated on the continuous appropriation of nature through the expansion of commodity frontiers into new 'untapped' areas. In recent decades, this expansion—including that on the Miskitu Coast—has been increasingly into areas traditionally occupied by indigenous peoples. Since the 1960s, indigenous and ethnic minority groups throughout Latin America have responded by lobbying national legislatures for legal recognition and protection of their cultural practices and control over their lands, waters, and natural resources. Indigenous demands have increasingly been codified in national constitutions and international conventions in recent decades.

The 1989 Indigenous and Tribal Peoples Convention 169 of the International Labor Organization (ILO 169) is an international convention ratified by 22 countries, including Nicaragua, which establishes standards for the treatment of indigenous peoples (ILO 1989). The convention's authors and signatories recognize the aspirations and fundamental rights of indigenous peoples to "exercise control over their institutions, ways of life and economic development and to maintain and develop their identities, languages, and religions, within the framework of the States in which they live" (ILO 1989, Preamble). These include the right to legally own and possess the land they have traditionally occupied and the right to participate in the use, management, and conservation of their natural resources (ILO 1989, Art 15.1).

A second international convention is the non-binding 2007 United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). As with ILO 169, the authors and signatories (including Nicaragua) declare the rights of indigenous peoples to own, develop, use, and control the "total environment" of their traditional territories, including land, air, water, and flora and fauna (UN 2007, Art. 26). They have rights to the conservation, restoration, and protection of their total environment with state and international assistance, the rights to determine and develop strategies for the development of their lands and resources, and the rights to free, informed, and prior consent, and just compensation for projects that impact them (UN 2007, Arts. 28, 30).

Under internal and international pressure, many states have recognized indigenous movements' demands for greater self-determination and autonomous legal control over their traditional territories and natural resources (Offen 2003; Ortega 2004; González 2015; Larson et al. 2016; Herlihy and Tappan 2019). In what Herlihy (1989) refers to as a "quiet revolution," indigenous movements have succeeded in gaining legal territorial title and autonomy over their lands and waters, and in doing so, have redrawn national maps (Ortega 2004; González 2015; Haarstad 2012; Kelly et al. 2017; Herlihy and Tappan 2019).

In recent decades, hundreds of thousands of hectares of territory have passed to indigenous control in Central America alone (Herlihy 1989, Larson et al. 2016; González 2015; Herlihy and Tappan 2019). Many of these new territories are governed as semi-autonomous "indigenous territorial jurisdictions" (ITJs) within broader multi-level governance frameworks of the states in which they exist (Ortega 2004; Larson and Soto 2012, Larson and Medoza-Lewis 2012; Baracco 2019; Herlihy and Tappan 2019, 69). Today, about 18 percent of the region is covered by ITJs, and in some countries, they encompass significant portions of the national territory, including one-third of Nicaragua and Honduras, one-quarter of Panama, and one-fifth of Costa Rica (Herlihy 1989, 2003; Herlihy and Tappan 2019; Herlihy, Fahrenbruch, and Tappan 2020). Despite these gains, there are persistent questions about what autonomy actually means on the ground within these larger multi-level governance regimes (Stevens 1997; Ortega 2004; Larson and Medoza-Lewis 2012; Finley-Brooks 2016; González 2019; Herlihy and Tappan 2019; Herlihy, Fahrenbruch, and Tappan 2020).

Within political ecology, multi-level governance regimes fit broadly within the ‘conservation and control’ thesis that interrogates the role of the state and foreign markets within conservation and natural resource management regimes (Zimmerer and Bassett 2003, 5-7; Robbins 2004, 129-170; Bixler, Dell’Angelo, Mfun, et al. 2015). The core of this thesis is that conservation and resource governance regimes are largely founded upon top-down neocolonial legacies of development, backed by apolitical Malthusian "tragedy of the commons" narratives that marginalize local governance (Stevens 1997; Robbins 2004). These regimes encourage the integration of local production systems into larger capitalist markets as part of top-down development strategies, but the result more often than not is marginalization of local populations, and increased conflict between the state and local users (Zimmerer and Bassett 2003, 5-7; Robbins 2004, 149-170; Bixler, Dell’Angelo, Mfun, et al. 2015).

The objectives of multi-level governance is to alleviate conflicts and increase efficiency by delegating some state functions—often related to the day-to-day management of natural resources—to lower levels of government. Logistically, the incorporation of locals can help reduce the state’s data gathering and enforcement costs, especially in remote regions that are hard to study and patrol (Pinkerton 1989; Carlson and Berks 2005). Additionally, locals interact with their natural resources daily and may be the first to recognize degradation and the best to help formulate and enforce rules on exploitation (Pinkerton 1989; Carlson and Berks 2005). Politically, multi-level regimes give locals a voice in natural resource exploitation decisions that may help stave off future conflicts (Pinkerton 1989; Carlson and Berks 2005).

Multi-level governance, however, does have large pitfalls, especially in terms of indigenous policy (Alfred and Corntassel 2005; Alfred 2009; Offen 2003; Hale 2005, 2011). Reviews of multi-level governance regimes involving indigenous peoples in Latin America (Ortega 2004; Larson and Soto 2012; González 2015), Canada (Alfred 2009), Europe, Canada, and Asia (Armitage 2008), and Africa (Wily 2003), identified several pitfalls. First is the assumption that the regime can operate correctly, given the vast power imbalances and cultural differences between the different levels of government (Pomeroy and Berks 1997; Castro and Nielsen 2001; Capistrano and Charles 2012; Alfred 2009; McNeish 2012). Central government personnel are often reluctant to redistribute powers to local officials who may not share the same values or education level. Indigenous groups face substantial difficulties in these situations because of cultural frictions, weak political capital, lack of access to legal assistance, and the general complexity of administrative and judicial systems that discourage them from challenging the state (Castro and Nielsen 2001; Natcher et al. 2005; Gisela and Wong 2018).

Even when 'power' is transferred, the results vary greatly. In some cases, local officials are given cursory roles as local 'advisors' to the state while, on the other side, participatory regimes that provide legal recognition of traditional land and resource use empower local institutions to take an active role in the management and resource allocation (Castro and Nielson 2001; Capistrano and Charles 2012; Bixler, Dell'Angelo, Mfun, et al. 2015). Critics argue that these many of these arrangements serve to placate local demands for self-determination but cede little power over broad strategic governance (Pomeroy and Berks 1997; Castro and Nielsen 2001; Capistrano and Charles 2012; McNeish 2012). In some cases, legislation is intentionally designed to be ambiguous to make it easier for the state to retain control (Ortega 2004). These challenges have led to 'implementation gaps' where rights are legally recognized on paper but not realized on the ground because of a lack of enforcement (Wright and Tomaselli 2019).

A second pitfall, and source of implementation gaps, is the lack of local institutional capacity to carry out the terms of the multi-level governance regime. Central governments and NGOs erroneously assume that indigenous peoples can simply throw off the 'yoke' of neocolonial institutions after hundreds of years of dependency and quickly develop effective institutions (Alfred and Corntassel 2005; Alfred 2009; Offen 2003; Hale 2005, 2011; Bixler, Dell'Angelo, Mfun, et al. 2015). Indigenous groups often lack resources and continue to rely on the state for guidance, rulemaking, and financial and technical support; a major challenge in some countries is getting the government provide these services (Ortega 2004; Alfred 2009; Castro and Nielsen 2001). It is not uncommon for indigenous communities to be presented with development projects, but not be provided with the resources to adequately understand and evaluate the proposals (Ortega 2004, 15).

In other cases, dependency leaves indigenous groups subject to 'Western' conceptions of land tenure and resource use that do not accurately reflect indigenous realities (Herlihy and Leake 1990; Capistrano and Charles 2012). In one example, Herlihy and Leake (1990) found that, among the Tawahka people of the La Muskitia region of eastern Honduras, one community of 650 persons used a subsistence zone of nearly 770 km^2 that overlapped with the subsistence zones of several surrounding communities. These findings challenged state bureaucrats' conceptions and demonstrated the inadequacy of their community-based titling plan that only granted the community 75 km² (Herlihy and Leake 1990).

A third pitfall is an erroneous and romanticized assumption that indigenous peoples are apolitical or politically homogenous groups that are ecologically inert and whose ways of life are an antipode to the greedy, destructive, and individualistic Western world (Redford, 1991). Although indigenous groups do often have a strong sense of connection and intimate knowledge of their lands and waters, it is folly to stereotype them as driven solely by utopian or environmentally innocuous ideals (Redford, 1991; Nadasdy 2005; McNeish 2012, 43-44). Indigenous peoples may not retain their indigenous knowledge or even consider themselves indigenous after generations of assimilationist policies and integration into Western capitalist systems (Metz 2006; Jamieson 2003). On the contrary, money and power often permeate indigenous communities and create a great deal of complexity and ambiguity regarding natural resource exploitation and development (Helms 1972; Nietschmann 1973; Redford, 1991; Offen 2004b; Metz 2006; Nadasdy 2005; Hobson-Herlihy 2012; McNeish 2012; Gisela and Wong 2018). As Alison Brysk (1996, 41) argued, "Cultural survival in the sense of the preservation of pre-contact, low technology indigenous cultures is neither viable nor desired by most groups…the important question is who manages the pace and content of development…". Many indigenous groups want development, including natural resource extraction, but they want greater control over the design and implementation of these initiatives as well as the benefits derived from them.

ORGANIZATION OF THE DISSERTATION

This dissertation is organized into seven chapters. In chapter two, I place this research in the broader historical context of the natural resources governance and boom-and-bust economy of the

Miskitu Coast. I review the available literature relevant to natural resources governance as well as several boom-and-bust natural resource extraction industries, including mahogany, rubber and gums, gold, pine, bananas, green sea turtle, and lobster. I do this to extract common historical themes that can be applied, along with the literature cited above, as a framework to analyze and understand the Miskitu Coast jellyfish fishery.

With this analytical framework in hand, I expand beyond Nicaragua's borders in chapter three to discuss the global market for jellyfish. I highlight several factors that impact the growth of the global jellyfish market, including mounting economic affluence in China and increasing demand for seafood, and emerging uses for jellyfish-derived collagen and gelatin. I also discuss the pattern of expanding jellyfish fisheries globally and the emergence of cannonball jellyfish fisheries in the Americas. I discuss the motivational factors for these developments, including the overexploitation of traditional fisheries in China and the commodification of the cannonball jellyfish in the U.S. I finish by discussing a recent food safety scare in China that heavily impacted jellyfish fisheries in the Americas, beginning in 2014.

I shift my focus in chapter four to the biophysical characteristics of the Miskitu Coast and the biology and ecology of jellyfish. I first provide the reader with a general overview of the physical geography of the Miskitu coast, with a focus on the impact of seasonal freshwater river outflows and currents on the brackish and near-coastal ecosystems of the coast. I then turn and focus on jellyfish biology. I briefly discuss the jellyfish lifecycle before focusing on the jellyfish bloom, arguably the most important factor in a jellyfish fishery. I discuss the limited literature on jellyfish blooms and work to put the observations of Miskitu Coast fishermen in context.

Following this discussion, I jump into the ‘nuts and bolts’ of jellyfish fisheries in chapter five. I provide a high-level overview of salted jellyfish production and discuss some of the common challenges facing jellyfish fisheries worldwide. I begin by describing a jellyfish fishery's general operation, including how jellyfish are caught and processed. I then discuss the challenges facing jellyfish processors and fishermen, including the low profit margins and the great inter and intra-annual fluctuations in jellyfish blooms and market prices. I conclude with a discussion of the adjustments that jellyfish fishermen and processors worldwide have had to make in response to the problems of nature inherent in jellyfish fisheries.

I return to the Miskitu Coast in chapter six and present the main results of my study. I begin by introducing Tuapi, my main study community, including a brief overview of its history, economy, and communal government structure. Following this, I provide a chronological description of the development, boom, and bust of the fishery between 2008 and 2018. I focus on the first JPF established on the coast by Moon International, and I explore Moon’s motivations for coming to Nicaragua. Next, I consider INPESCA’s role in the development of the fishery and the role jellyfish played in larger fisheries development initiatives on the coast. I then focus in on the operation of the fishery on the coast and specifically in Tuapi. I discuss the operational dynamics of the fishermen and JPFs, as well as the relationship between the community of Tuapi and the processors. I amplify my Tuapi results with narrative accounts from the communities of Haulover, Krukira, and Bismuna to provide a broader understanding of the operation and politics of the fishery along the coast and to help demonstrate why it worked better in some places than in others.

In the final chapter, I place the fishery within the context of the Miskitu Coast historical resource governance structures as well as the broader political ecology literature. I discuss several governance challenges faced by both central government and indigenous officials, and I evaluate what biophysical, political-economic, and cultural-historical factors played a role in the development, boom-and-bust of the jellyfish fishery. I conclude the dissertation with a sobering outlook on the future of the Miskitu Coast jellyfish fishery, and I offer several candid recommendations of how natural resources governance on the coast can be reformed to better reflect the intentions of Law 445.

CHAPTER 2: BOOM-AND-BUST ON THE MISKITU COAST

INTRODUCTION

The jellyfish fishery is not only boom-and-bust extractive industry to impact the Miskitu coast, but one of several since colonial times. By looking at these past industries and understanding how they developed and operated, how they were governed, and how they busted, we can comprehend how the jellyfish fishery fits within the historic and contemporary context of the coast. In this chapter, I provide brief and chronological narratives of several extractive industries that impacted the coast, including mahogany and pine lumbering, banana plantation agriculture, rubber tapping, gold mining, as well as the trade in green sea turtles and spiny lobsters. I consider the origins of these industries, the multi-scale factors that promoted their development, how they were operated and governed, and why they declined or failed. I also provide a brief overview of the development and evolution of natural resource governance on the Miskitu Coast.

A common current of nationalism and developmentalism has characterized the relationship between the Nicaraguan government and the coast that can be traced back to the colonial period. Animosities were inherited from the beginning as the Nicaraguan State struggled to exert sovereignty over the region after independence, often through the rampant promotion of boom-and-bust natural resource extraction. I also consider the ways the boom-and-bust economy has formed a similar mentality among the Miskitu people in terms of their thinking about the use of natural resources. My goal is to illuminate common themes that run through the literature to form a general framework to contextualize and understand the boom-and-bust of the jellyfish fishery.

This chapter is organized into three main periods: a) the colonial period, between the creation of the British protectorate known as the Mosquito Kingdom and the 'reincorporation' of the coast and the creation of the department of Zelaya by Nicaragua in 1894; b) the nationalist period, between reincorporation and the 1987 passage of Law 28: The Autonomy Statute of the Communities of the Atlantic Coast (*Estatuto de Autonomía de las Regiones de la Costa Atlántica de Nicaragua*) that dissolved Zelaya and created the North and Southern Autonomous Regions; and c) the autonomous period since.

THE COLONIAL PERIOD (1633-1894)

English/British Hegemony and the First Mahogany Boom-and-Bust

During the colonial period, the Miskitu Coast was defined by its relationship with England and later Great Britain (Floyd 1967; Dozier 1985; Offen 2002). The first settlements were established near Cabo Gracias a Dios and present-day Bluefields in 1633 by the English-chartered Providence Island Company, and the coast was established as an English Protectorate in 1638 (Floyd 1967; Hall and Brignoli 2003, 1.16.). As was customary in other English/British colonies, the Miskitu Coast, then known as the Mosquito Kingdom, was indirectly ruled via a local indigenous Miskitu King and several regional Miskitu generals, governors, and admirals (Conzemius 1932; Baracco 2019, 17). The English/British's major goals on the coast were to counter Spanish colonial power in the Caribbean, and like all mercantilist colonial empires, to control and exploit the coast's vast stores of natural resources (Dozier 1985; Bowett 1996; Offen 2004b). One of the first booms in natural resource exploitation on the coast focused on mahogany lumbering.

From the mid-1700s to the early 1900s, mahogany was a major interest of English/British and North American traders (Dozier 1985; Bowett 1996; Offen 2004b). Three mahogany species of the genus *Swietenia* are endemic to the Americas and grow in low humid, fertile riparian areas (Bowett 1996). Mahogany was prominent on the lowlands of the Miskitu Coast; however, their commodification began in Jamaica (Bowett 1996).

English merchant ships often shipped more to the colonies than the colonies shipped back in the early 16th century (Bowett 1996). This trade deficit meant that ships would often need to load up with worthless ballast before their return voyages to Europe; not a profitable situation (Bowett 1996). Jamaica needed more export commodities, and one option was lumber. Under the English, Jamaica was a center of sugar production in the Caribbean, and mahogany was abundant on the plains and low hills where sugarcane cultivation was most suitable (Bowett 1996). In the early 16th century, mahogany was largely unknown in Europe. As forests were cleared to establish plantations on Jamaica, mahogany was used as a local building material or as firewood in the sugar boilers (Bowett 1996). This was soon changed, however, by economic and political shifts.

At the time, shipping rates were based on volume, and lumber was bulky and of relatively low value. This made it unattractive to traders. However, this changed in 1721 when the English Parliament passed the Naval Stores Act that significantly reduced tariffs on lumber (Bowett 1996). With lower tariffs, English traders introduced mahogany into European markets as a stout building material and as a durable wood for furniture making. Although the grain of mahogany is not as decorative as other hardwoods, the wood is hard and ideal for carving and molding. As the European demand for ornate furniture expanded in the 18th century, demand for mahogany quickly increased (Bowett 1996; Anderson 2012). In less than a century, mahogany was transformed from firewood into a luxury commodity demanded by European society's highest echelons (Bowett 1996; Anderson 2012). This demand, however, could not be satiated by Jamaica alone.

In 1721, nearly all mahogany imported into England came from Jamaica, but by 1800, only about one-quarter did (Bowett 1996). As mahogany exports boomed, the easily accessible timber on Jamaica was depleted, and traders were forced to expand their commodity frontiers into less accessible and more costly areas, and eventually, off the island (Anderson 2012). As an English colony, the Miskitu Coast soon drew the attention of traders.

The first shipment of mahogany from the Miskitu Coast to Jamaica was in 1745, and in 1749, the British Superintendent of Miskitu Coast reported that mahogany was abundant in the territory (Dozier 1985; Bowett 1996). English colonists, many of whom were mahogany cutters, flocked to establish settlements there and secure logging concessions (Floyd 1967; Dozier 1985; Bowett 1996). The typical logging concession was for four miles of riverfront eight miles deep (Offen 2004). These concessions were often negotiated between the loggers, officials of the Miskitu King's government, and local indigenous leaders, to help assure cooperation and reduce conflict (Offen 2004b). After 1745, exports of mahogany grew quickly, and by 1769, over 700 thousand board feet were being shipped out annually (Bowett 1996).

The bust of the first mahogany boom was primarily related to politics. After the American Revolution, Great Britain agreed to cede the Miskitu Coast to Spain and evacuate all its colonists (Floyd 1967; Dozier 1985). Although the Spanish were not able to effectively establish sovereignty after the evacuation because of harassment by British holdouts and their Miskitu allies, the evacuations led to a great deal of political unrest and uncertainly on the coast as Miskitu factions competed for Spanish and British patronage (Floyd 1967; Dozier 1985; Baracco 2019). This uncertainly and unrest ultimately led to a collapse of trading relations and a decline in the production of mahogany and other commodities (Floyd 1967; Dozier 1985; Baracco 2019).

Nicaraguan Independence and the Miskitu Reserve

The collapse of the Spanish Empire in 1821 led to a period of 'anarchy' on the Miskitu Coast that eventually led to the reengagement of the British in 1837 (Baracco 2019). During the formation of the Federal Republic of Central America, Nicaragua suffered two territorial embarrassments, including the annexation of the Guanacaste Peninsula by Costa Rica, and a conflict with Honduras over a large tract of land north of the Río Coco; both increased Nicaragua's anxiety about British involvement on the Miskitu Coast (Offen 2004b). Like Spain before, Nicaragua sought territorial unity through the incorporation of the Miskitu Coast, which represented nearly half the territory that Nicaragua claimed (Offen 2004b; Baracco 2019). The Nicaraguans feared that, under British influence, the region would seek independence; to their chagrin, the British reestablished their protectorate and the Miskitu monarchy in 1837 (Floyd 1967; Dozier 1985; Offen 2004b; Gabbert 2011; Baracco 2019).

However, geopolitics in the hemisphere were changing, and the 1823 Monroe Doctrine signaled the growing influence of the U.S. in Latin America and the Caribbean. Nicaragua was of particular interest because the Río San Juan/Lake Nicaragua system was considered a top contender for a trans-isthmus canal. In 1860, after a brief war with Nicaragua and under heavy pressure from the U.S., Great Britain ceded sovereignty over the coast to Nicaragua in the Treaty of Managua (Dozier 1985; Baracco 2019). The treaty established a 'Miskitu Reserve' under Nicaraguan sovereignty, but administered autonomously by a Miskitu government and led by a Miskitu Chief (a descendant of the original Miskitu Kings) and a council comprised primarily of Creole elites and Anglo business interests (Offen 2004b; Gabbert 2011; Baracco 2019).

Nicaragua viewed the treaty as an approval to establish control over the coast and its natural resources (Offen 2004b; Baracco 2019). The Ministry of Finance was given a blank check to fund exploration in the region and to develop infrastructure to connect it to the Pacific. The Nicaraguan government also issued resource and land concessions to anyone willing to come in, settle, and help develop the region (Offen 2004b; Gabbert 2011). Although few took advantage of the offer, the Reserve government viewed these actions as violations of its autonomy under the treaty.

The Treaty of Managua was ambiguous, and there was confusion about what autonomy meant for the Reserve and what sovereignty meant for Nicaragua (Offen 2004b). Faced with Nicaraguan interference, the Reserve government sought British support, and in 1881, Great Britain and Nicaragua submitted the matter to the Austrian Emperor for arbitration. In his decision, the Emperor declared that Nicaragua could maintain a commissioner in the reserve to represent its interests, but that it had no right to issue resource concessions or regulate trade in and out of the region (Offen 2004b; Gabbert 2011). The decision infuriated Nicaragua and emboldened the Reserve government (Offen 2004b; Gabbert 2011).

To bolster its legitimacy, the Reserve government pushed a development agenda that promoted English style laws, worker protections, and natural resource development (Gabbert 2011). However, the powers of the Reserve government were weak, and they had little control over the actions of natural resource extractors (Offen 2004b; Dozier 1985; Gabbert 2011). British and later North American political and business interests were free to acquire resource concessions from the Reserve government at low cost and little if any economic or environmental regulatory restraints (Dozier 1985, 142; Hale 1996; Gabbert 2011). The situation was much the same for the Nicaraguan government and its concessionaires. The lack of infrastructure connecting the Miskitu Coast to the Pacific power centers made the monitoring of concessionaires difficult (Dozier 1985).

The Second Mahogany Boom

Mahogany lumbering boomed again after the reestablishment of British influence as traders rushed to fill the demand for the wood (Anderson 2004; Offen 2004b; Gismondi and Mouat 2009).

Mahogany traders faced several serious challenges, however, including sociopolitical unrest, labor shortages, high operational costs, and several problems of nature. During the first mahogany boom, logging concessions were arranged between traders, local leaders, and the government of the Miskitu King. During the second boom, however, traders were often granted large logging concessions without local communities' consultation, which led to tensions between loggers and locals (Dozier 1985; Offen 2004b). These tensions were partially assuaged by Miskitu men's employment on lumbering gangs, but traders, in general, viewed the Miskitu as lazy, deceitful, superstitious, and generally unreliable (Dozier 1985; Offen 2004b). Many traders chose to import their skilled and unskilled labor from the U.S. and the Caribbean (Nietschmann 1973; Dozier 1985; Offen 2004b).

Mahogany lumbering was not cheap, and a lumbering gang could cost as high as £2,500/year (~$300 thousand today) to operate; much of this cost was paid up front, months before any logs were ready for export (Offen 2004b). Costs were exacerbated by the seasonal nature of mahogany lumbering and the reliance on river transport. Before the coming of the railroad, gangs relied on oxen or mule teams to pull logs out of the forest—this restricted lumbering operations to the dry season when the ground was sufficiently firm (Bowett 1996). Gangs would typically cut trees during the dry season and then float them to the coast as rivers rose with the wet season (Bowett 1996). This seasonal pattern and reliance on rivers restricted lumbering to 3 or 4 months out of the year and to areas within about 8 km of a river. As accessible trees were exhausted, there was a constant pressure to push farther upriver into increasingly remote areas.

This pressure led to increased demand for larger and larger concessions (Offen 2004b). In 1836, the Reserve government issued a generous concession to Brian Vaughn to cut mahogany on any part of the 160 km long Río Wawa for $200/year (~$5,500 today). In 1865, Nicaragua issued an unlimited concession to William Vaughn Jr. to cut mahogany along the Río Coco for only 2,000 pesos per year and no import or export duties, and in 1884, George Emery of Boston, Massachusetts received a monopoly concession from the Reserve government to cut mahogany along the Río Grande de Matagalpa and Río Wawa and their tributaries. Despite the issuance of legal concessions, however, the traders were largely unregulated.

The dispersion of the lumbering gangs in remote areas with weak communication hamstrung both the Nicaraguan and Reserve governments' regulatory authority and left them dependent on the traders to report their activities (Offen 2004b). The natural resources of the region seemed inexhaustible at the time, and government officials' goal was development, not rational use.

By the turn of the century, however, the mahogany boom in Nicaragua, and throughout the Caribbean Basin, was beginning to bust (Anderson 2004; Offen 2004b).

The First Rubber Boom-and-bust

The Miskitu Coast experienced two boom-and-bust cycles in rubber and chicle gum extraction between the 1860s and 1960s. Europeans first experimented with natural rubber in the 1700s. Still, it wasn’t until the development of vulcanization in the 1800s that its use boomed in products like shoes, industrial belts and hoses, and tires (Dean 1987; Zepher and Musachio 2008). Through the early 1900s, the rubber market was dominated by Brazil and the Brazilian rubber tree (*Hevea brasiliensis*) (Barnham and Coombes 1994a, 1994b). Nicaragua was never a major player in the global rubber market, but in 1858, American rubber companies discovered that rubber from the local Panama rubber tree (*Castilla eleastica)* compared well with *Hevea* rubber (Dozier 1985, 116). This kicked off a boom in rubber tapping along the Río San Juan, and by 1871, rubber accounted for nearly one-fifth of Nicaragua’s exports (Offen 2004b).

Dozier (1985, 116) describes the rubber tappers' working conditions in Nicaragua as arduous and slave-like. As with mahogany cutting, rubber traders would hire and provision gangs of tappers to travel upriver for weeks or months at a time to collect rubber; after which, they were expected to return to deliver their product and pay off their debts (Dozier 1985). Hereditary debt-peonage was common, and regulation of the tapping was *laissez-faire*. Tappers had little incentive to ensure long-term production, and destructive exploitation was rampant (Belt 1985[1874]; Offen 2004b).

The Panama rubber tree was not as robust as the Brazilian tree and could only stand a few years of tapping. In many cases, the tapping methods opened up the trees to disease and pests, and in other cases, trees were simply felled and drained for a quick profit (Dozier 1985; Offen 2004b). Naturalist Thomas Belt remarked in 1874 of the rubber industry of the Rio San Juan,

> "A large tree, five feet in diameter, [will yield] about twenty gallons of milk, each gallon of which makes two and a half pounds of rubber…the tree recovers from the wounds and may be cut again after the lapse of a few months; but several that I saw were killed through the large Harlequin beetle (*Acrocinus longimanus*) laying its eggs in the cuts, and the grubs that are hatched boring great holes all through the trunk… the wood-dust thrown out of their burrows accumulates in heaps on the ground below. The government attempts no supervision of the forests: any one may cut the trees, and great destruction is going on amongst them through the young ones being tapped as well as the full-grown ones (Belt 1985[1874], 34)."

This destruction served to drive the rubber frontier's continued expansion deeper and deeper into the forest (Dozier 1985).

In 1860 the Nicaraguan government, increasingly concerned with the destruction, nationalized all rubber trees and threatened high fines for those who destroyed them. Unfortunately, as with the mahogany gangs, the rubber tappers' dispersion in remote areas with weak communication undercut the government’s regulatory authority, and by the 1890s, the wild trees along the Río San Juan were largely depleted (Offen 2004b). Some North American companies in the Miskitu Reserve experimented with rubber plantations around the Pearl Lagoon; however, the Panama rubber tree is adapted to a naturally disbursed distribution, and diseases spread rapidly in the cramped plantation conditions (Dozier 1985). Hurricanes in 1906 and 1908 destroyed the majority of the remaining plantations, effectively bringing an end to the first rubber boom. (Dozier 1985; Offen 2004b).

The Bluefields Banana Boom

The Miskitu Reserve saw a boom in the development of banana plantations in the 1800s, mainly around Bluefields and along the nearby Rio Escondido. Bananas, probably native to Southeast Asia, were brought to the Americas by the Spanish as slave food in the 1500s (Jenkins 2000). They were first grown on the island of Hispaniola in 1512 and subsequently spread rapidly to Mexico, Central America, and the Caribbean, becoming a food staple alongside their cousin the plantain (Jenkins 2000).

In Panama, Carl Augustus Frank started the first commercial banana plantations in Central America in the 1860s (Jenkins 2000; Offen 2004b). Frank successfully introduced bananas into luxury markets on the East Coast of the U.S.; a single banana cost $0.10 in the 1870s, the average hourly wage for many at the time (Jenkins 2000). As bananas increased in popularity, however, production increased, prices decreased, and by the turn of the century, they were cheap and abundant throughout the U.S. (Jenkins 2000).

Observing the growing demand for the fruit, Minor Keith, the founder of the United Fruit Company and builder of the San Jose-Limón railroad in Costa Rica, started planting bananas in the hinterlands of Limón to provide freight for his fledgling railroad (Jenkins 2000; Offen 2004b). By 1885 he was exporting about 500 million bunches to the U.S. annually, and soon he expanded his operations to other areas of the Caribbean basin, including Bluefields and the Río Escondido in the Miskitu Reserve (Dozier 1985, 120; Offen 2004b; Pineda 2006).

The 1881 Miskitu Coast arbitration conveyed a sense of economic and political stability that encouraged investment in the Reserve. Following Keith, several American merchants and banana planters established commissaries (company stores) and plantations along the Río Escondido (Dozier 1985; Offen 2004b). By the turn of the century, monthly production along the river reached 180 thousand bunches, and 180 km of the Río Escondido frontage had been converted to banana plantations (Offen 2004b).

The Placer Gold Boom

Rubber tappers working outside the Miskitu Reserve in the headwaters of the Rio Prinzipolka and Rio Coco returned to Managua with tales of rich gold placer deposits in 1889 (Parsons 1955b). Nicaraguan officials rushed to implement legislation to regulate the anticipated gold rush (Offen 2004). For a fee of 50 pesos up front and 20 pesos a year afterward, anyone could stake a 100 square meter claim. To the Nicaraguan government's chagrin, it was the Miskitu Reserve communities of Bluefields and Prinzipolka that became the main transshipment points of the gold rush (Offen 2004b). The gold deposits were located in national lands, but the rivers that facilitated the movement of gold, goods, and people flowed through the Miskitu Reserve.

By 1892, one shaft mine, *La Constancia*, was in operation, and an estimated 800 placer deposits were being worked, mainly by North American and European prospectors (Parsons 1955b; Offen 2004b). An estimated $9,000 worth of gold (~$300,000 today) was departing Bluefields each month (Offen 2004b). The easily accessible placer deposits were largely depleted by 1900, however, and gold mining was quickly transitioning to underground shaft mining. The small-scale placer boom was a bust, but the industrial gold boom was just beginning.

THE NATIONALIST PERIOD (1894-1987)

Reincorporation of the Miskitu Coast

Nicaragua invaded the Miskitu Reserve and converted it into the Department of Zelaya in 1894. Inflamed by earlier arbitration, Nicaragua used the continued British influence in the Reserve government, along with the desires of American investors and the recent discovery of gold, to justify the annexation (Floyd 1967; Dozier 1985; Vilas 1989; Offen 2004b). After a brief military intervention in 1905, Great Britain signed the Altimirano-Harrison Treaty recognizing the abolition of the Reserve and Nicaragua’s absolute sovereignty over the coast.

The treaty obliged Nicaragua to recognize indigenous and Creole property rights by allowing the ‘Indians’ to live in their villages and follow their customs as long as they did not violate Nicaraguan law and public morality (Great Britain, Mosquitia, and Nicaragua 1906). It also obliged the government to recognize pre-existing property titles and to preserve public pasture lands (an area not defined) around each village. In cases where no title existed, the government was obliged to grant each family at least eight manzanas (~5.5 hectares) of land (Great Britain, Mosquitia, and Nicaragua 1906). The treaty did not mention of natural resource concessions, and although some titles were granted, the vast majority of the coast became national lands and waters on which residents only had usufruct rights (Vilas 1989; Larson and Lewis-Mendoza 2012).

North American business interests encouraged the reincorporation; however, president José Santos Zelaya took a hostile stance towards them, which led to a great deal of economic and political unrest on the coast (Dozier 1985). In 1909, North Americans on the coast threw their financial support behind a rebellion led by the governor of Zelaya, Juan José Estrada, in hopes that relations would improve with Zelaya gone (Dozier 1985). The rebellion led to Zelaya's resignation and the involvement of the U.S. military after the execution of two North American businessmen and combatants (Dozier 1985). This started a nearly 20 year period of U.S. military involvement (to protect U.S. interests) that, combined with a series of pro-American administrations, led to a period of unprecedented foreign investment on the coast (Dozier 1985; Offen 2004b; Pineda 2006).

The coast continued to develop as a source of natural resources as Nicaragua worked to establish military, cultural, and economic hegemony there (Vilas 1989; Hale 1996). The Nicaraguan government issued and profited from monopolistic resource concessions without regard to local populations and encouraged mestizo colonization (Vilas 1989; Hale 1996; Pineda 2006). One official, Dr. Frutoz Ruiz, chief of a presidential commission sent to the coast to resolve a land and labor dispute, called for Nicaragua to actively fight the "barbarity" of the coast and initiate a colonization program to populate the region with "Hispanic-Nicaraguan blood, language, customs, and culture" (Pineda 2006, 81). The decades following reincorporation were defined by *laissez-faire* natural resource governance and a greater influence of North American business interests than by the Nicaraguan State (Vilas 1989; Hale 1996; Pineda 2006). The region was far from the capital, and the lack of infrastructure hampered the government's influence.[2] As before, the government largely looked to foreign companies to develop and modernize the coast.

The Mahogany and Bluefields Banana Busts

At the time of the reincorporation, the largest exporter of mahogany on the coast was North American George Emery. By the late 1800s, a significant market had developed in the U.S. for hardwoods, and Emery's Indianapolis sawmill was one of the largest producers (Gismondi and Mouat 2009). The exhaustion of merchantable hardwoods in the U.S., however, encouraged him to seek out new sources in Central and South America, and in 1884, he received a concession from the Reserve government to cut mahogany along the Río Grande, Río Wawa, and their tributaries (Gismondi and Mouat 2009). Emery subsequently renegotiated this contract with the Nicaraguan government after reincorporation. Nicaragua was interested in incorporating the region into the national polity through infrastructure development, and they saw Emery as a vehicle to do so. Under the new contract, Emery enjoyed a lumbering monopoly on all uncultivated national lands in the Department of Zelaya, under the conditions that he would plant two trees for each one he cut and build 50 miles of heavy rail-line connecting the Río Grande to the Department of Matagalpa (Gismondi and Mouat 2009).

By the early 1900s, however, the second mahogany boom was quickly busting. There were only estimated to be about 1,000 merchantable trees left in 1907 when the Emery concession was canceled (Gismondi and Mouat 2009). Mahogany trees take about 25 years to mature, relatively fast compared with other hardwood species, but not fast enough to supply the mahogany boom indefinitely without replanting efforts. After the cancelation of his contract, it was found that

[2] A paved road into the southern part of the coast was not finished until 1961, while an 'all weather' dirt road between Managua and Bilwi was not built until 1981 (Sollis 1989).

Emery grossly neglected his replanting and infrastructure duties. Emery only planted one tree for every 1,000 he cut, only paid taxes on 1 out of every 100, and more infuriating to Nicaragua, he only laid 25 miles of light track that were virtually useless and did not connect the Río Grande with Matagalpa (Gismondi and Mouat 2009).

Emery and those before him extracted millions of dollars' worth of mahogany but, in the end, left little in terms of development (Offen 2004b). On the contrary, the booms led to the destructive exploitation of the abundant mahogany described by the Miskitu Coast superintendent in 1749. The cutting of roads and the destabilization of river banks also contributed to increased sediment loads in the region's rivers, which filled in lagoons and bays, and caused even more economic harm to fishing and shipping (Dozier 1985).

By World War I, the Río Escondido banana boom was also unraveling. A half-century of heavy banana cultivation had depleted the soils and yields were declining, and at the same time conflict was brewing. After the reincorporation, United Fruit, like George Emery, renegotiated their contract with the Nicaraguan government. To the dismay of smaller producers, United was granted a monopoly on transit and shipping on the Río Escondido. United used the monopoly to force out many smaller competitors and accumulate 78 thousand hectares of land (Offen 2004b). United's aggressive tactics led to a great deal of conflict and animosity towards the firm among the independent producers that had dominated production along the river during the Reserve Period. Conflict tied to the monopoly and the 1909 Estrada Rebellion led to severe physical damage to the banana plantations and economic turmoil in the coastal economy. Local credit markets, which many banana producers relied on to pay their laborers, froze, and without laborers to tend to the plantations, production collapsed (Dozier 1985). World War I further depressed banana production and encouraged many producers to close their plantations and switch to cattle ranching, effectively bringing an end to the Bluefields banana boom (Dozier 1985, 194).

Bragman's Bluff Pine and Banana Boom

The 1920s saw the rise of a new boom industry on the Miskitu Coast around Bilwi in what would become the RACCN. Extensive areas on the coast between sea-level and 900 m are covered by Caribbean pine (*Pinus caribea*) savanna (Parsons 1955a; Denevan 1961; de Vries, Hildebrand, and Graaf 1978). Although lumbering of pine occurred on a small scale during the colonial period, those traders were more interested in pine for resin and turpentine than for lumber (Parsons 1955a; de Vries, Hildebrand, and Graaf 1978). However, in the 1920s, destructive exploitation in the U.S. forced some lumber barons to look abroad for new supply regions.

The 1800s was a time of rapid destructive exploitation of forests in the U.S. Driven by the industrial revolution, lumber production rose from just 500 million board feet in 1801 to 8 billion by mid-century and a peak of 46 billion in 1904 (Williams 1990, 152). By the 1920s, however, the forests of the eastern states, the lake states, and the south were largely logged out, and lumber companies were looking to expand into the Pacific Northwest and Latin America (Williams 1990). One of these companies was the Salman Brick and Lumber Company of Louisiana.

Salman began as a brickmaking company in Slidell, LA, in 1882 but soon expanded into lumbering (Chambers 1925). The company built its first mill and acquired the logging rights to a vast tract of pine and cypress forest in southern Louisiana in 1890 (Chambers 1925; Howe 2014). Fed by 20 miles of rail-line and three trains, the mill's production rose to 100 thousand board feet/day by 1916 (Chambers 1925; Howe 2014). The concession was soon logged out, however, and the company moved to establish new operations in Mexico and Nicaragua (Chambers 1925; Pineda 2006)

In partnership with Vaccaro Bros. Inc., the precursor to the Standard Fruit company, Salman formed the Bragman's Bluff Lumber and Fruit Company in Bilwi in 1921 (Parsons 1955a; Pineda 2006). Bragman's secured a monopoly concession from the Nicaraguan government to cut lumber on 20 thousand hectares of pine savanna around Bilwi for $2/hectare (~$26/hectare today) (Parsons 1955a; Pineda 2006). The company was initially set up to supply lumber to Standard Fruit's Central American and Caribbean operations; however, it later served other markets in Europe and the Caribbean (Parsons 1955a).

Bragman's was the largest employer in Nicaragua by 1926, with over two thousand domestic and foreign workers and concessions totaling over 80 thousand hectares (Pineda 2006, Centero and Cuthbert 2004). Pine and banana exports grew quickly. Between 1929 and 1932, lumber exports grew from 9.6 million board feet to 39.8 million (Parsons 1955a). In terms of banana production, Bragman's recorded an all-time high production of 6.1 million clusters in 1931, nearly half of all Nicaraguan exports by value that year (Dozier 1985; Centero and Cuthburt 2004).

The company invested heavily in transforming Bilwi into a modern milling and shipping center, including the construction of a modern mill, a deep-water port, and over 100 miles of rail-line and roads into the interior to transport lumber and bananas (Parsons 1955a, Pineda 2006). This investment, however, did not extend to the local workforce. Bragman's management was exclusively white, and skilled labor positions were filled by African Americans and West Indians who had experience with lumbering and railroads; the most physically demanding and lowest paid unskilled positions were left for locals (Pineda 2006).

Low wages and high unemployment, combined with political unrest in the 1930s marked the beginning of a downturn in Bragman's operations. The managers and skilled laborers worked on annual contracts, while the unskilled laborers worked daily or weekly and experienced drastic fluctuations in employment. In 1935, amid the Great Depression, Bragman's company laid off 60 percent of its workforce, a major upset to the local economy (Pineda 2006). Although pine lumbering continued after World War II, banana production did not. Attacks during the Sandino Rebellion killed at least eight American workers, caused much damage to the banana plantation infrastructure, and resulted in the evacuation of Bragman's foreign employees (Dozier 1985). A decreased demand for bananas during the Great Depression combined with banana disease outbreaks, and two hurricanes in 1935 and 1941 contributed to the bust of the export banana industry by the early 1940s (Parsons 1955a; Dozier 1985; Vilas 1989).

Smaller independent bananas cultivation continued after World War II, but the commercial banana industry never recovered; by 1960, exports at Bilwi were a paltry 9,753 bunches (Centeno and Cuthbert 2004). Although some efforts were made during the Sandinista revolution to revive the industry, Nicaragua has never been competitive in the post-war period. In 2016, Nicaragua exported about 91 thousand tons of bananas, just two percent of total Central American banana exports (FAO n.d.a). Today, bananas are still an important cash crop for farmers in the region, but primarily for local markets (Dozier 1985; Offen 2004b).

Industrial Gold Mining Boom

At least 46 gold mines shafts were operating by the 1920s in what is now called the 'Mining Triangle' between the present-day communities of Siuna, Rosita, and Bonanza (See map in Figure 1) (Offen 2004b). Before the 1930s, however, investment in gold extraction was relatively tepid.

Gold prices were low, and the mines were remote; a person could expect to travel about a month to reach the mining area from New Orleans, and freight often took twice the time (Parsons 1955b; Dozier 1985). The development of air transportation in the 1930s and 1940s dramatically reduced these times, and this, combined with booming gold prices during the Great Depression and World War II, led to a boom in industrial gold mining (Parsons 1955b; Dozier 1985).

The mining boom stimulated the region's economy beyond the mining triangle, and by 1921, about 2,500 persons were directly or indirectly employed by the industry (Vilas 1989). The industry created jobs for port workers in Bilwi and Waspan, as well as increased the demand for agricultural products from area farmers (Dozier 1985). Bilwi served as the main port for equipment and materials coming in and gold going out, and Waspan became a major hub for food and lumber products destined for the mining triangle (Dozier 1985).

Like other industries, the managers and technicians were North Americans, lower-level supervisors were mestizo, and the laborers were a mix of indigenous, creoles, and mestizos (Parsons 1955b). Wages were low, although subsidized prices in company stores partially offset this, and living and working condition were tough; workplace injuries were common, and many miners suffered from silicosis, tuberculosis, and other maladies (Parsons 1955b; Dozier 1985; Vilas 1989)

Gold mining, like the mahogany and rubber industries, was not effectively regulated. The government relied on the mining companies to report the quantity and richness of the gold ore they exported because the government lacked an independent laboratory to do so (Vilas 1989). Environmental regulations were also non-existent, and the cyanide reduction (cyanidation) and mercury amalgamation methods were widely used in gold extraction at the time[3]. The mines dumped their toxic wastes and tailings directly into the region's waterways, which led to the contamination of several rivers and the forced relocation of several indigenous Mayangna villages (Offen 2004b). As long as the companies paid their monthly authorization fee, modest taxes, and provided support for local public services, the government looked the other way (Parsons, 1955b; Vilas 1989) [4].

War Time Rubber Boom-and-Bust

When the first Ford Model T rolled off the assembly lines in 1908, it ignited a second global rubber boom; automobiles would come to represent half the demand for rubber in the following decades (Zepher and Musachio 2008). Rubber prices were high and Brazilian production could not meet the demand, opening up opportunities for competitors. The British and Dutch developed low-cost rubber plantation industries in their Southeast Asian colonies, and by 1907 they had about 433 thousand acres under cultivation. By 1913, the region overtook wild Brazilian production, and by World War II, 90 percent of the global rubber market was supplied by Southeast Asia (Herbert and Bisio 1985; Zephyr and Musachio 2008). In Nicaragua, the stocks of natural and plantation rubber had been seriously degraded, and the flood of cheap Southeast Asia rubber quashed any remaining interest in Nicaraguan rubber production.

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[3] Cyanidation and mercury amalgamation both involve the chemical extraction of gold from ore. Cyanidation uses a dilute solution of cyanide along with lime, oxygen, and in some cases, lead nitrate, to dissolve the gold. The solution is then treated through chemical and mechanical processes to extract the gold (Eugene and Mujumdar 2009). In mercury amalgamation, mercury is added to crushed gold-bearing ore wherein it binds with the gold to form an amalgamation. The amalgamation is then boiled to vaporize the mercury, leaving the pure gold behind (EPA 2018). In both cases, the waste ore is discarded with the mine tailings. Cyanide quickly degrades when exposed to sunlight; however, other hazardous substances, including lead and mercury, can persist in the environment for many years (Eugene and Mujumdar 2009, EPA 2018).

[4] The mines were allowed to import their equipment and supplies duty free, and Parsons (1955b) estimated a direct tax rate on gold exports of only about 1.4 percent, based on a rate of $17/kg tax rate and a 1955 gold price of $330/oz.

However, interest in Nicaraguan rubber changed quickly with the outbreak of World War II and the Japanese occupation of rubber-producing areas in Southeast Asia. Cut off from rubber suppliers, the U.S. rushed to sign deals with 17 Latin American countries, including Nicaragua, to increase natural rubber production (Herbert and Bisio 1985; Offen 1998). In 1940, the U.S. Rubber Development Corporation (RDC) established a base in Waspan, and in 1942, signed a deal with the Nicaraguan government to buy all rubber for a price of $0.33/pound. The company established more than 40 commissaries along the Río Coco and employed about five thousand rubber tappers and 200 plant workers. Between 1942 and 1947, about 5,100 MT of rubber were exported, four times greater than Panama, the next highest Central American supplier (Offen 1998).

Post-War Modernization

With support from the United Nations, World Bank, and the U.S., the Nicaraguan government took a more hands-on approach to development and natural resources governance after World War II (Hale 1996). The regime passed several laws[5] to regulate the rational use of natural resources and generate a "higher local added value" by requiring some concessionaires to operate processing facilities inside the country (Asamblea Nacional de Nicaragua 1961, Ch3; Vilas 1989, 68). The government also initiated large top-down conservation projects on the coast, including the Northern Forests Project that prompted reforestation of the pine savannas of northern Zelaya that

[5] Law 316, the General Law on the Exploitation of Natural Wealth of 1958 (Ley General Sobre Explotación de Nuestras Riquezas Naturales) declared the Nicaraguan State the legal owner of all natural resources not legally owned including the majority of the 'national lands and waters' on the Miskitu Coast (Asamblea Nacional de Nicaragua 1958; Vilas 1989). Sub-sector laws were also passed including Law 557: The Special Law on Fishing of 1961 (Ley Especial Sobre Explotación De La Pesca) that mandated that all concession holders operate a processing facility within Nicaragua (Asamblea Nacional de Nicaragua1961; Vilas 1989). Similar laws were passed for mining and logging in an effort to retain more value in the country and provide jobs (Vilas 1989).

had been decimated by the lumber industry (Vilas 1989). Despite these actions, governance remained top-down, and regulation remained weak.

The post-war period became known more for the continuation of *laissez-faire* capitalism, corruption, and destructive exploitation than for protection, rational use, and development (Thorson 1982; Pfeiffer 1986; Vilas 1989; Nietschmann 1990). The period saw the great deterioration of fish, shrimp, turtle, and lobster stocks, as well as the region's forests. The Northern Forest Project created a series of forest reserves that encompassed nearly four million acres; however, the central government failed to consult local communities who claimed over 500 thousand of the acres (Vilas 1989; Nietschmann 1997). By 1975, 40 percent of the Zelaya Department was under logging concessions, and many of the reserves were eventually logged out (Vilas 1989; Nietschmann 1990, Nietschmann 1997). Sollis (1989, 491) highlighted that the government continued to issue concessions to foreign companies without requirements to invest in "restocking or reafforestation, in environmental protection, nor in infrastructure and productive activity that might provide long-term employment to break the vicissitudes of the boom-and-bust cycle…"

These actions, combined with economic decline and wider regional indigenous rights movements, mobilized the ethnic and indigenous groups on the coast (Vilas 1989; Hale 1996). The Alliance for the Progress of Miskitu and Sumu, ALPROMISU, was formed in 1973 to help counter the government's control of indigenous lands and represent indigenous interests to the government and industry (Vilas 1989; Meringer 2010). The group pushed for a regional indigenous organization, a greater indigenous role in local governance, and greater integration into the national system (Meringer 2010). It raised awareness of the historic marginalization in the region, the region's importance in terms of natural resources, and demanded the Coast's 'fair share' of government proceeds (Vilas 1989; Meringer 2010, 6-8). The central government accepted these demands to a point and offered the group a seat in the Nicaraguan National Congress, along with local administrative positions, with some funding for the organization's projects; however, the group was never legally recognized by the government (Vilas 1989; Hale 1996; Meringer 2010).

The Sandinista Revolution

The Sandinista National Liberation Front (FSLN) deposed the regime of Dictator Anastasio Somoza in 1979 and set about enacting socialist reform policies. On the Miskitu Coast, however, little of the core policies related to natural resources changed. FSLN policy towards the coast included three of the core elements of the previous century: development of natural resources, integration of the population and economy into the national polity, and top-down control (Vilas 1989). In their 1969 FSLN Historical Program (a development strategy), Sandinista leaders laid out their goals to convert the coast's arable lands to agriculture and livestock raising and to develop the coast's lumber and fishing industries. Upon taking power in 1979, they declared that all terrestrial and aquatic natural resources in the country were the exclusive property of the Nicaraguan state (Vilas 1989, 110).

The FSLN enacted policies to promote local cultures and discourage discrimination, but much of the policy was still tinged with mestizo elitism and racism, which fomented mistrust and animosity between coastal populations and the FSLN (Vilas 1989, Hale 1996). The FSLN encouraged the formation of popular organizations, but not ethnic-based organizations. They pushed at first for the coast to be represented by the national FSLN-backed Association of Rural Workers. ALPROMISU refused and was viewed internally among some of its more radical members as sympathetic to the old Somoza regime (Meringer 2010). These more radical elements split from ALPROMISO to form a new group called MISURASATA (Miskitu, Sumu, Rama, and Sandinistas Working Together). MISURASATA was more sympathetic to the FSLN revolutionary cause and promoted a historical Miskitu vision of resistance instead of the ALPROMISO vision of adaptation and development (Meringer 2010).

As MISURASATA displaced Sandinista-backed officials and gained political power on the coast, it began pushing for legal indigenous territorial land rights (Vilas 1989). Between October 1980 and February 1981, MISURASATA leaders formulated their proposal for indigenous territorial rights to the entire Miskitu Coast, but FSLN military police arrested the leaders before they could publicize the proposal (Hale 1996, 135). MISURASATA reacted to the violence with violence, and with support from the U.S. fought the FSLN to a standstill during the civil war that followed the Sandinista Revolution (Hale 1996).

The coastal resistance viewed the Sandinistas as invaders, and they wanted self-determination, territorial autonomy, and control over their natural resources (Nietschmann 1990). Despite this, the FSLN repeatedly rejected proposals for indigenous autonomy. As with prior governments dating back to independence, the FSLN feared that coastal self-governance would threaten Nicaraguan sovereignty over the region (Nietschmann 1990; Nietschmann 1997; Gonzáles 2016). The resulting protracted civil-war (known as the Contra-Sandinista War) led to the collapse of the coastal economy and natural resource extraction until the 1990s (Nietschmann 1990).

Post War Rubber Bust and Gum Boom-and-Bust

The World War II rubber boom in Nicaragua was based on wartime subsidies, and after the war, when the subsidies disappeared, the industry quickly busted (Offen 1998). Asian and Brazilian sources once again flooded the market with natural rubber, and synthetic rubber that was perfected during the war was beginning to displace natural rubber all together (Dozier 1985; Pineda 2006). The US Rubber Development Corporation canceled their contract with Nicaragua in 1947; however, the region continued production of natural gums tied to the U.S. Wrigley Chewing Gum Company (Offen 1998).

Chewing gum became popular in the U.S. in the late 1800s and spread worldwide with American soldiers during the World Wars (Fenimore 2008). Like rubber, the primary source of natural gums was in Asia. During World War II, Wrigley was cut off from their natural supplies of gums from Asia and worked with the Rubber Development Corporation to develop operations in Nicaragua, purchasing *níspero* and *tunu* gums (Offen 1998). Continued exploitation after the war was encouraged by the nationalization of the chicle gum industry in Mexico in 1946, which nearly doubled the price of *chicle* gum as an alternative (Fenimore 2008).

At first, gum operations in Nicaragua focused on níspero production in the Department of Jinotega, but by the 1950s, most of the trees had been destroyed by over-tapping (Offen 1998). The industry then shifted to the exploitation of tunu along the Río Coco, and Wrigley built a processing plant in Waspan in 1955 (Offen 1998). Tunu was much more resilient than níspero and could be tapped for half the year followed by a six month rest period. At its peak, between 20 and 30 thousand trees were being tapped each month (Offen 1998; Offen 2004b).

Although the gum industry was a boom for the local economy, it never played a major role in the national economy. Exports between 1950 and 1980 averaged about 350 MT per year, and export income peaked at $456 thousand in 1969 (Offen 1998). By the 1960s, chewing gum manufacturers were following the lead of rubber manufactures and turning to cheaper synthetic gums (Offen 1998). Wrigley eventually pulled out of Nicaragua in 1979 after their processing plant was burned during the onset of the Sandinista Revolution (Dozier 1985).

Gold's Stagnation

The gold boom peaked during the 1940s and 1950s when Nicaragua ranked as one of the top 15 gold producers in the world. Between 1939 and 1945, gold represented over half the state's exports by monetary value (Vilas 1989; Arengi and Hodgson 2000). The gold industry's momentum began to slow, and gold was ultimately supplanted by coffee in the 1950s (Parsons 1955b). From a peak of over $660/oz. in 1934, gold prices fell precipitously after World War II to less than $250/oz. by 1970. The Bonanza and Siuna mines closed in 1962, and the region's largest mining company, the Canadian La Luz Mines Limited, suspended all exploration and laid off half its workforce in 1971 (Dozier 1985).

During the Sandinista revolution, the nationalization of the mines and the expulsion of their North American managers and technicians caused gold production to collapse further. The Sandinistas found that the foreign domination of the mines' managerial and technical positions left no one to operate the mines after the takeover. After the Sandinistas left power in 1990, the Bonanza mine reopened under successive neo-liberal governments. Through the 1990s, Nicaragua was ranked first or second in gold production in the Caribbean basin and Central America (Arengi and Hodgson 2000).

Despite near-record gold prices, gold in 2019 only represented about eight percent of exports, down from over half during the 1940s (Parsons 1955b; MIT n.d.). An estimated 221 MT of gold have been mined in Nicaragua, over half from the Mining Triangle around Siuna, Rosita, and Bonanza, and it is estimated that the region still holds about 45 MT (Arengi and Hodgson 2000). The Sandinista administration of Daniel Ortega is now working to improve the region's infrastructure, including a new modern highway connecting the area to the Pacific.

The Pine Lumbering Bust

Following World War II, lumbering continued with vigor pushing inland from Bilwi, and by 1953, Bragman's successor, the Nicaraguan Longleaf Pine Company (NIPCO), had pushed the forest frontier 100 km inland, leaving a cut-over waste in its wake (Parsons 1955a; Pineda 2006). At the time, geographer James Parsons (1955a) observed the destructive exploitation,

> "The life expectancy of the coastal pine forests of the Miskito Shore cannot exceed very few years…In many cut-over areas, more-over, only a very few small, non-merchantable trees have been left standing as seed stocks for the future…At present there is no forester, no fire prevention crew, and no inventory of the merchantable timber still standing… Like sarsaparilla, turtle, rubber, mahogany, and bananas before, pine lumbering, which has revived the economy of the coast in recent years, will soon drop off to insignificant levels" (Parsons 1955a, 57).

Depending on the environment, quality of tending, and fire suppression, plantings of Caribbean pine can be ready in 15 years for pulp and in 30 years for lumber (de Vries, Hildebrand, and Graaf 1978). While the Nicaraguan government attempted to institute conservation and forest fire prevention programs in the 1960s and 1970s, regrowth could not keep pace with demand resulting in the severe degradation of the coast's pines. Parsons' observations in 1955 proved true; NIPCO production peaked in 1960 at just over 28.4 million board feet and declined after that until they ended operations in 1963 (Centeno and Cuthbert 2004; Pineda 2006). NIPCO exhausted nearly 750 thousand acres of pine savanna in 20 years (Vilas 1989; Offen 2004). To add insult to injury, the U.S. Atlantic Chemical Company acquired much of the NIPCO concession in 1960 and set about building a turpentine plant to exploit the resin-rich tree stumps left by NIPCO (Sollis 1989; Pineda 2006).

The FSLN tried to reinvigorate the lumber industry through state-sponsored mills in the 1980s, but this was short lived because of fighting on the coast and destruction of vital infrastructure (Nietschmann 1990). Several lumber concessions were issued after the war by subsequent neoliberal governments, and lumbering still occurs today, but like bananas, it is primarily for local and national markets; wood products only accounted for about 0.28 percent of Nicaraguan exports in 2017 (Nietschmann 1990; Centeno and Cuthbert 2004; MIT n.d).

Green Sea Turtle Boom-and-bust

There was little commercial interest in the fisheries of the Miskitu Coast before 1950. With the stagnation of many of the land-based industries, however, the Nicaraguan government turned its attention to developing the region's untapped marine resources, including the green sea turtle (Vilas 1989; Nietschmann 1973). Green sea turtles (*Chelonia mydas*) are found in the tropics worldwide, but the largest populations were historically in the Caribbean Sea around the Cayman Islands and along the Costa Rican and Nicaraguan coasts (King 1995; Offen 2020). Green sea turtles were among the first natural resources involved in foreign commerce in the Caribbean, and early relations between the Miskitu and the English were based largely on the trade of turtles (Nietschmann 1973; Nietschmann 1979; Offen 2020).

An adult green sea turtle weighs between 250 to 350 pounds, and the abundant flotillas of green sea turtles supplied meat, eggs, leather, oil, and calipee[6] to ship crews and a booming plantation slave population (Parsons 1962; Nietschmann 1979). What started as a utilitarian protein source

[6] Calipee a gelatinous substance that covers the lower shell of the turtle and is used as a base for turtle soup.

for seamen and slaves, however, was soon adopted by the upper classes of the Caribbean, England, and the U.S. Turtle meat and turtle soup became popular dishes during formal banquets, and both were said to have medicinal properties that helped ease digestion after a big meal (Parsons 1962; King 1995; Offen 2020).

Commercial trade of turtles between the Caribbean and England began in the mid-1700s (Parsons 1962; King 1995). Between the 17th and 18th centuries, the Cayman Islands became the center of commercial turtling in the Caribbean, and by 1640, the islands' economy was focused primarily on turtling (Parsons 1962; King 1995). Turtle hunters easily captured the sedentary and slow-moving females on the beaches as they attempted to lay their eggs, also pursuing others at sea. A ship could catch between 30 and 50 turtles a night and the fleet delivered upwards of 13 thousand turtles to traders in Jamaica annually (King 1995).[7]

High demand and ease of capture led to destructive exploitation, and by the 1840s, the turtle populations were decimated, and the Cayman Islands turtle boom was bust (King 1995: Offen 2020). Like the mahogany cutters of Jamaica, the Cayman Islanders expanded the turtling frontier off the islands to Cuba, Honduras, and Nicaragua (King 1995). By 1878, annual arrivals of live turtles in England reached 15 thousand; almost all were caught off Nicaragua's coast (King 1995).

Around the mid-1800s, canning techniques were developed that allowed lower-cost canned turtle to be sold to England and the U.S., which led to a dramatic increase in turtle consumption and exploitation. In Nicaragua, reported catches by the Cayman fleet ranged between 2000 and 3000 turtles per year between 1840 and the 1960s (Parsons 1962).

[7] The ecology of green sea turtles makes them easy to capture. At sea, they move in large flotillas in predictable diurnal and multi-year patterns to and from feeding grounds and nesting beaches (Nietschmann 1974). Strong swimmers at sea, they are slow and helpless on land. They drag themselves up the beaches to their nesting spot leaving a clear trail directly to them and their egg clutches (Nietschmann 1974). A hunter or gatherer need only walk up and flip a turtle on its back, or follow the drag trail to the unguarded nest for the tasty eggs (Parsons 1962).

In the 1960s, several processing facilities were built in Bilwi, Bluefields, and the Corn Islands for processing sea turtles purchased from Miskitu fishermen (Nietschmann 1979). At first, the companies would send boats to Miskitu communities to collect turtles; however, they later began stationing boats near the turtling grounds and providing nets to the fishermen to increase yields (Nietschmann 1979).

The turtle industry's industrialization resulted in a rapid rise in the exploitation of green sea turtles on the Miskitu Coast. Nietschmann (1973) found that in a single Miskitu community, exploitation of green sea turtles increased 128 percent between 1969 and 1971, and sales of the green turtle outside the community increased 1,455 percent (Nietschmann 1973, Table VI). The processing companies were exporting about 10 thousand turtles annually, but by the mid-1970s, turtle populations were in steep decline, and turtle hunters were finding it difficult to make money (Nietschmann 1973; Nietschmann 1979).

Although the Nicaraguan turtlery would have likely succumbed to the degradation of green sea turtle populations, as happened in the Cayman Islands, its demise came from the developed world's rising environmentalist movement. In 1973, the green sea turtle was listed in both the U.S. Endangered Species Act and the Convention of International Trade in Endangered Species (CITES) (King 1995; Garland and Carthy 2010). CITES went into effect internationally in 1975 and in Nicaragua in 1977, effectively ending the foreign trade of green sea turtles and changing the cultural perceptions of sea turtle consumption in North America and Europe (Nietschmann 1979; Garland and Carthy 2010). Today, Nicaraguans still harvest the largest number of green sea turtles of any country in the Caribbean, but like bananas, they are primarily for subsistence and local markets within Nicaragua (Garland and Carthy 2010).

Lobster Boom

Growing demand for lobster in North America has helped fuel a boom in the exploitation of spiny lobsters (*Panulirus argus; Panulirus guttatus*) on the Miskitu Coast since the 1960s (Dodds 1998; Jacobson 2004). From Honduras to Nicaragua, thousands of divers and support workers were mobilized to feed the demand, but like bananas and mahogany, lobster meat was not always in high demand. Before the late 1800s, the big-clawed American lobster (*Homarus americanus*) was considered a trash species in the U.S. and Canada. A pile of lobster shells outside a home was considered a sign of poverty, and the crustacean was more likely to be used to fatten pigs, bait hooks, or manure fields than to be eaten by humans (Mowat 1984; King 2011).

Cultural tastes began to change in the mid-1800s; however, with the development of canned lobster in North America and Europe (Mowat 1984). A lobster quickly spoils after death, so for most of history, only those who lived close to the sea knew about them. Canning allowed cooked lobster to be shipped around the world, and as it was, a taste for lobster developed (Mowat 1985; King 2011). By the turn of the century, over 70 canneries were operating on the east coast of the U.S. and Canada, and the Canadians alone were landing 140 thousand tons a year (Mowat 1985; King 2011).[8]

By 1902, however, the boom was going bust. Demand was higher than ever, but the fisheries were seriously degraded and production was just a tenth of what it was 15 years prior (Mowat 1984). 1907 marked the beginning of 40 years of decline in North American lobster production (Mowat 1984, 185). As lobster prices increased between 1905 and 1929, fishermen increased the number of traps by 62 percent, yet yields fell by half (Woodward 2005, King 2011, 91). The Great Depression busted the industry in the 1930s; the increasing rarity of lobster had converted it into

[8] Landings refers to the amount of fish caught and brought to land. In contrast, the term catch refers to landing plus any animals caught but discarded at sea before return to land.

a luxury cuisine, and the economic crash depressed luxury consumption (Woodward 2005, 191). To control their costs, hotels and restaurants began sourcing smaller and cheaper lobsters from abroad (Woodward 2005).

The popularity and price of American lobster again boomed after World War WWII; between 1946 and 1975, lobster's consumer price increased 300 percent (Jones 2008). In the 1970s-1980s, there was a rapid expansion in lobster landings and consumption driven by their popularization by casual dining restaurants like Red Lobster (McGill 1989; Jacobson 2004). Faced with high prices for the overexploited American lobster, restaurants, and wholesalers looked abroad to countries like Honduras and Nicaragua that had abundant lobster populations and low labor and production costs (Jacobson 2004).

In 1961, six trap boats were brought to the Miskitu Coast from the U.S., and by the time of the Sandinista Revolution in 1979, over 100 boats were operating in the region (World Bank 1999). At the same time, there was a boom in artisanal diving activity. Between 1964 and 1978, lobster landings in Nicaragua grew 1,060 percent from 113 MT thousand to 1,315 MT (World Bank 1999). The Sandinistas' nationalization of the fleet combined with violence along the coast severely curtailed fishing activity, and landings plummeted nearly 86 percent between 1979 and 1989 (Nietschmann 1990; World Bank 1999)

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THE AUTONOMOUS PERIOD (1987-PRESENT)

Neoliberalism and the Autonomy Statute

To end the civil war, the FSLN adopted Law 28: the Autonomy Statute of the Communities of the Atlantic Coast (*Estatuto de Autonomía de las Regiones de la Costa Atlántica de Nicaragua*) in 1987.[9] Law 28 divided the department of Zelaya into Northern and Southern Autonomous Regions and created a multi-level governance framework that recognized 'on paper' ethnic and indigenous property rights and gave the newly-formed regional councils veto power over the issuance of natural resources concessions and the power to establish natural resource regulations. However, the law lacked enforcement and the enabling legislation to make it functional on the ground (Anaya and Grossman 2002; González 2019). It was also ambiguous with much of the autonomy subject to the plans of the central government (Law 28, Art.11), agreements between the regional and central governments (Art. 9), and national laws (Art. 24) (Asamblea Nacional de Nicaragua 1987). This implementation gap and ambiguity proved problematic in the following years.

With Law 28, the Central Government was willing to decentralize control over social services, but they were not as willing to threaten territorial unity or Nicaraguan sovereignty over the nation's largest remaining stores of natural resources. Years of civil war had bankrupted the nation, and the International Monetary Fund was pushing Nicaragua to implement neoliberal reforms including cuts to social services and the implementation of an economic model heavily based on the export of natural resources (Chasteen 2006; Robinson 2001). The former MISURASATA leader and INPESCA Director Steadman Fagoth highlighted in a 2013 interview with *Wani Revista del Caribe Nicaragüense*: "the Central Government was more than happy to transfer responsibilities over healthcare and education to the regional councils because these were large public expenditures, but they were not going to relinquish control over natural resources like petroleum, forests, mines, and fisheries that provided the government with income (Rivas 2013, 23). The post-war administrations of Violetta Chamorro, Arnoldo Alemán, and Enrique Bolaños all continued

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[9] While Law 28 was passed in 1987, it did not take effect until after the elections of 1990.

to issue concessions for natural resources on the coast while working to undermine the effectiveness of the regional councils by interfering in coastal politics and largely refusing to provide them with the requisite operating funds (Vilas 1989; Hale 1996; Anaya and Grossman 2002; Nietschmann 1997; Gonzáles 2016).

Conflict over Law 28 and natural resources rights came to a head in at least two documented cases in the 1990s. First, to protect their traditional fishing waters from industrial fishing, 23 coastal Miskitu communities in the RACCN entered into an agreement in 1991 with the Nicaraguan Institute of Natural Resources and Environment, and the U.S. Agency for International Development (USAID) financed Caribbean Conservation Corporation (CCC) to establish a 12 thousand km^2 Miskito Coast Protected Area (MCPA). The MCPA was supposed to be a bottom-up community management scheme; the central government would recognize the communities' land, lagoon, and sea territories, and the Miskitu communities would manage the area with financial and technical assistance from national and international collaborators (Nietschmann 1997, 209). By 1992, however, this goal was discarded in favor of the traditional top-down model (Nietschmann 1997). The CCC accused the Miskitu of being the primary threat to the sustainability of the area's fisheries (as opposed to the commercial fishing fleets), and suggested that the area be converted to a biosphere reserve with restricted access (Nietschmann 1997). In response, the communities abandoned the project and banned the CCC and later the USAID from their territory (Nietschmann 1997).

Despite the conflict over the MCPA, the proverbial straw that broke the camel's back landed around the same time in the small inland community of Awas Tingni in the RACCN. The Nicaraguan government issued lumbering concessions to two foreign companies for 250 thousand acres of forest claimed by the indigenous community, and the community was fighting back. With the assistance of a group of US-based lawyers and students, Awas Tingni sued the Nicaraguan government in the Inter-American Court for Human Rights (IACHR) (Anaya and Grossman 2002). In 2001, the court ruled that the government had violated the terms of Law 28 and ordered the immediate recognition of indigenous rights and the titling of their lands (Anaya and Grossman 2002). The result was the adoption of "Law 445: the Communal Property Regime of the Indigenous Peoples and Ethnic Communities of the Autonomous Regions of the Atlantic Coast of Nicaragua and of the Bocay, Coco, Indio, and Maíz Rivers" (*Ley 445: Régimen de propiedad comunal de los pueblos indígenas y comunidades étnicas de las regiones autónomas de la Costa Atlántica de Nicaragua y de los ríos Bocay, Coco, Indio y Maiz*) (Asamblea Nacional de Nicaragua 2003).

Figure 5: Indigenous and Afro-descendant Territories create by Law 445. Sources: Williamson, Mendoza, Valerio, et al. (2019), and the National Demarcation and Titling Commission (CONADETI 2013).

Law 445 laid out the mechanisms for demarcating and titling the lands of the RACCN and RACCS, covering nearly 31 percent of the national territory, into 23 multi-communal indigenous and afro-descendant territories (Figure 5). In terms of natural resources governance, the law established a multi-level system that recognized indigenous authorities and guaranteed the "full recognition of communal property ownership rights, the use, administration and management of traditional lands and their resources…" (Asamblea Nacional de Nicaragua 2003, Ch.1, Ar.2; Larson and Lewis-Mendoza 2012; Gonzáles 2016).

Lobster's Stagnation

Lobster catches boomed again following the end of the conflict in the 1990s. The government re-privatized the fishing fleets, legalized lobster diving, and opened up the fisheries to help pay off wars debts and promote the development of the coast (Meltzoff and Schull 1999). Between 1990 and 2000, landings of lobster grew 507 percent (ADPESCA 2000). In 2012, there were estimated to be over fifteen thousand fishermen participating in the fishery, 79 percent of whom were small-scale artisanal fishermen (mostly divers) (INPESCA 2013). In 2015, lobster represented 65 percent of Miskitu Coast seafood exports by value (Monnereau 2012; INPESCA 2016). In a region where many communities depend on seafood, most of the Miskitu Coast population directly or indirectly depends on lobster income (Farrell 2010).

Most of this lobster was historically caught by artisanal Miskitu divers or divers on industrial boats owned by Mestizos or Creoles from the Bay Islands of Honduras or the Corn Islands of Nicaragua. As with the rubber tappers and mahogany cutters of the past, dive teams are often hired as 'outside contractors' without formal written contracts (Farrell 2010). The dive teams get paid for what they catch but are required to pay the boat owner a portion of their earnings for operational expenses and pay back any cash advances after they return (World Bank 1999; Farrell 2010; Herlihy and Hobson Herlihy 1991).

Weak regulation of the lobster fishery has led to destructive exploitation that has been detrimental for humans and lobsters alike (Meltzoff and Schull 1999; Farrell 2010). Like green sea turtles, immature lobsters (less than 5 oz. or with a tail length less than 14 cm) are 'protected' by international treaty and cannot be exported. These regulations, however, have not prevented the exploitation of immature lobsters. Measurement of lobsters is not done until the diver surfaces, so by the time a lobster is found to be too small, it may already be dead (Farrell 2010). A diver's pay is largely based on luck, and as Farrell (2010, 202) highlighted, "leaving a lobster is like leaving cash," and on the seafloor, all lobsters that are perceived to be legal. Farrell (2010) estimates that about 17 percent of all lobsters caught are too small to export. Small lobsters are sold on local markets or are carried home (Meltzoff and Schull 1999; Farrell 2010; Per. Observation 2018).

In the early years of the fishery, large and plentiful lobsters were found in shallow waters along the coast, and free divers were able to capture them without assistance. However, the insatiable demand for lobster and the introduction of industrial trapping quickly depleted the 'easy' lobsters and forced divers to dive more often, in deeper waters, and for longer periods using antiquated and often malfunctioning SCUBA equipment (Farrell 2010; Meltzoff and Schull 1999). This shift in technique and technology has precipitated an epidemic of decompression related injuries and deaths that have impacted many lobster divers on the Miskitu Coast (Farrell 2010).

The deaths and injuries of lobster divers have been a more direct threat to lobster diving than the health of the fishery. In response to outcries from social justice activists in Nicaragua and abroad, the Nicaraguan government passed "Law 613: the Law for the Protection and Security of Persons Dedicated to the Activity of Diving" (*Ley de Protección y Seguridad a las Personas Dedicadas a la Actividad de Buceo*) in 2008. The law called for the prohibition of commercial lobster diving by 2011 and tasked INPESCA with developing alternatives for divers, their employers, and support workers (Asamblea Nacional de Nicaragua 2008). In 2009, Nicaragua also signed "Regional Agreement OSP-02-2009: the Regulation for the Regional Management of the Caribbean Lobster Fishery" (*Reglamento para el Ordenamiento Regional de la Pesquería de Langonsta del Caribe*), with the other Central America countries, that also called for the abolition of tank-assisted lobster diving by 2011 (OSPESCA 2009). Unfortunately, political pressure from the divers and lobster processors and a lack of viable economic alternatives for divers and support workers have made it difficult for INPESCA to phase out diving (Farrell 2010; González 2018).[10]

INPESCA has worked to create a management plan for the lobster fishery in recent years to help stabilize and grow lobster populations. However, as INPESCA Director of Investigations Renaldi Barnutty-Navaro highlighted in a 2002 FAO lobster fisheries workshop that these efforts have faced several institutional challenges including a lack of operating budget to support biological studies and monitoring aboard boats and in processing facilities, INPESCA's inability to adequately regulate artisanal fishing and prevent overfishing and capture immature lobsters, and a lack of education among artisanal and industrial fishermen concerning lobster biology (Barnutty-Navaro 2003). As discussed in Chapter 6 below, these chronic issues also defined INPESCA's governance of the jellyfish fishery.

Law 445 and the FSLN

Not unexpectedly, the Nicaraguan government dragged its feet on the execution of Law 445 for years, and it was not implemented until the return of the FSLN to power under Daniel Ortega

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[10] Dating back to the Sandinista Revolution, there have been efforts to increase the adoption of trap fishing. However, active hunting by divers is much more effective than a passive trap, and traps cost money (Farell 2010). This economic reality keeps traps out of the hands of many divers, even the most frugal. While traps eliminate diving related injuries, they also eliminate employment opportunities for divers. As Farell (2010) highlighted, a trap boat employs a crew of about eight as opposed to a diver boat that employs 18 to 20 dive teams plus additional support staff to cook, clean, and manage the diving equipment (Dodds 1998; Farell 2010; Wolff 2012).

in 2008. In 2006, YATAMA, a Miskitu Coast indigenous organization that emerged out of the Contra-Sandinista War, entered into a political alliance with the FSLN. The goal was to marginalize the FSLN's political competitors in the RACCN, and in return, the FSLN would push for implementation of Law 445 (Gonzáles 2016). Demarcation and titling of the territories finally began five years after the law was passed after the FSLN retook control of the national government (Larson and Lewis-Mendoza 2012; Gonzáles 2016).

There have been several challenges, however, related to the implementation of Law 445 dealing with natural resource extraction. First, Law 445 established a new multi-level governance regime on the coast (Figure 6). The law empowers duly elected communal governments to authorize or prohibit the exploitation of natural resources on communal lands by third parties (Asamblea Nacional de Nicaragua 2003, Art. 10). For common use resources that cannot be assigned to one community, or resource conflicts between communities, the law empowers the relevant territorial assembly or assemblies to authorize a special resource commission to issue/deny the concession or resolve the dispute (Asamblea Nacional de Nicaragua 2003, Art. 10).

In terms of the municipal, regional, and national governments, the law emphasizes in several articles that these governmental levels will recognize and respect communal and territorial rights and provide technical assistance where applicable (Arts. 11, 25, 31). The Autonomous Regional Councils, and the Central Government in the case of protected areas, shall provide technical assistance in the consultation, negotiation, and authorization of concessions for the rational use of natural resources (Arts. 10, 16, 17, 27). This assistance is rendered by the Technical Office of the Natural Resource Secretary of the Regional Councils (SERENA), the relevant national agency (ex. INPESCA), or both (Asamblea Nacional de Nicaragua 2003; Larson and Lewis-Mendoza 2012).

SERENA officials typically works in close coordination with Central Government agencies like INPESCA because of a lack of financial resources (Larson and Lewis-Mendoza 2012).

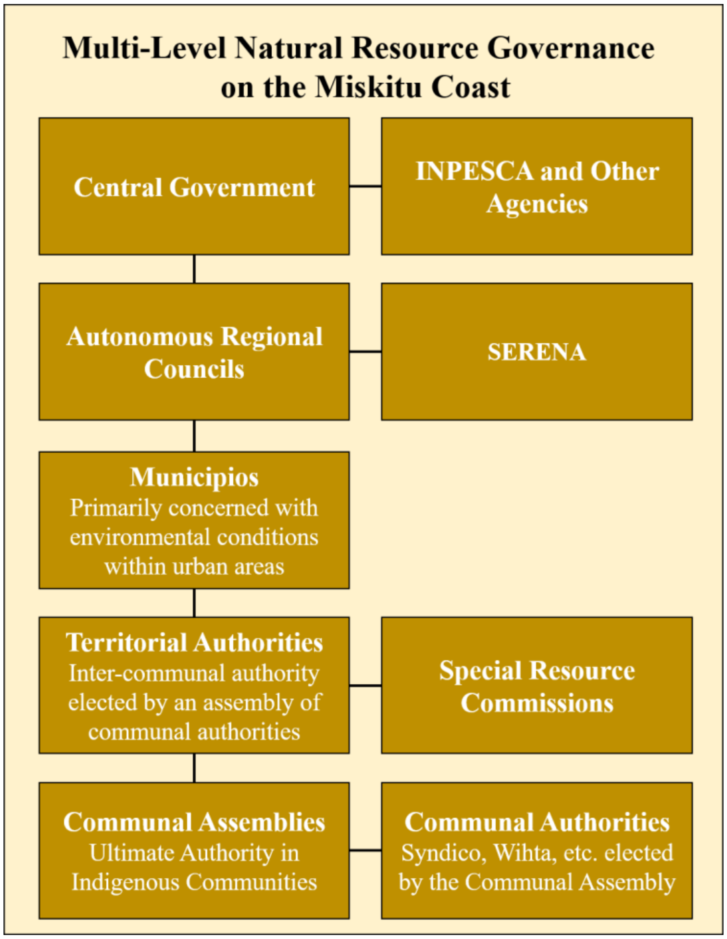

Figure 6: Multi-level Governance Structure on the Miskitu Coast under Law 445.

Law 445 has created a great deal of jurisdictional ambiguity and confusion on the coast especially regarding what rights are conferred by the territorial titles. This ambiguity has translated directly into conflicts over the governance of the region's fisheries in recent years. In 2016, the fledgling territory of Tawira, which includes the Miskitu Keys, began selling territorial fishing permits to non-local fishermen (Medina 2017). Article 33 of the law states that indigenous and afro-descendant communities have the exclusive rights to exploit marine resources for non-industrial uses within three miles of the coastline and 25 miles around adjacent cays and islands (Asamblea Nacional de Nicaragua 2003). When I interviewed Tawira President Anderson Toby in

November 2017, he argued that as the titleholder of the Miskitu Keys, the Tawira territorial government should have the right to issue and profit from concessions for the exploitation of natural resources there (Toby 2017). INPESCA vehemently opposed Tawira's interpretation of the law, however, and directed fishermen and Nicaraguan authorities to ignore the territorial permits (Medina 2017).[11] The Tawira initiative subsequently failed for a lack of enforcement power.

The Miskitu Keys are a part of the *Cayos Miskitos y Franja Costera Inmediata* Biological Reserve, and Article 27 of Law 445 states that, "the administration of protected areas shall be carried out under a joint administration between the indigenous communities, or their representative NGO, and the state" (Asamblea Nacional de Nicaragua 2003). INPESCA argued that this article and Law 489: Fishing and Aquaculture Law of 2004 (*Ley de Pesca y Acuicultura*) give them the sole right to issues fishing permits in all of Nicaragua. Law 489 dictates that INPESCA must work with the regional government, however, not with the territories, in the issuance of licenses and concessions as well as the development of regulations and scientific studies (Asamblea Nacional de Nicaragua 2005, Ch. 2, and Art.5.5). INPESCA used the law to delegitimize the Tawira permits and Tawira's role in fisheries governance. According to Tawira President Anderson Toby, INPESCA has refused to even communicate with Tawira since the conflict (Toby 2017). The Tawira case demonstrates the ambiguity of natural resources governance on the coast and the Central Government's continued reluctance to delegate its power. INPESCA has repeatedly rebuffed demands for greater local control over fisheries governance, arguing that it would be inconvenient for national development programs and projects (Gonzalez 2018, 269).

[11] In Nicaragua, Law 489, Ch.1 Art. 10 tasks the Coast Guard with enforcing national fisheries laws on both coasts and on internal waters (Asamblea Nacional de Nicaragua 2004). INPESCA does not have law enforcement authority of its own.

In addition to Tawira's interpretation of Law 445, concerns have been raised about the power granted to the state by Article 34 to collect all proceeds from natural resource concessions in the Autonomous Regions. These proceeds are collected by the Ministry of Treasury and Public Credit and allocated 25 percent to the Central Government and 25 percent each to the indigenous community, municipality, and autonomous region where the resources were exploited (Asamblea Nacional de Nicaragua 2003 Ch. 6, Art. 34). In terms of fishing concessions, including those issued to jellyfish processors, Law 489 (Ch. 1, Art. 108) stipulates that the funds may only be used to promote the fishing sector (Asamblea Nacional de Nicaragua 2004). Both Law 445 and 489 stipulated that the use of these funds will be overseen by the National Ministry of Finance and Public Credit, together with regional authorities, and audited by the Comptroller General of the Republic (Asamblea Nacional de Nicaragua 2003 Ch. 6, Art. 34; 2004 Ch. 2, Art. 107).

With the '25-25-25-25' distribution, Law 445 seeks to ameliorate the historical asymmetrical relations of natural resources extraction by sending 75 percent of the concession proceeds back to the coast. However, the use of these funds remains under the paternalistic control of the Central Government, which places huge limitations on autonomous development. Furthermore, Tawira and many communities complain about a lack of transparency and not getting their fair share. As I discuss in Chapter 7, the territories and communities lack the capacity to account for the fisheries resources that are leaving their waters, and they have little to no ability to independently calculate what Law 445 funds they should receive.

Finally, concerns have been expressed about FSLN influence and interference in territorial and communal elections. The regional indigenous organization YATAMA has long argued that national political parties should not exist within indigenous politics and that leaders should be elected in communal assemblies per traditional custom (Gonzáles 2016). However, the FSLN has increased its efforts in recent years to gain political power in territorial and communal governments. Instead of traditional communal assembly elections, the FSLN has demanded ballot elections where they have an advantage. As the national ruling party, the FSLN controls government purse strings and can muster many more resources for political campaigns than YATAMA. Additionally, the FSLN controls the regional governments, which are charged with observing and certifying territorial and communal elections (Asamblea Nacional de Nicaragua 2003, Art. 7, 8). This certification power has been used to deny certification to non-Sandinista authorities and to certify un-elected Sandinista supporters in their place (González 2019). This has led to instances of "double-certification" and dueling communal governments where both factions claim legitimacy (González 2019, 90). This situation has been detrimental to local natural resources governance, and it has created ambiguity about who the legitimate communal representatives are. This impacts negotiations on natural resources concessions, including some instances of forum shopping where concessionaires play one faction off the other to gain/maintain access and legitimacy in the community (González 2019).

A HISTORICAL FRAMEWORK

Centralized and Development-Focused Natural Resources Governance

The aim of this chapter was to provide a broad overview of the evolution of natural resource governance on the Miskitu Coast and review some of the major boom-and-bust extractive natural resources industries that have operated there. I briefly described the forces behind their creation, the governance of the industries, and the reasons for their ultimate decline. Out of this review emerges several common historical themes that can be used to contextualize and evaluate the jellyfish fishery.

The development of extractive natural resources industries on the Miskitu Coast has historically been centralized. Both the Miskitu Reserve and Nicaraguan governments promoted foreign investment by extractive industries as a strategy for developing and exerting sovereignty over the region. This is reflected in the promotion of top-down conservation schemes and the issuance of large monopolistic concessions without local peoples' participation. Even after the passage of Laws 28 and 445, the national government has resisted delegating natural resources governance authority to territorial and communal governments. This was demonstrated by the conflict over Tawira's issuance of territorial fishing permits in 2017 and the fact that the Central Government still retains power over the collection, distribution, and oversight of funds collected from the exploitation of natural resources on the coast.

Nicaragua's natural resources governance has historically been development-focused and has valued natural resource extraction over the environment and rational use. Although the government has periodically created natural resources regulations, there has been a persistent inability or unwillingness to enforce the laws or regulate extractive industries beyond the sale of concessions. Despite nationalizing the rubber trees and threatening stiff penalties in the 1860s, the government could do little to stem their destruction along the Río San Juan. Additionally, while the Zelaya regime eventually terminated the rapacious Emery concession, they had little ability to enforce its terms or the terms of other concessions. They also had little ability to track the gold leaving the mining triangle and to stop the mines from dumping toxic waste into local waterways. The central government has relied almost exclusively on the companies themselves to report and regulate their activities, and this is still an issue with fisheries as INPESCA's budgetary struggles have limited its ability to independently monitor and regulate fisheries.

Boom-and-Bust Mentality in Communal Natural Resources Governance

Although not explicitly discussed in much of the literature I reviewed above, years of engagement in the boom-and-bust extractive economy has led to the development of a boom-and-bust mentality in many communities, which has had an important impact on communal-level natural resources governance. This mentality is an important component of the framework given the new role of communal governments in sanctioning natural resources extraction under Law 445. I argue that this mentality is the reason why many communities agreed to allow jellyfish processing despite a lack of information on the fishery, this is discussed further in Chapters 7.

This so-called "boom-and-bust mentality" was born of dependency and economic insecurity. In the past, it was common for Miskitu men to periodically leave their communities for a year or more to work for foreign firms in logging, rubber, mining camps, and banana plantations (Nietschmann 1973; Helms 1971; Pineda 2006). Instead of subsistence activities, men would often send money and store-bought goods to their families. Subsistence agriculture, hunting, fishing, and animal husbandry were still maintained, but the Miskitu developed a dependency on cash and commercial products (Helms 1971, 115; Nietschmann 1973; 1979). Many non-local commercial foods like wheat flour, beans, coffee, sugar, lard, and domesticated meat became traditional, and non-food wares like clothing, axes, machetes, saws, cooking pots, sewing machines, and soaps became status symbols (Nietschmann 1973).

Dependency meant painful withdrawals after many extractive industries busted after World War II. As rubber contracts were canceled, and the plantations, mines, and logging camps were closed, many were left feeling deprived and isolated (Helms 1971, 115). Geographer Bernard Nietschmann observed in the community of Tasbapauni that the residents suffered from an "overburden of desires for luxury and foreign goods" (Nietschmann 1973, 44). With this said, the

Miskitu communities have demonstrated great resilience through multiple boom-and-bust cycles because of the persistence of subsistence activities like agriculture and fishing that help buffer them from destitution. In the words of the grandfather in my Tuapi homestay, “As long as you have a fishing net, you will never go hungry in Tuapi”. Despite this, commercial goods are coveted by many, and the inability to acquire them is something that strikes at the core of individual self-identity and the general morale of the community (Helms 1971; Nietschmann 1973).

Anthropologist Laura Hobson-Herlihy demonstrates this well in her work among the Miskitu of the Honduran Muskitia. In her book, *The Mermaid and the Lobster Diver: Gender, Sexuality, and Money on the Miskitu Coast,* she discusses folk songs about lobster divers that return from sea. Those who return with bags of seafood and cash are viewed as “macho men,” “rock stars,” and “heroes” in their communities; however, those that return empty-handed are viewed as “zero men”: impotent, useless, and undesirable (Hobson-Herlihy 2012, 108-111).

On a similar note as Hobson-Herlihy, anthropologist Mark Jamieson (2002) argues that, In reaction to feelings of deprivation, the Miskitu practice ‘crab antics’ in their economic dealings with each other,

> “Among the [Miskitu] the image of the limited good is common…one's social ascent is inevitably bought at the expense of others, much as a crab's attempt to climb out of a barrel is predicated on its ability push down competitors, Miskitu people often see economic success as a zero-sum game in which individuals acquire wealth by denying economic assistance to others” (Jamieson 2002, 281-282).

If economic success is a zero-sum game that is won by denying others, I add that this sentiment also aptly applies to the Miskitu relationship with the environment. As many of the boom-and-bust industries highlighted above demonstrate, natural resources are finite, and if one is to deny others access, then one needs to capture the resources before the others regardless of the long-term ramifications to the environment or target resource.

In his 1973 book, *Between Land and Water: The Subsistence Ecology of the Miskito Indian, Eastern Nicaragua*, geographer Bernard Nietschmann relays a quote from a Tasbapauni informant that gets at the heart of the dilemma facing coastal residents in the boom-and-bust economy, "When the company there, got to get. When dey leave, dats gone blank; dey no looking you" (Nietschmann 1973, 195). No one wants to be a zero man or the bottom crab. In a boom-and-bust economy where you don't know how long the resources and cash will last or when the next opportunity might arise, it's better to get the resources and/or company work now before someone else does and worry about the human and environmental impacts later.

Dependence on Foreign Actors and Markets

All of the extractive industries on the Miskitu Coast were heavily, if not solely, reliant on the forces of globalization, and the ebb and flow of foreign markets, technology, and politics. As I demonstrated in Chapter 1, the making and unmaking of natural resources are highly dependent on fickle cultural practices, technological innovation, and politics. Cultural trends, technology, and promotive government policies can fuel demand and encourage extraction while changing cultural tastes, and punitive governmental policy can destroy demand and discourage production.

In the case of the rubber booms in Nicaragua, the development of vulcanization technology increased the utility of natural rubbers and created a global demand during the industrial revolution that eventually spread to the Miskitu Coast with the help of North American scientists. Eighty years later, a second rubber boom developed on the Rio Coco during World War II to fulfill the national security needs of the U.S. and her allies; however, the boom quickly busted after the war with the cancellation of subsidies and the development of synthetic rubber technology. In this case, a combination of global and local technological development and war and peacetime government policies helped drive the booms-and-busts.

In terms of cultural tastes, banana plantations boomed on the Miskitu Coast between the late 19th and mid-20th centuries to feed a booming demand for the exotic fruit in the U.S. However, the boom was busted by local political violence and upheaval spurred by U.S. foreign policy and a decline in the demand for bananas during the Great Depression and World Wars. Green sea turtle products were once popular in European and American kitchens and drove a nearly two-century long boom in turtling in the Caribbean. However, the rise of global environmentalist movements in the 1970s, and the listing of the green sea turtle as an endangered species, quickly quashed the export market and changed cultural tastes for sea turtle in Europe and North America.

All of the industries were also heavily reliant on foreign-based firms and investment. None of the natural resources exploited on the Miskitu Coast were commodified on the coast. The markets for the products were created elsewhere and spread into Nicaragua through commodity frontier expansion as destructive exploitation reduced the profitability of other areas' resources. Mahogany and Pine were first exploited on the coast after the easy trees had been felled on Jamaica and in eth U.S., and industrial turtling companies arrived after the turtle populations of the Cayman Islands were depleted.

The operation of the extractive industries also favored foreign labor over local labor. Extractive industries have largely employed their foreign managers and technicians and neglected to educate or train residents who have largely been relegated to the lower rungs of the employment hierarchy (Vilas 1989). Historically, there was little diffusion of technology, training, or knowledge of markets, and as a result, there was little local institutional capacity to sustain the industries when the firms pulled out. This was especially the case with the mining and banana industries that required a great deal of technical knowledge and access to outside markets. Vilas (1989, 45) explains that when the industries busted and the foreign firms pulled out, they left behind "empty hole[s]" figuratively in terms of underdevelopment and unemployment, and literally in terms of depleted natural resources.

The Problem of Nature

All the extractive industries highlighted above had to contend with the inherent biophysical characteristic of the resources that they were exploiting. Although extractors benefited from some of these natural characteristics, like the tendency of mahogany to grow close to rivers, the vulnerability of egg-laying female sea turtles, and the tendency of pines to grow in thick stands, most had to contend with characteristics that either directly hindered their operations or made them vulnerable to external socioeconomic and political upheavals (Parsons 1962; Dozier 1985; King 1995; Bowett 1996; Offen 2004b; Gismondi and Mouat 2009).

In most cases, the natural regrowth/reproduction rates of the resources were simply not sufficient to supply the boom markets they were sold into, leading to destructive exploitation. Several of the extractive industries on the Miskitu Coast ultimately busted because of the destruction of the resource base. Mahogany was a major export from the coast during the 18th and 19th centuries, but by the early 1900s, few merchantable trees were remaining (Offen 2004b; Gismondi and Mouat 2009). Likewise, wild stocks of Panama rubber trees along the Río San Juan were largely depleted by the 1890s because of over tapping, and by the mid-20th century, the coast's extensive pine savanna had been reduced to stumps (Belt 1985[1874]; Dozier 1985; Offen

2004b). More recently, the degradation of lobster stocks resulted in a stagnation of production and an increase in diving-related injuries (Meltzoff and Schull 1999; Farrell 2010).

Extractors also faced geographical challenges. The extraction of mahogany and rubber was challenging because of the trees' naturally dispersed nature that required cutters and tappers to work in remote areas for weeks or months without contact with the buyers (Dozier 1985; Offen 2004b). To cope with this uncertainty, some rubber buyers instituted debt peonage systems that encouraged tappers to use destructive methods that killed the trees (Belt 1985[1874]; Dozier 1985). Lobster divers have faced similar financial pressures and have had to face the reality that lobster reproduction has not been able to meet demand and that many of the remaining lobsters live in deeper waters that are dangerous to divers (Meltzoff and Schull 1999; Farrell 2010).

Even on plantations, where the problems of nature could theoretically be better controlled, extractors faced insurmountable challenges. Rubber buyers that established rubber plantations around the Pearl Lagoon found that they had to contend with the rapid spread of disease in the unnatural conditions that eventually quashed their operations (Dozier 1985; Offen 2004b). Banana growers encountered similar issues on their plantations as the fruit is particularly susceptible to pests and disease and requires constant tending. This high level of labor-intensive maintenance left banana producers vulnerable to economic and political hazards that created upheaval in financial and labor markets and wars and natural hazards that caused physical damage to the plantations (Parsons 1955a; Dozier 1985; Vilas 1989; Pineda 2006).

CHAPTER 3: THE GLOBAL MARKET FOR JELLYFISH

INTRODUCTION

This chapter aims to elucidate an understanding of how consumer demand for jellyfish in China helped lead to the development of the Miskitu Coast jellyfish fishery. Although it is nearly impossible to connect a clear line between any one factor and jellyfish consumption, I discuss several factors that may be impacting the global jellyfish market. These factors include growing economic affluence in China and a general increase in seafood consumption and the use of traditional medicines, emerging industrial uses for collagen and gelatin derived from marine sources, and food safety concerns in China related to foreign seafood imports and dietary aluminum consumption. I also discuss advances in food and fisheries research in the U.S. that facilitate the commodification of the cannonball jellyfish and precipitated the formation of jellyfish fisheries in the Americas.

THE DEMAND FOR JELLYFISH

Jellyfish is consumed in Thailand and Vietnam as street food, in Japan as sushi, and in Japan and Korea as a low-fat health food and food additive (Rudloe 1995; Hsieh, Leong, and Rudloe 2001; Loh 2018). The main source of demand, however, is China where jellyfish have deep cultural significance and have been consumed for at least 1,700 years (Hsieh, Leong, and Rudloe 2001). Between 1970 and 2016, global landings of jellyfish reported to the FAO increased 610 percent from just under 60 thousand MT to 420 thousand MT (FAO n.d.b). Although some researchers consider these figures to be grossly underestimated because of the unofficial status of jellyfish fisheries in many countries (e.g., Brotz 2017), it is generally agreed that the demand for jellyfish has increased substantially in recent years, leading to the establishment of new jellyfish fisheries worldwide (Hsieh, Leong, and Rudloe 2001; Wenda 2001; You, Ma, Gao, et al. 2016; Dong, Liu, and Keesing 2014; You, Yongming, Caihua, et al. 2016; Brotz 2017).

A major driver in the global jellyfish market's growth has been changing demographics and perceptions of wealth in China. These changes have had corresponding effects on diets and the consumption of seafood and Chinese luxury seafood commodities (CLSCs) - a class of seafood commodities defined by their high price, significance in social practices, and use in Chinese traditional medicine (Fabinyi 2011; Fabinyi and Liu 2014; Fabinyi and Liu 2016). Examples of CLSCs include sea urchin, lobster, sea cucumber, fish maw, live reef fish, seahorse, geoduck, and jellyfish (Anderson and Anderson 1977; Hsieh, Leong, and Rudloe 2001; CAPLOG 2014; Fabinyi 2011; Fabinyi 2016; Fabinyi and Liu 2016). These changes in consumption, however, are relatively recent.

During the communist period of Mao Zedong (1949-1976), China was dedicated to isolation and self-reliance. Private enterprises at all levels were considered “tails of capitalism” that needed to be cut off (Schell 1984, p 3). Any indication that one was serving him or herself at the expense of others was punished, sometimes by social shaming, and in other instances with internment in re-education camps or execution. Wealth, the seeking of wealth, or its display, was considered bourgeoisie and antithetical to Chinese society (Schell 1984).

Things began to change in 1976 when Mao died. The Third Plenum of the Eleventh Party Central Committee declared, in 1978, that the nation should commit itself, not to class struggle and socialist purity, but to opening up and modernizing the economy (Schell 1984; Di 2018). The committee called for an abandonment of the Maoist model of centralized planning and sought to empower workers and entrepreneurs. The committee now encouraged its citizens to excel with bonuses and pay raises for production, free markets in which to sell their goods, and with popular slogans like "Get Rich by Working" and "To Get Rich is Glorious" (Schell 1984, 13). The party confirmed these policies again in 2002, and by 2006 there were over 4.9 million registered private enterprises in the country (Di 2018).

The Chinese population has quickly grown wealthier and more urban under this new policy. In 1970, only 17 percent of the Chinese population was urbanized, but by 2016, 57 percent was (World Bank n.d.). GNI/capita has also grown 7,000 percent over this same period from $120 to $8,260 (World Bank n.d.). This growth in wealth has resulted in a robust consumer culture among the middle and upper classes who are now purchasing automobiles, homes, and other luxury and consumer products at rates not seen before in Chinese history (Barton, Chen, and Jin 2013; Di 2018).

Increased wealth has also resulted in diet changes. Animal proteins have become symbols of prosperity, and growing incomes have facilitated an increase in the consumption of meat, poultry, and seafood (Tai 1990; Cai et al. 1998; Ma et al. 2008; Huang and Gale 2009; Barton, Chen, and Jin 2013). Seafood consumption in China has grown 665 percent since 1970 from 4.53 kg/person to 34.67 kg/person in 2013 (FAO n.d.b) (Figure 7). An additional boost to seafood has come from the growing popularity of Southern Chinese (Cantonese) cuisine, which emphasizes seafood (Andersen and Andersen 1977; Fabinyi 2011: 87). China has become increasingly reliant on foreign fisheries as demand has increased. Chinese imports of seafood grew from 314 thousand MT in 1970 to 10.9 million MT in 2013, increasing over 3,300 percent (FAO n.d.b). Although per/capita consumption still lags behind Japan and South Korea, it is rising quickly, and China is now the largest importer of seafood in the world by volume (Figure 7).

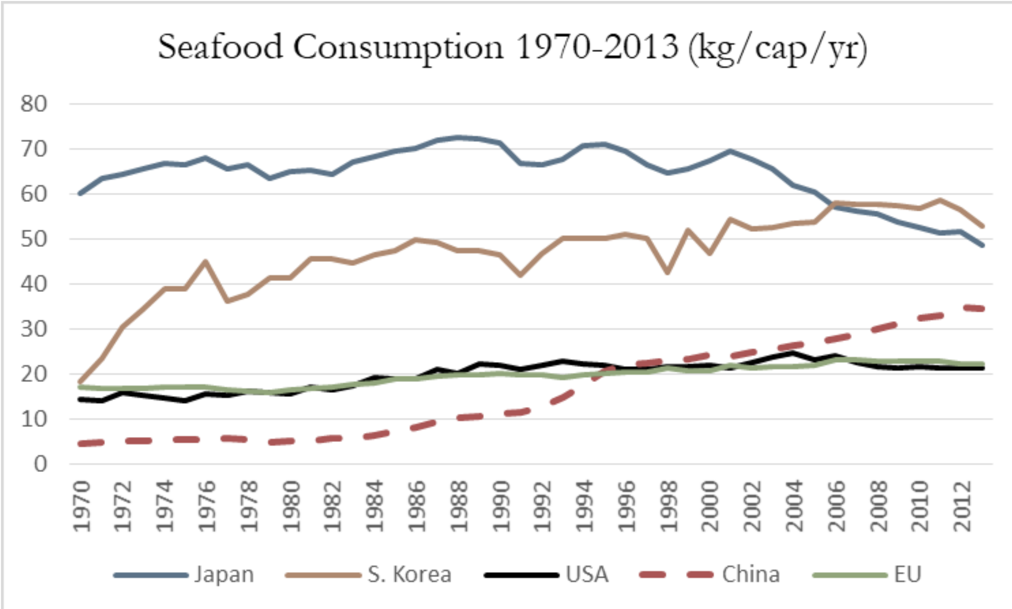

Figure 7: Seafood Consumption for Select Countries (1970-2013). (Adapted from Fahrenbruch 2018; Data Source: FAO n.d.b.)

In addition to a general increase in the per/capita consumption of seafood in China, a growing economy has also meant an increase in the cultural practice of banqueting and a corresponding increase in the consumption of CLSCs (Fabinyi 2011; Fabinyi and Liu 2014, 2016). Banquets are sites where relationships are created and managed through a potlatch type of practice of gift-giving, a practice known as *guanxixue* (gwan-she-shwe) (Yang 1994; Fabinyi 2011; Fabinyi and Liu 2014, 2016; Di 2018). In traditional Chinese society, guanxixue was the practice of currying favor that was necessary to conduct official business. Those in need of official relationships would engage in gift-giving rituals to build reciprocity with those in power (Yang, 1994). The better and more expensive the gift, the better one's chances of building reciprocal capital (Yang, 1994).[12]

CLSCs are status symbols of banquets and celebrations (Fabinyi, 2011). Although jellyfish is not particularly expensive (about \$10 to \$12/kg for the highest quality), a jellyfish salad is considered a necessity, or even the "star attraction", at weddings and holiday celebrations like

[12] Some argue that reforms in China have diminished the importance of the practice in official dealings (Guthrie 1998), it is still considered important in wider Chinese society (Yang 1994; Fabinyi 2011; Fabinyi and Liu 2017).

Lunar New Year (Tai 1990, 99; Rudloe 1992; Hsieh, Leong, and Rudloe 2001; Fabinyi, 2011; Loh 2018, 1).

Jellyfish is also valued in traditional Chinese medicine. Jellyfish is reported to have various medicinal uses, including ridding the body of excessive heat while ‘warming up’ the sex organs (Rudloe 1995, 23). Jellyfish is also said to assist the respiratory system by thinning phlegm in the lungs, soothing irritated throats, and curing bronchitis and asthma. It aids the circulatory system by eliminating blockages, lowering high blood pressure, and for women, stimulating blood flow during the menstrual cycle. Jellyfish helps the skeletal and digestive systems as well by softening bone spurs, alleviating back pain and arthritis, curing gall stones and ulcers, and generally aiding in digestion (Rudloe 1995, 23; Hsieh, Leong, and Rudloe 2001). A jellyfish poultice or salve has also been used to treat burns (Rudloe 1995).

Jellyfish have also gained attention in the food and beverage and bio-medical industries as a source of collagen and gelatin (Rudloe 1995; Hsieh, Leong, and Rudloe 2001). The fastest-growing markets for jellyfish outside of traditional food and medicinal consumption is industrial collagen and gelatin. In 2016, the global collagen and gelatin trade was estimated to be worth $3.71 billion. The market is expected to grow substantially in the coming years as demand from the food and beverage, cosmetics, and pharmaceutical and healthcare industries increases (Grand View Research 2019). The low immune reactivity and biodegradability make collagens and gelatins important ingredients in these industries (Addad et al. 2011; Hoyer et al. 2014; Silva et al. 2014).

The majority of industrial collagen and gelatin have been derived from bovine or porcine sources. Concerns about mad cow disease and the sustainability of raising cattle and religious and cultural objections to porcine products have encouraged researchers to seek out new sources (Nagai et al. 1999; Addad et al. 2011; Hoyer et al. 2014; Silva et al. 2014; Grand View Research

2019). Out of all the sources, marine sources are expected to grow the fastest (Silva et al. 2014; Grand View Research 2019). Although marine sources have primarily focused on deriving collagen from fish scales, bones, and skins, researchers have begun to explore jellyfish (Nagai, Ogawa, Nakamura, et al. 1999; Addad, Exposito, Faye, et al. 2011; Hoyer, Bernhardt, Lode, et al. 2014). In a study of Nomura's jellyfish (*N. nomurai*), Kimura, Miura, and Park (1983) concluded that its primary edible component was collagen, and Nagai, Ogawa, Nakamura, et al. (1999) found that 46.4 percent of the dry weight of the *S. meleagris* (cannonball jellyfish) exumbrella (the upper surface of the bell) was collagen; considered a highly concentrated source. Cho, Ahn, Koo, et al. (2014) conclude that the gelatin derived from the *R. hispidum* jellyfish was suitable for use in some food and cosmetics products.

Collagen is a structurally important component of body tissues like tendons, skin, and bones, and it is involved in many biological functions ranging from growth to tissue repair; as such, it is important to the pharmaceuticals and healthcare industries. In a study of collagen derived from the barrel jellyfish (*R. pulmo*), Addad, Exposito, Faye, et al. (2011) found that it behaved similarly to human collagen and was a potentially viable alternative to mammalian and human-derived collagens in biomedical and cosmetics applications. Hoyer, Bernhardt, Lode, et al. (2014) found that collagen derived from the flame jellyfish *(R. esculentum*) could be used to mimic the extracellular matrices of human cartilage. Despite the rapid growth of the industrial collagen and gelatin market, the main driver of global jellyfish consumption is primality food and traditional medicinal uses by consumers in China (Hsieh, Leong, and Rudloe 2001).

THE EXPANSION OF THE JELLYFISH FRONTIER

The Exploitation of Edible Jellyfish Species

China has historically been the main producer and consumer of jellyfish; however, domestic fisheries have been seriously degraded, and despite dramatic increases in fishing, Chinese jellyfish fishermen have been hard-pressed to satisfy increasing demand (Dong, Liu, and Keesing 2014). You, Yongming, Caihua, et al. (2016) report on the Liaodong Bay in the Yellow Sea, one of China's main jellyfish fisheries. Before the 1980s, only a few hundred boats collected jellyfish in the bay each year, and the jellyfish blooms lasted about two months. By the 1990s, however, shrimp and fish stocks in the bay were degraded due to pollution, overfishing, environmental change, and more fishermen were turning to jellyfish as a last source of income. Today, over ten thousand boats collect jellyfish in the bay, often illegally, and the blooms are depleted in only a few hours (You, Yongming, Caihua, et al. 2016). Annual harvests of jellyfish in China have been in decline since the early 2000s despite stock enhancements that annually 'seed' waterbodies with aquaculture raised jellyfish(You, Ma, Gao, et al. 2007; Dong, Liu, and Keesing 2014).

Booming demand and overexploitation of traditional fisheries have resulted in dramatic changes to the global jellyfish market. Higher prices have prompted the introduction of jellyfish aquaculture and fake jellyfish scams in China, and the development of wild jellyfish fisheries abroad in non-traditional markets (Wenda 2001; You, Ma, Gao, et al. 2016; Dong, Liu, and Keesing 2014; Yip 2016; You, Yongming, Caihua, et al. 2016; Brotz 2017). Jellyfish fisheries outside of China first emerged in Southeast Asia among the overseas Chinese populations in the 1950s (Omori and Nakano 2001). Today, jellyfish fisheries exist in the U.S., Australia, Turkey, Bahrain, Mexico, Honduras, Ecuador, and Nicaragua, and fisheries have been investigated in Canada, Brazil, Argentina, and Peru (Figure 8) (Rudloe 1995; Omori and Nakano 2001; López-

Martínez and Álvarez-Tello 2013; Brotz, Schiariti, Lopez-Martínez, et al. 2016; Brotz 2017; Bazi, Pessatti, and, Junior 2019). At least 35 species of jellyfish are currently exploited or have been investigated for exploitation worldwide (Omori and Nakano 2001; Brotz, Schiariti, Lopez-Martínez, et al. 20162016).

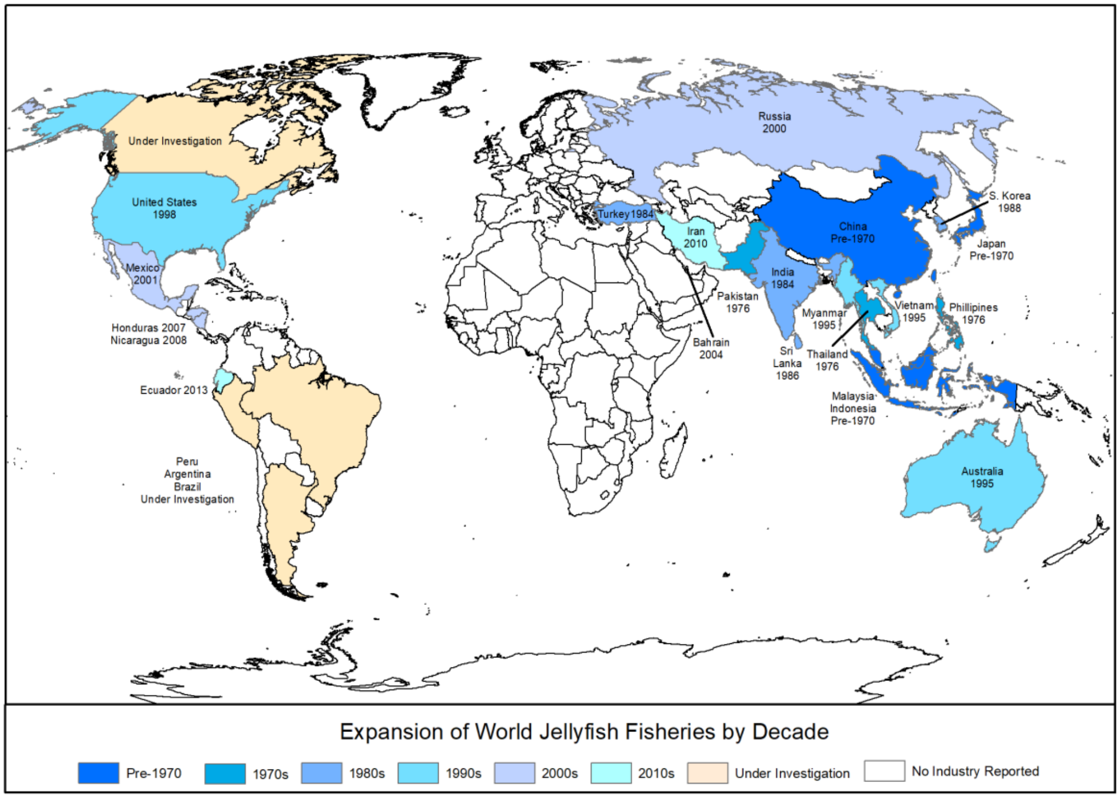

Figure 8: A Map of the Expansion of Jellyfish Fisheries by Decade. In countries listed as under investigation, there is documentation showing that jellyfish fisheries have been studied but no indication that jellyfish are currently being caught and processed for commercial purposes. (Adapted from Fahrenbruch 2018; Data Source: FAO, Brotz 2017; Bazi, Pessatti, and Junior 2019).

Global jellyfish production largely tracked the wild production in China between 1970 and 2005, while Southeast Asian production fluctuated dramatically between 0 and 100 thousand metric MT over the same time. Since 2005, however, production has decoupled from Chinese wild production. Despite fluctuating dramatically in recent years, production in the Americas briefly overtook Southeast Asia in 2014, signifying the boom in the development of jellyfish fisheries in the region (Figure 9).

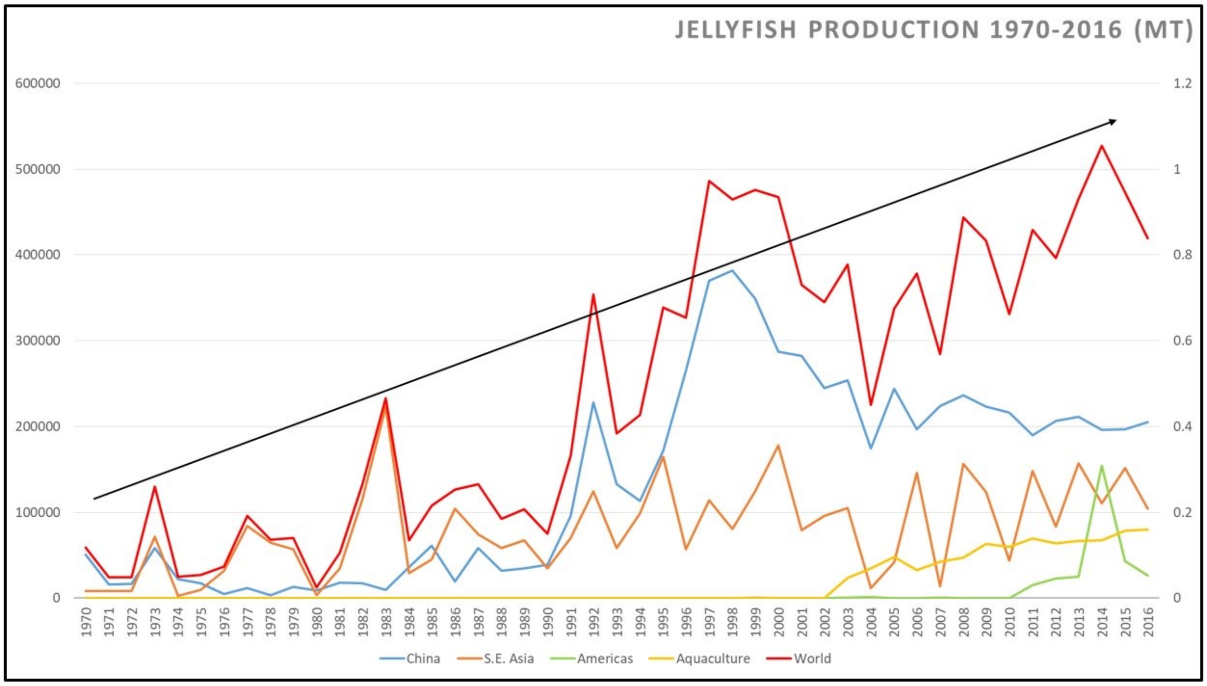

Figure 9: Trends in jellyfish production (1970-2016) (Adapted from Fahrenbruch 2018; Data Source FAO n.d.b.).

The Commodification of the Cannonball Jellyfish

The primary target species in the Americas is the cannonball jellyfish (*S. meleagris)* (Figure 10). Cannonballs are relatively small in terms of edible jellyfish species; maximum bell diameter averages between 20 and 25 cm, and they reach a maximum weight of 1 to 2 kg (Rudloe 1995). The coloration of the species varies from white/translucent with brown borders or purple/red spots on the bells to a homogenous blue pigment; the former appears to be more common in the Atlantic, and the latter is more common in the Pacific. Cannonball jellyfish have been reported from the Northeastern U.S. to Brazil in the western Atlantic, Gulf of Mexico, and the Caribbean Sea, from southern California to Ecuador in the eastern Pacific and from the Sea of Japan to the South China Sea in the western Pacific (Kramp 1961; Larson 1976; Omori 1978).

Figure 10: A Cannonball Jellyfish (*Stomolophus meleagris*). (Source: Author, Tuapi 2017)

Cannonballs were first considered as a potential American fishery in the U.S. in the 1980s. Research by Yao-Wen Huang (1988) and others at the University of Georgia Marine Extension Service developed the first commercial methods for processing cannonball jellyfish. The first experimental fishery was started in Florida in the 1990s with the support of the U.S. Economic Development Administration, the Southeastern Fisheries Association, and the Florida International Affairs Commission (Rudloe 1992, 1995; Jones and Rudloe 1995). The fishery's target market was China, and the goal was to create a new fishery to support the Gulf of Mexico region’s shrimpers who were being undercut by farmed shrimp (Jones and Rudloe 1995).

Researcher Jack Rudloe of the Gulf Specimen Marine Laboratory in Panacea, Florida, led the effort to establish the experimental fishery. Rudloe processed a small batch of cannonball jellyfish in 1991 and introduced them to Chinese jellyfish traders in Malaysia. Although cannonball jellyfish have been reported in East Asian waters, Rudloe found that the traders were completely unfamiliar with the product. The processed cannonballs generated interest. Traders commented that it might be used to imitate some local species, but they questioned the viability of the product due to the cannonball's small size (Rudloe 1992, 25).

Rudloe (1995) also found similar challenges when he carried samples to China in 1994. Despite a superior color, texture, and product yield that was nearly twice that of traditional species, Chinese traders were skeptical that cannonballs could compete head-to-head with local species. The primary species exploited in China, the flame jellyfish *(R. esculentum)*, typically reaches weights of 9 to 22kg and bell diameters of 25 to 40 cm or greater. Rudloe learned that Chinese jellyfish dealers typically look for bells of 40 cm and larger, nearly twice the size of the largest cannonball jellyfish (Rudloe 1995). Rudloe and the Chinese traders determined that cannonballs would be primarily useful in the growing, but lowest-value, shredded jellyfish market (Rudloe 1995).

In addition to being relegated to the lowest rung of the Chinese jellyfish market, the U.S. cannonball fishery faced other challenges. High labor costs, processing time, strict regulatory environment, and shipping costs to get product to market in China all disadvantaged U.S. processors (Rudloe 1995). At the time, low-grade jellyfish was selling for ~$1.99/kg on Chinese markets, but the cost to produce 1kg of finished cannonball jellyfish in the U.S. was ~$2.35 (Rudloe 1995). There was no profit in cannonballs, and, for a time, the fishery was tempered in the U.S. The market for jellyfish was still growing in China, however, and interest began to grow in the cheaper labor markets and weaker regulatory systems of Latin America.

The first cannonball fisheries in Latin America developed on the Gulf of Mexico in the Mexican state of Tabasco in the early 2000s and later on the Gulf of California in the state of Sonora. In Sonora, 1kg of jellyfish cost about $1.47 to produce on the high end, but it could be exported for between $1.50 and $1.70/kg depending on market conditions; a slim margin, but a profit nonetheless (Álvarez-Tello, 2007; López-Martínez and Álvarez-Tello 2013). By 2013, the processing time of cannonballs had been reduced, export prices had risen to over $4/kg. and the first regulated commercial jellyfish fishery opened in Georgia (Page 2015, Brotz, Schiariti, Lopez-Martínez, et al. 2016). Jellyfish fisheries also continued to expand into new Latin American countries, including Ecuador, Honduras, and Nicaragua (Brotz, Schiariti, Lopez-Martínez, et al. 2016).

THE 2014 CHINESE DIETARY ALUMINUM SCARE

In recent decades, the Chinese food supply has been rocked by a series of food security scares related to tainted or otherwise unsafe food products, and unfortunately, jellyfish markets have not been spared (Lam et al. 2013). An outbreak of hepatitis in Shanghai in 1991 was blamed in part on tainted jellyfish, and more recently, jellyfish have been implicated in food safety scandals involving mislabeled packaged foods and even fake jellyfish scams (Rudloe 1995, Armani et al. 2012; Yip 2016). Chinese officials broke up multiple crime syndicates in 2013, 2014, and 2016 that were producing fake jellyfish made of a cocktail of alginic acid, ammonium alum, and calcium chloride anhydrous (Yip 2016).

Food safety scares in China have often focused on domestic issues and have benefited exporters in Europe, Oceania, and North America; areas considered to have stricter safety standards. However, a rash of food safety incidents in 2013 involving ‘polluted’ imported seafood from the U.S., Canada, Korea, Thailand, and Taiwan prompted the Chinese government to crack down on seafood imports and raised alarm bells among the Chinese public (Godfry 2013; Godfry 2014). One outcome of this crackdown that directly impacted jellyfish markets was the 2014 dietary aluminum scare.

As will be discussed in Chapter 5, jellyfish processing requires the use of alum, typically potassium alum (a hydrated double sulfate of aluminum and potassium). Alum acts as a firming agent. It binds to the proteins in the jellyfish tissue and gives it a crunchy texture that is the food's hallmark. Unfortunately, while salt can be removed easily through repeated soakings in water, the alum is more resistant (Hsieh, Leong, and Rudloe 2001; Brotz, Schiariti, Lopez-Martínez, et al. 2016). The result is that ready-to-eat jellyfish still contains high levels of aluminum, which can accumulate in the body and cause neurological and renal diseases. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) has established a provisional tolerable weekly aluminum intake (PTWI) of 1 mg/kg of body weight. Wong et al. (2010) report that ready-to-eat samples of jellyfish in Hong Kong had an average aluminum concentration of 1,200mg/kg; the next highest was steamed bread, buns, and cakes that use aluminum-containing baking powder (100 to 320 mg/kg). Similar studies in the city of Shenzhen and the province of Zhejiang found average aluminum concentrations of 528 mg/kg and 4,862 mg/kg, respectively (Yang, Jiang, Huang, et al. 2014; Zhang, Tang, Huang, et al. 2016).

A 2009 report by the Hong Kong Government's Centre for Food Safety recommended that food processors find alternatives to aluminum-based additives and that consumers avoid excessive consumption of impacted products, including jellyfish (HKCFS 2009). The aluminum scare hit the mainland in 2014 when the Chinese National Center for Food Safety Risk Assessment (CFSA) released a report that estimated that one-third of the Chinese population was a risk of illness due to elevated levels of aluminum caused by dietary intake (CFSA 2015). Although the CFSA focused primarily on reducing aluminum additives in flour-based products, the report also highlighted jellyfish as a highly concentrated source and recommended limiting consumption (CFSA 2015).

The CFSA report and recent crackdowns on seafood imports spelled disaster for jellyfish producers in the Americas. Although the CFSA did not specifically mention jellyfish from the Americas in their report, researcher Julie Berwald (2017) argues that the report effectively drew a 'dotted line' to jellyfish suppliers outside of Asia. Rumors spread among consumers and buyers of shoddy/unprofessional operations, unsafe and negligent protocols, and jellyfish tainted by excessive amounts of alum (Berwald 2017, 47). According to Berwald, the report and following food safety scare destroyed demand for U.S. cannonball jellyfish. Almost overnight, jellyfish buyers began to shun American producers, and U.S. exports plunged 87 percent from 2.1 million kilograms in 2014 to only 291 thousand kilograms in 2015 (NMFS n.d.). Berwald does not mention Latin America, but it is likely that the crisis extended to cannonball fisheries in Latin America and likely contributed to the collapse of the Miskitu Coast fishery beginning in 2015.

SUMMARY

This chapter aimed to expand beyond Nicaragua and provide the reader with an understanding of the dynamics surrounding the demand for jellyfish and recent changes in the global jellyfish market. Jellyfish has strong social significance in China and is important in social banqueting practices and as a traditional medicine for several ailments. In general, as Chinese consumers gain affluence, they are eating more animal proteins, including jellyfish. However, traditional fisheries have been unable to supply consumer demand, resulting in an expansion of the jellyfish commodity frontier well beyond Asia.

The development of cannonball fisheries in the Americas was facilitated by researchers in the U.S. in the 1980s and 1990s. Despite slow initial development, cannonball fisheries have grown and expanded in the U.S. and several Latin American countries. However, this growth was seriously tempered in 2014 by a concern for unsafe processing techniques and unsafe levels of dietary aluminum in jellyfish. Fair or not, American jellyfish fisheries were targeted for scorn by jellyfish dealers leading to a crash in the U.S market and likely those in Latin America as well.

CHAPTER 4: THE BIOLOGICAL CONTEXT OF JELLYFISH FISHERIES

INTRODUCTION

The Miskitu Coast jellyfish fishery, like other jellyfish fisheries around the world, depended on the seasonal occurrence of large jellyfish blooms to operate. This chapter aims to provide background on jellyfish blooms and the general biology of the scyphozoan jellyfish—the class of jellyfish that the majority of edible species, including the cannonball jellyfish, belong to—as well as the observed behavior of cannonballs along the Miskitu Coast. I begin with a description of the physical geography of the Miskitu Coast to provide a foundation to better understand the Tuapi jellyfish fishermen's observations. I briefly review the lifecycle of the scyphozoan jellyfish and then define and describe their "bloom and bust" nature. Despite the importance of blooming behavior to jellyfish fisheries, there is a general dearth of research to help fishermen, processors, and managers predict their occurrence, duration, and collapse. I discuss the observations of Miskitu fishermen and place them into context with the existing literature. Although this dissertation is not an explicit biological study of the Miskitu Coast jellyfish fishery or cannonball jellyfish populations, I hope to provide a foundation for future research of this kind.

THE PHYSICAL GEOGRAPHY OF THE MISKITU COAST

The Miskitu Coast is characterized by a low-lying coastal plain that has developed over millions of years as the result of sediment erosion from the Central American crystalline highlands (Wallace 1997). The major biomes include pine savannas, tropical rainforest, riparian areas, mangroves, brackish lagoons, bays, marsh, estuaries, and beaches (Nietschmann 1973, 1989). Offshore, the coast has an extensive continental shelf that extends 100 to 200 kilometers in some areas. Washed by the warm Caribbean current and fed by nutrient-rich runoff, the continental shelf and the region's vast brackish lagoons support extensive coastal mangroves and vast underwater areas of seagrass. These ecosystems provide the habitats for a variety of brackish and marine species, including sea turtles, conch, shrimp, spiny lobster, sea cucumber, a variety of scaled fish, and jellyfish (Nietschmann 1973; Jackson and D'Croz 1997). These species are heavily influenced by both near-shore currents and seasonal shifts in water salinity that correspond with seasonal fluctuations of freshwater outflow from the region's rivers.

Five navigable rivers and several large, brackish estuarine/lagoon systems define the Miskitu Coast (See map in Figure 1). From north to south, the Río Coco marks the northern frontier with Honduras and drains the central highlands of the Departments of Madriz and Estelí in North Central Nicaragua. On the mid-coast north of the RACCN-RACCS border, the Río Prinzipolka drains the highlands of Jinotega and the Eastern RACCN, and just south of the RACCN-RACCS border, the Río Grande de Matagalpa drains the highlands of the Department of Matagalpa. Near Bluefields, the Río Escondido drains the Department of Chontales into Bluefields Bay; and finally, the Río San Juan drains Lake Nicaragua to the Caribbean and marks Nicaragua's international border with Costa Rica. The coast's major brackish estuarine/lagoon systems include Sandy Bay and the Bismuna, Dakura, Pahara, Karatá, and Wouhnta lagoons in the RACCN and the Pearl Lagoon and Bluefields Bay in the RACCS (See Map in Figure 1). These systems drain much of the Nicaraguan interior and expel a great quantity of freshwater that causes dramatic seasonal fluctuations in the salinity levels of estuaries, brackish lagoons, and the near-coastal water zone.

The Miskitu Coast lies within the belt of northeasterly trade winds and has a humid tropical lowland climate (Köppen climate *Af*); temperature and relative humidity are high year-round. The average temperature range is between 24°C (76°F) in January and February and 27°C (81°F) in May and June (Parsons 1955a; Nietschmann 1973). The wettest months are June and July, and the driest are March and April. Bilwi in the RACCN receives about 3,300 millimeters of precipitation per year, and Bluefields in the RACCS receives about 4,100 millimeters (Parsons 1955a; Nietschmann 1973) (Figure 11).

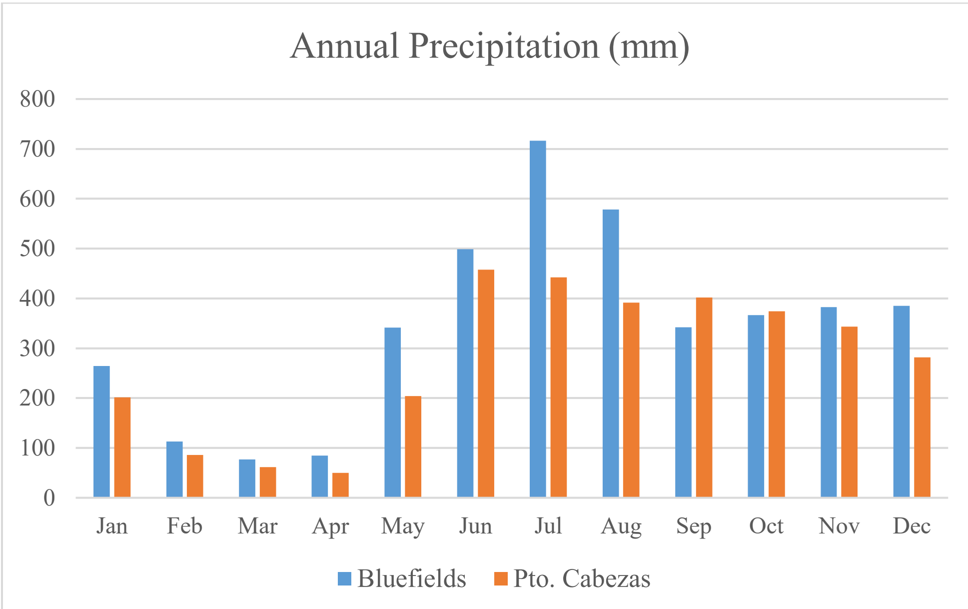

Figure 11: Annual Precipitation on the Miskitu Coast (Source: Nietschmann 1973)

The coast experiences both wet (*invierno*) and dry (*verano*) seasons. January and February experience periods of intermittent rain with the onset of verano. Vernano begins in late February and runs through mid-May. During this time, the northeast trade winds shift northward and tend to be calmer along the Miskitu Coast, helping to calm wave action and coastal currents. In March, the driest month, the region still receives about 70 millimeters of rain, but there are many days without precipitation (Nietschmann 1973). Invierno begins quickly in late May as precipitation increases to 200 to 300 millimeters. The northeast trade winds, shifting southward, are strongest during this time, and thunderstorms discourage fishing and agricultural activity (Nietschmann 1973). The heaviest rains come in July and slowly taper off until January. Two short relatively drier periods, known in Miskitu as *pupu wita* (late May to early June) and *mani lupia* (mid-September to early October), arrest the deluge of invierno for a few weeks each (Nietschmann

1973). November and December are marked periods of strong *nortes* or *frente fríos*; northern and northwestern winds that signal advancing cold fronts. These winds help counteract and calm wave action along parts of the Coast. It is during these fronts that fishermen say the fishing is the best.

During invierno, storms cause heavy outflows of freshwater and debris from rivers and lagoons. Trash from upriver villages, dead animals, plant material, and in some cases, whole trees are flushed out into the coastal fishing grounds. The torrential rains flood the coastal lowlands and flush out saline water from the lagoons and create sediment-laden freshwater plumes along the coast. The coast is impacted year-round by the Panama-Colombian Gyre (Figure 12); a counter clockwise current that occurs along the Caribbean coast of Central America from Cape Gracias a Dios to northeastern Venezuela (Gyory, Mariano, and Ryan n.d.). This strong counter-current pulls and stretches the freshwater plumes to the south along the coast, creating a band of brackish, turbid, and debris-laden water that locals call in Spanish the '*leche*' or milk.

The width of the leche belt varies throughout the year but can extend 13 to 16 km offshore and more than 30 km during periods of exceptionally high outflow (Nietschmann 1973, 72). The widening and thinning of the leche belt have a major impact on the behavior of brackish and near-coastal marine species, including jellyfish. During invierno or tropical storms/hurricanes, when river outflow is high, the leche belt expands and drives freshwater intolerant species out of the brackish systems and away from the coast. However, with the onset of the dry season, river outflow abates and allows higher salinity water to move closer to the coast along with freshwater intolerant species. Jellyfish are typically captured within one or two kilometers of the coast, well within the influence of the leche belt (Tuapi Focus Group, December 2017). The leche belt plays a major role in the distribution of jellyfish and the operation of the jellyfish fishery, as discussed below.

Figure 12: A Map of the Panama-Colombia Gyre Counter Current. Simplified from Gyory, Mariano, and Ryan (n.d.)

JELLYFISH BLOOMS

The Jellyfish Lifecycle

Jellyfish biology and jellyfish fisheries and their management have been discussed in detail by researchers, and I do not recreate this work here (Arai 1997; Kingsford, Pitt, and Gillanders 2000; Pitt and Lucas 2014; Brotz 2017). However, it is important to discuss the lifecycle dynamics of jellyfish and their blooming behavior to understand the observations of the Miskitu Coast fishermen and the operational challenges of the Miskitu Coast jellyfish fishery and jellyfish fisheries in general.

The jellyfish lifecycle is much more complex than most other sexually reproducing marine animals, and it is exceedingly difficult to predict population dynamics one year to the next. The jellyfish lifecycle has six stages, two of which, the *medusa* and *polyp* stages, are capable of reproducing (Figure 13). The stage that is exploited in jellyfish fisheries is the sexually reproducing free-floating *medusa* stage. During sexual reproduction, the medusas release male and female gametes into the water column that combine to form the free-floating *planula* stage. A planula can swim in the water column for a few hours to several days before settling, if it finds and settles on a suitable substrate, it attaches and develops into a *syphistoma* and then a polyp (Arai 1997).

Polyps can reproduce asexually through two distinct mechanisms. First, they can deploy *podocysts* that settle and form new clone polyps and eventually polyp colonies, or under the right environmental conditions, they can develop into *strobila* and create new free-swimming *ephyrae* (immature medusas) via the process of *strobilation* (Arai 1997; Lucas and Dawson 2014). The ephyra often grows and matures quickly into a medusa; however, some species' ephyrae have been found to delay maturation if food levels are low or wave action is too high (Arai 1997).

A single strobila can spawn several ephyrae or can return to the polyp phase and continue to reproduce asexually via podocysts. Polyps can live multiple years, strobilate multiple times, and can even reduce themselves back to podocysts if environmental conditions are bad (Arai 1997; Kingsford, Pitt, and Gillanders 2000). Perennial polyp colonies are thought to serve as important buffers against population collapse and are the key to some kinds of blooms. Unfortunately, there has been little research done in the field to confirm this. The rush to develop jellyfish fisheries to satisfy booming demand has outpaced the research necessary to understand their operation and to formulate management plans. To date, and the polyp beds for most individual jellyfish fisheries—including *R. esculentum,* the most popular and longest exploited jellyfish species in the world—

remain unknown to fisheries managers (Kingsford, Pitt, and Gillanders 2000; Tang, Sun, and Zhang 2019).

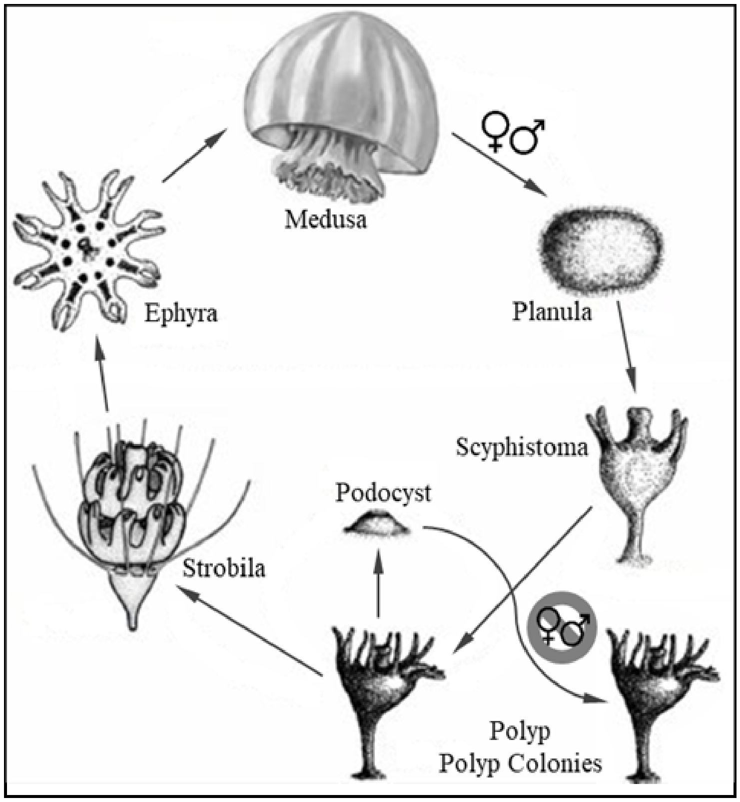

Figure 13: Life Cycle of *S. meleagris*. Adapted from Calder (1982).

Evolution and Blooms

Phylogenetic analysis has shown that only a subset of jellyfish species bloom, including the cannonball jellyfish. This suggests that the behavior benefited the survival and propagation of those species and not a general adaptation across all jellyfish (Hamner and Dawson 2009; Lucas and Dawson 2014). Blooms are hypothesized to benefit survivability and propagation in several ways related to reproduction, feeding, and predation (Arai 1997; Kingsford, Pitt, and Gillanders 2000; Hamner and Dawson 2009; Lucas and Dawson 2014). First, blooms are thought to be an adaptation that increases the likelihood of gamete fertilization during spawning, and Kingsford, Pitt, and Gillanders (2000) suggested that some species only release their gametes during blooms (Arai 1997, Kingsford, Pitt, and Gillanders 2000).

Next, in terms of predation, jellyfish are voracious predators of zooplankton, and dense blooms of the medusas are thought to be an adaptation to physically exclude other predators, leaving more food for the bloom (Hamner and Dawson 2009; Pitt, Budarf, Btowne, et al. 2014). Blooms may also protect jellyfish from predation. Jellyfish predation was long thought to be limited to a few specialist species, including the leatherback turtle and the ocean sunfish; however, jellyfish consumption is now known to be much more widespread. Jellyfish form an important component of the diet for a range of animals, including marine fishes, octopuses, crustaceans, turtles, sea birds, and penguins (Cardona, de Quevedo, Borrell, et al. 2012; Hays, Doyle, and Houghton 2018).[13] Blooms may help protect individuals from predation by providing many alternatives to predators, increasing the rate that predator satiation occurs, and increasing predator confusion (Molles 2008, 338-341).

The Environment, Strobilation, and Bloom Persistence

Jellyfish populations and blooms are directly related to strobilation (Arai 1997; Gershwin 2013). The mass strobilation of polyp colonies releases many ephyrae into a small area, increasing the likelihood that blooms will develop in the future (Arai 1997). Although little is known about natural strobilation, laboratory experiments have stimulated strobilation by shocking polyps with rapid environmental changes (Arai 1997). You, Ma, Gao, et al. (2007) found that water

[13] Leather back turtles, whose main source of food is jellyfish, have been observed to consume 73 percent of their body weight each day in jellyfish (Heaslip et al. 2012). There is still a very poor understanding of jellyfish role in the food chain and the list of species that consume jellyfish is still increasing. In a 2017 study of the stomach contest of 107 fish species showed that 39 had consumed jellyfish, 23 of which were not previously known to consume jellyfish (Diaz-Briz et al. 2012). It has also been found that some jellyfish polyps prey on the polyps of competing jellyfish species (Tang, Sun, and Zhang 2019).

temperature had a strong impact on the strobilation of *R. esculentum*. The authors found that strobilation would not occur below 13°C and that optimal salinity for strobilation was between 14 and 20 parts per thousand (ppt.), low compared with normal ocean salinity of 35 ppt. In a separate study of *R. esculentum* in Liaodong Bay, Lu, Liu, and Guo (1989) found a slightly positive correlation between freshwater inflow into the bay and the abundance of jellyfish, suggesting that seasonal changes in temperature and salinity could stimulate strobilation. Researchers hypothesize that polyps sense danger during rapid environmental changes and strobilate to quickly make their genetic information mobile to propagate it to more environmentally conducive areas (Arai 1997).

Contrary to a danger response hypothesis, Girón-Nava, López-Sagástegui, and Aburto-Oropeza (2015) suggested some correlation between a massive bloom of cannonball jellyfish in the Gulf of California in 2012 and sea surface temperatures and chlorophyll-a concentrations. The authors argue that it could have been the opportunity presented by the abundance of food, represented by the chlorophyll-a concentrations, that triggered a prolonged strobilation event that created and sustained the large bloom. Jellyfish are voracious predators and eat a wide range of zooplankton, picoplankton, and microplankton (Pitt, Budarf, Btowne, et al. 2014). They also have a great deal of plasticity in their biomass (Pitt, Budarf, Btowne, et al. 2014). A jellyfish is about 96 percent water and only 0.5 percent carbon, while most marine animals are only about 75 percent water (Pitt, Budarf, Btowne, et al. 2014). This high ratio of water to carbon allows jellyfish to grow 3.5 times faster than other marine organisms to take advantage of booms in food abundance or quickly lose biomass when resources are scarce (Pitt, Budarf, Btowne, et al. 2014). Arai (1997) also suggested that the ephyra for some species can delay maturation when environmental conditions such as food, salinity, and wave action are not amenable, but develop and mature quickly when they are. This ability to quickly increase biomass, however, is a two-edged sword.

Matched with a voracious appetite, the rapid increase in biomass may lead to the rapid depletion of available food in an area that can lead to a rapid physical reduction in biomass caused by starvation or secondary perils including predation, parasitism, and disease (Pitt, Budarf, Btowne, et al. 2014; Girón-Nava, López-Sagástegui, and Aburto-Oropeza 2015).

Currents, Salinity, and Blooms

The Tuapi fishermen that I knew were unaware of jellyfish evolution, polyp colonies and strobilation, or the water's chlorophyll content; however, they understood key environmental conditions that impacted the blooms, including currents, wave action, precipitation, river discharge, and lunar cycles. Tuapi fishermen describe how the jellyfish blooms migrate from north to south. Carried by the Panama-Colombia Gyre current, they appear earlier in the season near the Honduran border and steadily drifting south, reaching Sandy Bay first, then Krukira/Tuapi, and finally Bilwi (Tuapi Focus Group, December 2018).

Many jellyfish species, including the cannonball jellyfish, are strong swimmers; however, they are nonetheless heavily influenced by river, tidal, surface, and prevailing currents (Shanks and Graham 1987; Arai 1997; Lucas and Dawson 2014). Currents interacting with bays and lagoons or concave areas of a coastline can create eddies and gyres that can trap and aggregate jellyfish creating blooms (Graham, Pages, and Hamner 2001; Lucas and Dawson 2014). Wind-driven surface currents and strong tidal-pumping forces can also cause jellyfish aggregations in near-coast waters, or conversely, weak tidal-pumping, heavy river outflow, or both can push blooms out to sea (Graham, Pages, and Hamner 2001). At the meso (100 to 1000 km) or coarse (1 to 100 km) scales, distributions of jellyfish are largely a result of these factors (Lucas and Dawson 2014). Like those along the Miskitu Coast, current-driven movement patterns have been documented in jellyfish fisheries in Mexico, the U.S., and China (Rudloe 1992; 1995; López-Martínez and Álvarez-Tello 2013). However, because of a lack of research, it is unclear if the Miskitu Coast blooms were associated with specific populations and water bodies or composed of members of various populations throughout the Caribbean basin and beyond.

Wave action has been shown to impact the vertical swimming behaviors of jellyfish (Arai 1997). Tuapi fishermen noted that jellyfish blooms tend to occur during dry weather when wave action is low, especially during November and December, when strong *nortes* sweep down from the north. Nortes bring dryer northwest/offshore winds that help calm the wave action (Tuapi Focus Group, December 2018). Arai (1997) highlighted that many jellyfish species remain in deeper waters during periods of high wave action, and Shanks and Graham (1987) observed that when bumped or tumbled, the cannonball jellyfish turns 90 degrees and swims the other way. Impact with debris flushed out by a storm could result in similar behavior; however, this has not been studied. Nevertheless, if surface conditions are turbulent or there is a lot of debris, jellyfish behavior may keep them away from the surface and out of fishermen's reach.

Another, and possibly more important, factor from the fishermen's accounts of the leche is the heavy outflow of freshwater into the near-coastal waters and the impact on salinity levels. Fishermen noted that after periods of high precipitation when there is a lot of leche, many fish "run" and disappear from near-coast waters and jellyfish stay deep and do not rise to the surface. Freshwater tends to have a salinity concentration of 0.5 ppt or lower and is much less dense than that of full seawater that has a salinity concentration of 35 ppt. As a result, freshwater floats on top of denser seawater, creating a saltwater wedge or *halocline* where the two meet (Figure 14). The halocline change's location and steepness throughout the year and even throughout the day because of tidal pumping, wind speed and direction, and river outflow.

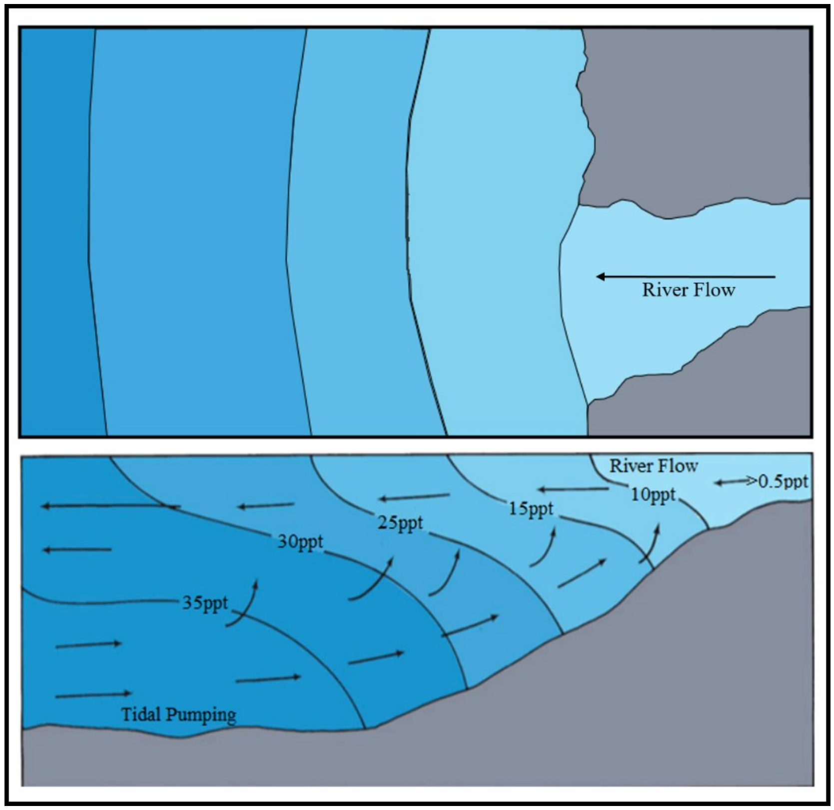

Figure 14: Generalized Halocline and Circulation in Near-coast Waters.

In a daily cycle, high tides push the halocline farther into the estuary overcoming the force of outflowing freshwater and increasing the salinity in the estuary and near-coast waters. Low tides reduce this pressure allowing river water to expel saline water, lowering salinity in the estuary and near-coast waters. This balancing act can be exacerbated during periods of higher and lower river outflow. High river outflow, such as occurs after storms, can expel saltwater from an estuary or brackish waterbody and create freshwater plumes that extend the halocline many kilometers away from the coast. As the halocline extends away from the coast, freshwater intolerant species are forced to "run" out to sea (Nietschmann 1973, 73). Conversely, periods of low river outflow can allow these species to move closer to the coast and into estuaries, and brackish water bodies.

Just as strobilation appears to be stimulated by temperature and salinity changes, jellyfish behavior and survival may also be impacted by these changes. Jellyfish are *osmoconformers* meaning they cannot regulate their internal salinity in relation to the external environment. Rapid changes in salinity can harm osmoconformers and have a major impact on their behavior. Jellyfish have been observed to aggregate around sharp haloclines where salinity concentrations change quickly, and laboratory and field observations suggest that salinity plays a major role in the distribution and vertical and horizontal movement of jellyfish. In laboratory experiments, Arai (1973) placed *P. pileus* jellyfish in large cylinders with varying salinity concentrations. In the cylinders with high salinity concentrations (>25 ppt), the jellyfish actively moved to the lower salinity levels, while they tended to move to a higher salinity level when the salinity concentrations were decreased (~20 ppt). These results suggest that jellyfish can seek out amenable salinity concentrations in the laboratory, but this also likely applies to jellyfish behavior in the wild as well.

Some species have been observed to disappear from bodies of water after heavy precipitation and corresponding reductions in salinity. In the western Mediterranean, Goy et al. (1989) observed from 200 years of records that *P. noctiluca* blooms correlated well with high temperatures, high atmospheric pressure, and low precipitation. In Western Australia, Rippingdale and Kelly (1995) found that populations of *P. punctata* appeared to persist during dry periods when salinity was high but disappeared upon the onset of heavy rains. Similar observations were made of *C. quinquecirrha* in the Chesapeake Bay, *A. aurita* in coastal lagoons in Taiwan, and by jellyfish fishermen of *C. helmburi* in Indonesia (Cargo and King 1990; Purcell, White, Nemazie, et al. 1999; Lo and Chen 2008; Pitt, Budarf, Btowne, et al. 2014; Nishikawa, Ohtsuka, Mujiono, et al. 2015).

Similar field studies in the U.S. and Mexico on cannonball jellyfish also suggest a reaction to changes in salinity. Torres et al. (2017) recorded the abundance of cannonball jellyfish in a brackish estuary/lagoon system in Tabasco, Mexico. The authors found that upstream in the system where salinities were lower, cannonball abundance was lower and vice versa, suggesting that salinity impacted their distribution in the system. Similar observations have also been made in the Gulf of California by Sauceo et al. (2011). Kraeuter and Selzer (1975) studied the seasonal migration of cannonball jellyfish out of and into the Doboy Sound in the State of Georgia. They observed that a large number of juveniles moved out of the sound and towards the sea during the summer. By early autumn, the authors recorded large numbers of medium-size individuals in the near-coastal waters, but these jellyfish disappeared by November. By early March of the following year, large mature jellyfish appeared in the near-coastal waters moving back towards the sound. Although the authors do not frame it in the context of precipitation and river outflow, Georgia has a Köppen humid subtropical climate (*Cfa*), and the majority of precipitation falls during the summer and the least during the winter/early spring. River outflows would have been highest and salinity lowest when the jellyfish were moving out of the sound, while the opposite would have been the case when the jellyfish were moving back into the sound.

It is not known for certain if the above observations reflect the physical expulsion of jellyfish from the water bodies caused by heavy outflow currents, their intentional retreat from areas of reduced salinity, or both. However, they suggest that salinity and a shift in the halocline impact jellyfish distribution in an area. These jellyfish may be being pushed away from brackish and near-coast waters or are being forces down to lower and more saline levels of the water column keeping them out of reach of observers. Drier conditions with lower river outflows may allow the halocline to move in closer to the coast allowing the jellyfish to return to near-coast and near-surface waters where fishermen can catch them. Tuapi fishermen noted that jellyfish blooms tend to occur with the onset of the dry season, although the greatest catches occurred in November and December, months before the driest months of February, March, and April.

The final physical factors that Tuapi fishermen observed to impact jellyfish behavior include lunar cycles. Tuapi fishermen observed that the blooms tended to occur during the days leading up to and following the full moon (Tuapi Focus Group, December 2018). The reason for it is poorly understood, although many jellyfish species have been observed to make diurnal or nocturnal vertical migration between the surface and the depths. Some suggest that this behavior is the result of an attraction or repulsion to/from light or cues provided by gravity or pressure sensors (Arai 1997; Lucas and Dawson 2014). It is also possible that the stronger tidal forces simply push the halocline closer to shore during these periods, allowing jellyfish to follow.

SUMMARY

This chapter aimed to provide the reader with a cursory understanding of the physical geography of the Miskitu Coast, the general lifecycle of a scyphozoan jellyfish, and the limited research that has been done to understand jellyfish blooms. Although this dissertation does not provide a methodology for predicting jellyfish blooms on the Miskitu Coast, I included local jellyfish fishermen's accounts to lay a foundation for future research that may do so. Readers are implored to remember that jellyfish blooms are caused by the interactions between a suite of abiotic and biotic factors that are time and place-specific (Lucas and Dawson 2014, 35). Although blooms tend to occur during relatively predictable time periods and in relatively predictable places, their causal factors are still poorly understood, making the accurate prediction of bloom size, duration, and day-to-day location difficult. This uncertainty is a defining factor of jellyfish fisheries.

CHAPTER 5: THE OPERATIONAL CONTEXT OF JELLYFISH FISHERIES

INTRODUCTION

During the Miskitu Coast jellyfish boom, jellyfish landings occurred primarily between October and May, with the largest harvests reported during November and December in 2014 (Figure 15). The blooms were often inconsistent, and it was difficult to predict where or when they would occur; they could be abundant one day only to disappear or shift significantly in their geographic distribution the next (Tuapi Focus Group, December 2017). This unpredictability was also the case season to season. Between 2013 and 2015, blooms provided millions of kilograms of product for jellyfish processors; however, between late 2015 and early 2018, the blooms were weak, helping to precipitate the fishery's rapid decline (Tuapi Focus Group, December 2017). The blooms rebounded in late 2018, but by then, it was too late for several processors who shuttered during the bust.

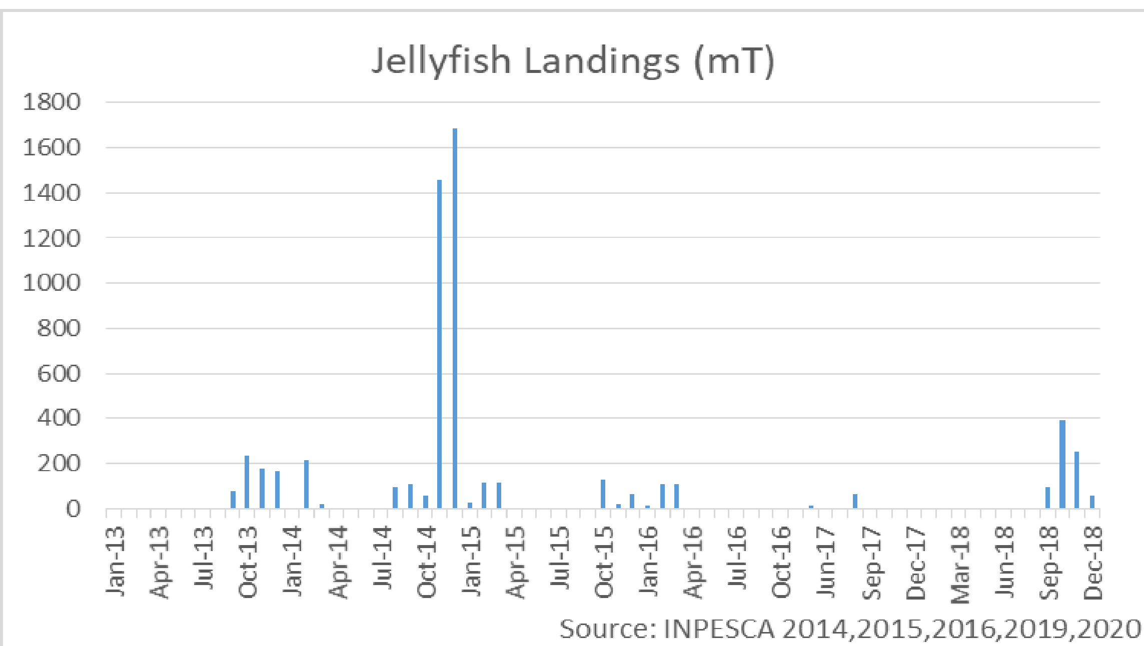

Figure 15: Reported Monthly Landings of Jellyfish on the Miskitu Coast (2013-2018). (Source: INPESCA)

Jellyfish fisheries worldwide struggle with the same issues of uncertainty and inter and intra-annual volatility. This chapter reviews the limited literature on jellyfish fisheries and contextualizes the operational challenges experienced on the Miskitu Coast with other operations. I begin by discussing the general operation of a jellyfish fishery, which is similar worldwide. I then discuss the common challenges that jellyfish fisheries face and the adjustments that fishermen and processors make to account for them.

THE GENERAL OPERATION OF A JELLYFISH FISHERY

Catching and Processing Jellyfish

During jellyfish blooms, fishermen typically collect jellyfish from near the ocean surface. In most fisheries, jellyfish are collected by small crews of artisanal fishermen using small boats and handheld dip-nets, seines, or set-nets; however, there have been instances of industrial fishing in the U.S. and Australia using shrimp trawlers (Kingsford, Pitt, and Gillanders 2000; Lopez-Martinez and Alvarez-Tello 2013; Page 2015; Gul, Jahangir, and Schiariti 2015; Brotz 2017; Ling 2017; Nitin and Ranipeta 2018). Small boats and handheld dip-nets are most common on the Miskitu Coast.

Jellyfish Processing Facilities (JPFs) take on several forms around the world, including modern and partially automated facilities like those in the U.S. and Mexico, permanent but rudimentary facilities that have concrete salting basins and corrugated metal rooves like those reported in Malaysia, Pakistan, and on the Miskitu Coast, and ephemeral operations that use plastic or tarp basins and are set-up seasonally like those documented in Honduras and India (Rudloe 1993; Mohan, Rajapackiam, and Rajan 2011; Gul, Jahangir, and Schiariti 2015 ; Ling 2017).

Jellyfish processing methods and end products are similar regardless of the setup or target species. A jellyfish contains various body parts, only some of which are consumed (Figure 16). The first step in processing jellyfish is to separate them into oral arms and bells and manually remove any tentacles, gonads, and gut material (Rudloe 1995). For some species, such as the cannonball jellyfish, both the bells and oral arms are processed for export, but for others, only the bells or oral arms are marketable (Rudloe 1993; Kingsford, Pitt, and Gillanders 2000; Hsieh, Leong, and Rudloe 2001; Kitamura and Omori 2010; Lopez-Martinez and Alvarez-Tello 2013; Gul, Jahangir, and Schiariti 2015).

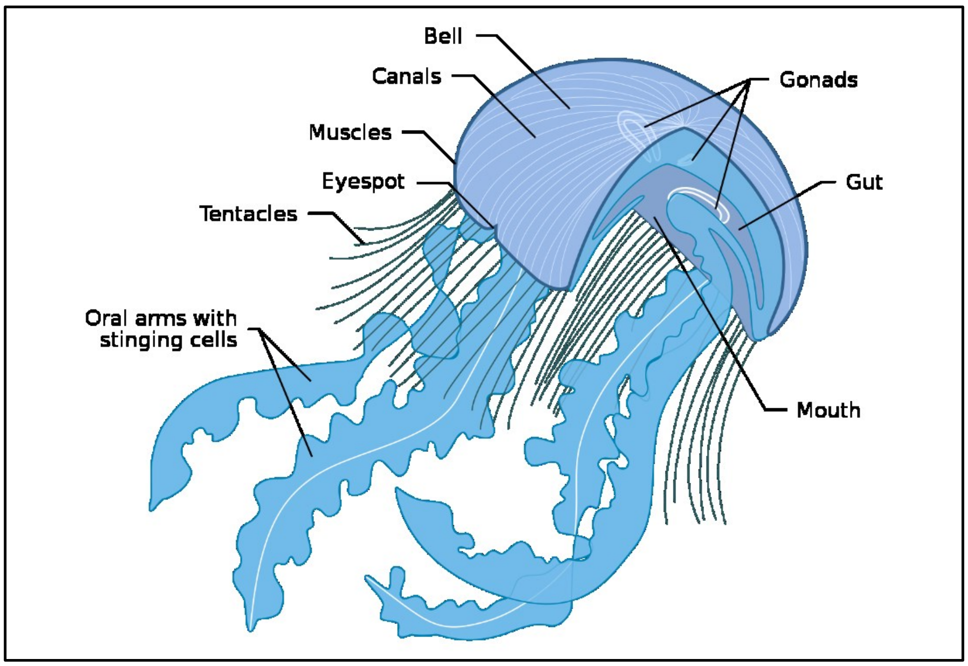

Figure 16: A Diagram of Jellyfish Anatomy (Source: Creative Commons/Wikipedia)

Following separation, the parts are loaded to large basins where they are washed to remove mucus and debris so that the curing chemicals can better penetrate the flesh and increase the speed of the curing process (Jones and Rudloe 1995). After cleaning, the parts are moved through a series of brining basins where they are treated, over several days, with salt, alum (typically potassium alum), and in some cases, soda (sodium bicarbonate). The salt draws water out of the flesh via osmosis, the alum penetrates and binds to the jellyfish proteins giving it the desired crunchy texture, and the soda helps balance the pH and retard spoilage (Rudloe 1993; Jones and Rudloe 1995; Hsieh, Leong, and Rudloe 2001). After several days of curing, the jellyfish is packaged for shipping with additional salt or brine.

The Importance of Jellyfish Blooms

Dock prices for fishermen and product yields for processors are both typically low. Dock prices reported in the literature range from \$0.11 to \$0.22 per kilogram for cannonball jellyfish in the Americas between 2008 and 2015 to a high of \$0.94 per kilogram of *R. esculentum* in China in 2005 (Álvarez-Tello 2007; Page 2009; Dong et al. 2009; Lopez-Martinez and Alvarez-Tello 2013; Nitin and Ranipeta 2018). Researchers estimate that 100 kilograms of raw cannonball jellyfish can yield between 10 to 22 kg of finished product, while the yield of Chinese species is closer to 5 kilograms per 100 (Rudloe 1993; Jones and Rudloe 1995; Álvarez 2007). With dock prices measured in pennies and yields of only 5 to 22 percent, volume is the key factor to jellyfish fishermen and processor success; the more jellyfish you can catch and process, the better your chances of earning a profit.

For fishermen, volume depends on speed. Speed determines how many fishing trips can be taken in a day, and the rate of spoilage and how much of the catch is suitable for sale. When jellyfish come out of the water, they are plump and well-shaped, but they quickly begin to lose water, flatten out and spoil. Processors often buy jellyfish by standardized baskets or by weight, and fresh, plump jellyfish weigh more and fill more baskets than dehydrated jellyfish, while spoiled jellyfish cannot be sold at all. Spoilage can occur within a few hours in sub-tropical and tropical climates where jellyfish fishermen do not have air-conditioned holds. For processors, volume depends on the ability to buy and process large quantities of jellyfish from fishermen quickly, which allows processors to minimize downtime and maximize the operational efficiency of the JPF (Rudloe and Jones 1995; Álvarez-Tello 2007).

The challenges of volume and speed have been addressed in some ways through the use of motorized boats and mobile processing stations that follow the fishermen; however, these technological adjustments are of secondary importance compared to the natural blooming behavior of jellyfish (Rudloe 1995). Large blooms with abundant jellyfish facilitate quicker fill times, more frequent fishing trips, lower spoilage rates, and greater overall daily volumes entering the JPF. In comparison, weak blooms mean longer search/collection times, fewer daily trips, increased fuel usage for motorized boats, increased rates of spoilage, and ultimately reduced volumes and profit for both processors and fishermen. Unfortunately, jellyfish blooms are notoriously unpredictable, and in the next section, I discuss general adjustments made in jellyfish fisheries to account for this uncertainly.

THE OPERATIONAL CHALLENGES OF A JELLYFISH FISHERY

Variation in Jellyfish Blooms and Market Prices

Processors and fishermen have to contend with great inter, intra-annual, and spatial variability in jellyfish blooms that create a great deal of volatility in fishing conditions and markets (Kingsford, Pitt, and Gillanders 2000; Nishikawa, Thu, Ha, et al2008). Between 1970 and 2016, the average annual change (AAC) in the global landings of jellyfish was 52.6 percent with a massive standard deviation of 81 percent (FAO n.d.b). In comparison, global landings of marine fish had an average annual change of only 3.1 percent and a standard deviation of 2.8 percent over the same period (Figure 17). These numbers reflect the dramatic year-to-year swings in global jellyfish production, but they hide the even more dramatic swings in local jellyfish fisheries through data aggregation.

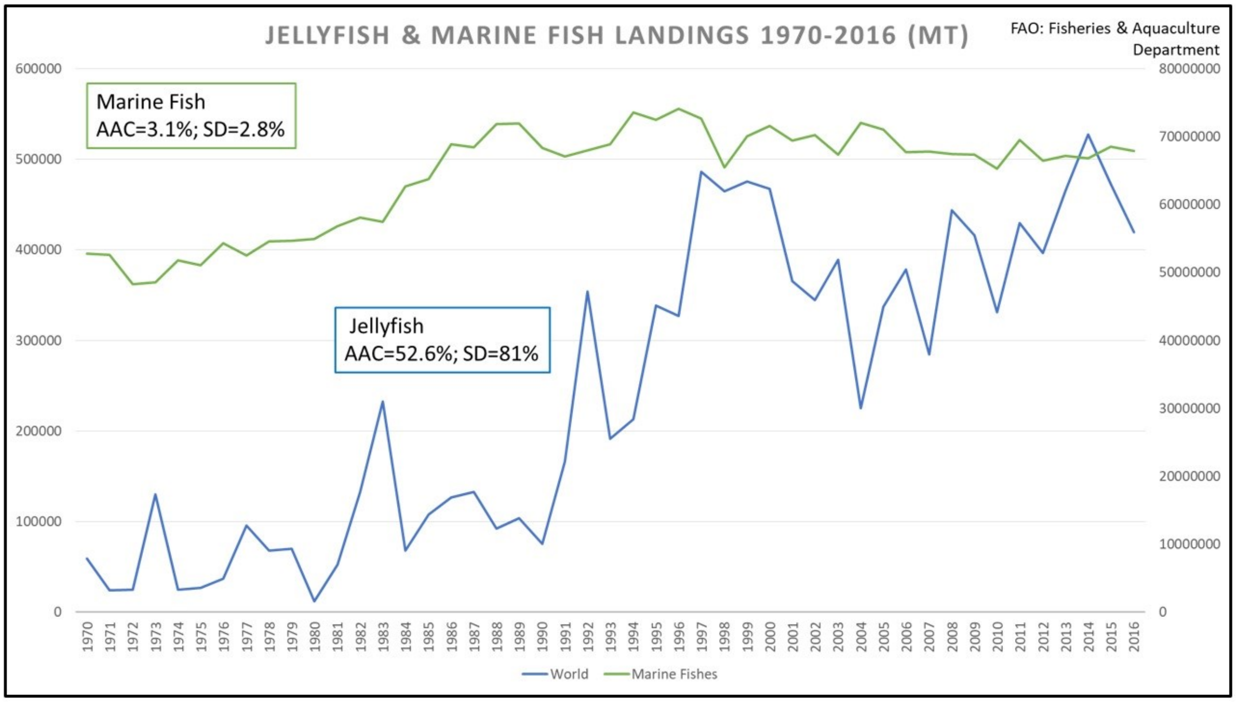

Figure 17: The Volatility of Global Jellyfish Landings Versus Landings of Marine Fishes (MT); AAC = Average Annual Change (FAO)

Girón-Nava, López-Sagástegui, and Aburto-Oropeza (2015) report on a massive bloom of cannonball jellyfish in the northernmost extension of Mexico's Gulf of California known as the Gulf of Santa Clara in 2013 that allowed fishermen to harvest 20 thousand MT worth $3.5 million in a few days. Anticipating similar blooms the next year, excited locals rushed to invest in infrastructure and equipment, but the bloom did not return, resulting in heavy losses. Nishikawa, Thu, Ha, et al. (2008) report that the jellyfish fishery in Haiphong, Vietnam, experienced a similar production whiplash between 2000 and 2002. In 2001, the fishery produced 1,700 MT of jellyfish, which was 325 percent higher than that produced in 2000; however, production declined 85 percent in 2002. Although Haiphong was the most dramatic case, six communities between 1995 and 2005 reported instances where production doubled or more from the previous year, and six instances where the following year's production fell by at least half (Nishikawa, Thu, Ha, et al. 2008, 229).

Wild fluctuations also occur within seasons. Javier Álvarez-Tello (2007) reports on the intra-annual variability of cannonball jellyfish blooms in 2006 and the impact on fishermen's incomes delivering to one JPF called Pesquera México S.A. (PMSA) in Guaymas, Mexico. Over 39 days, the total landings varied wildly from day to day between 4.7 MT and 152.4 MT, fluctuations directly related to jellyfish abundance. These vacillations brought dramatic changes to fishermen's incomes, ranging wildly from a low of about Mex$20/day to a high of about Mex$850/day (Javier Álvarez-Tello 2007, 53).

In addition to uncertainly about jellyfish blooms, processors and fishermen have also had to contend with wild swings in market prices. The PMSA JPF in Guaymas recorded profit margins in 2006 that vacillated between a razor-thin 1.9 percent and 13.5 percent depending on the volatility of foreign market prices set by foreign jellyfish buyers (Álvarez-Tello 2007, 54). Rudloe (1993) also observed dramatic market price fluctuations in the 1990s in Qingdao and Laizhou China tied to fluctuations in jellyfish blooms. In 1990 and 1991, jellyfish production in China was very low which led to a high market price (no figure reported). In 1992, however, jellyfish harvests boomed, and the country realized a record 250 million MT of finished product. As a result, the market price dropped to its lowest point ever ($0.72/kg). Production declined precipitously in 1993 and 1994, and the price rebounded to $1.99/kg, a price increase of 176 percent in three years. Faced with these massive fluctuations, fishermen and JPF have had to adjust.

Common Adjustments Made by Fishermen

Jellyfish fishermen have made several adjustments to account for the uncertainty of jellyfish blooms. The first is diversification. Most artisanal fishermen are generalists. Jellyfish blooms are typically seasonal, so if fishermen can’t catch and sell jellyfish, they will catch something else.

Another adjustment to the temporal and spatial variation in jellyfish blooms is the competitive mania or derby fishing. Jellyfish blooms are the fire sales of marine fisheries. They are exceptionally easy to exploit and require limited technology, they bloom and bust dramatically and unpredictably, and their low value means that fishermen need to move tons of them to make an acceptable profit. This means that the entry barriers are low, and fishermen are motivated to take maximum advantage as fast as possible before the blooms disappear or are fished out. An example of this is the Liaodong Bay, China jellyfish fishery. As highlighted in Chapter 3, You, Yongming, Caihua, et al. (2016) report that, each year, over ten thousand boats rush in a mania to collect jellyfish as fast as they can because the 'season' only lasts a few hours!

A similar situation has developed in the Gulf of California jellyfish fishery. Álvarez-Tello explained in a 2018 email that in the early 2000s, only a few companies had the experience to process jellyfish, so the fishery was small and self-regulated, but after 2005, Chinese entrepreneurs increasingly became involved in the fishery. They made deals with fishermen's associations directly and brought in their technicians to establish and direct new JPF operations. Like the Liaodong Bay, competition increased and now thousands of boats rush to collect jellyfish, and the season has been reduced from a few months to a few days (Álvarez-Tello 2017/2018).

In Than Hoa, Vietnam, jellyfish exports tripled between 1995 and 2005 (Nishikawa, Thu, Ha, et al. 2008, 229). About 100 boats participated in the fishery in 2007, extracting an estimated 0.8 to 1.2 million jellyfish in 40 days. The researchers question the potential impact that removing so many jellyfish so quickly could have on the population and wider ecosystem and regret that there have been no data collected to evaluate this despite the rapid expansion of the fishery, a point also echoed by Gul, Jahangir, and Schiariti (2015) in Pakistan.

Common Adjustments Made by JPFs

Processors have also had to make several adjustments to account for the uncertainty of jellyfish blooms. JPFs are designed to process jellyfish, and this is problematic if jellyfish processing is not profitable because of market or biological fluctuations. The literature suggests that JPFs have adjusted to temporal variation in three ways. First, like fishermen, they diversify the kinds of species they can process to spread their risk over a variety of species and markets. In Mexico, because of the sporadic and ephemeral nature of jellyfish in the Gulf of California, none of the JPFs in the Guyamas region focus specifically on jellyfish but also process other species as well (Álvarez 2007, 50). Ling (2017) and Nishikawa, Thu, Ha, et al. (2008) report similar diversification strategies in JPFs in Malaysia and Vietnam. Nishikawa, Thu, Ha, et al. (2008) observed that a JPF in Than Hoa, Vietnam processed jellyfish between March and May but then switched to processing fish and shrimp caught by the same fishermen. Ling (2017) observed the same in a JPF in Kampung Sampat, Malaysia.

Second, some jellyfish processors minimize their upfront investment to reduce their exposure to bust seasons. One way to minimize investment is by using ephemeral and low-cost JPFs that are cheap to build and maintain. Nitin and Ranipeta (2018) and Aguilar (2015) report low-investment ephemeral operations in Machilipatam, India, and in Kaukira, Honduras. In Machilipatam, the JPFs were nothing more than open-air bamboo or stick frames covered with tarps that were set up seasonally on or near the beach. Similar JPFs in Honduras are stick and tarp structures with plastic basins that are built on the beach (Figure 18). These structures cost little to build and maintain and can be easily closed or abandoned if business conditions decline.

Figure 18: A Rudimentary JPF near Kaukira, Gracias a Dios, Honduras. Instead of concrete basins, builder's lumber, and a metal roof, this JPF uses plastic basins, a low grade 'stick' frame, and a tarp roof. Such a set-up is not designed to last long, but it is cheap to build for a processor concerned with reducing their upfront investment and risk. (Source: Author, 2014).

The third buffer against temporal variability is the durability of cured jellyfish. Properly cured jellyfish can be stored for up to two years, and longer, if refrigerated (Rudloe and Jones 1995). Although one to two-year-old jellyfish are not as desirable in Chinese markets as same-year jellyfish, Rudloe (1993) observed that jellyfish dealers used this long shelf life to stockpile jellyfish during boom years when prices were low so that they would have a product to sell in the bust years when prices were high.

Finally, in addition to temporal fluctuations in production and market prices, processors have also had to adjust to the spatial variation of jellyfish blooms. Jellyfish blooms tend to be patchy and unpredictable. They will appear in an area one day, only to move significantly or disappear entirely the next (Kingsford, Pitt, and Gillanders 2000). Jellyfish fisheries have had to account for this dynamic, and the main adjustment appears to be the spatial disbursement of JPFs along coastlines and migratory labor. Prevailing currents carry jellyfish and jellyfish blooms, and in areas where they are not aggregated by eddies and gyres, a bloom can move many kilometers from day-to-day. In these areas, processors need to follow the blooms if they want to maximize jellyfish collection. Rudloe (1995) observed the migratory nature of the jellyfish fishermen and laborers in Laizhou, China,

> "Many of the [processors] were not from the Laizhou or Yanti Area, but from the south coast of China. Their families, who made up a small army of processors followed the movements, migrations, and growth cycles of the jellyfish. Jellyfish wasn't a byproduct of another fishing operation, it was their primary target species. They followed the movements and migrations of the big *Rhopilema esculenta* jellyfish along the coast… when the season was over [in Laizhou], the fleet of processors [moved on] (Rudloe 1995, 4).

Rudloe implies that the jellyfish were merely transiting through the Laizhou and Yanti areas along with the processors. Laizhou is one of many processing stations along the coast that spring to life annually when the jellyfish pass through (Rudloe 1995, Dong, Liu, and Keesing 2014). By spatially distributing processing stations along the coast, the jellyfish processors could exploit the blooms as they moved. Similar seasonal movements of jellyfish and spatial distributions of JPFs have also been documented in Vietnam, Pakistan, and Mexico (Nishikawa, Thu, Ha, et al. 2008; Lopez-Martinez and Álvarez-Tello 2013; Gul, Jahangir, and Schiariti 2015).

SUMMARY

In this chapter, I detailed the operational context for the Miskitu Coast jellyfish fishery. I reviewed the general methods used to process jellyfish, the common operational challenges facing jellyfish fisheries, and the common adjustments made by processors and fishermen to account for them. In general, jellyfish is a low value and delicate product that requires speed and volume; both fishermen and processors are required to move great quantities of jellyfish to make money and thus rely on the occurrence of large and persistent jellyfish blooms to do so. Unfortunately, regardless of location, target species, or setup, jellyfish processors and fishermen around the world regularly face dramatic volatility in both jellyfish blooms and markets. In response, fishermen and processors have had to adjust their operations to protect themselves, including diversifying the kind of species they catch/process, participating in 'mania' or derby fishing, limiting upfront investment in JPFs, geographically dispersing JPFs, and by stockpiling cured jellyfish in good years to sell in bad years. Most of these adjustments were also made on the Miskitu Coast as I will detailed below in Chapter 6.

CHAPTER 6: THE MISKITU COAST JELLYFISH FISHERY

INTRODUCTION

In this chapter, I present the results of my research on the Miskitu Coast. I begin by providing a general overview of my main study community, Tuapi, including its location, a brief history, community demographics, and its communal governance structure and economy. Next, I discuss the development of the jellyfish fishery, including the motivations of the first processor on the coast, and the motivations of INPESCA to promote the fishery's development. I continue by providing a broad overview of the boom-and-bust between 2013 and 2017, including a timeline of JPF openings and closings and a year-by-year accounting of jellyfish exports. After this review, I look at the fishery's operation and residents' experiences. I discuss the development of the fishery, the operational dynamics of the JPFs in the Tuapi area, the relationships between the JPFs and the community, and I discuss possible reasons for their ultimate demise. Finally, I contrast the experiences of Tuapi with those of three other communities to provide a better-rounded overview of the fishery on the coast and to demonstrate why some JPFs did better than others.

THE COMMUNITY OF TUAPI

Location and History

The community of Tuapi is located approximately 10 km northeast from the RACCN capital of Bilwi, in the *municipio* of Puerto Cabezas, and in the indigenous territorial jurisdiction of *Tawira Tasbaika* (called simply Tawira below; see Figures 5 and 28). The present-day settlement of Tuapi radiates around a central core area that includes the school, Moravian Church, baseball stadium, and the cemetery (Figure 19). The community is bordered by the Tuapi River on the south and west, the Caribbean Sea to the east, and open pine savanna to the north.

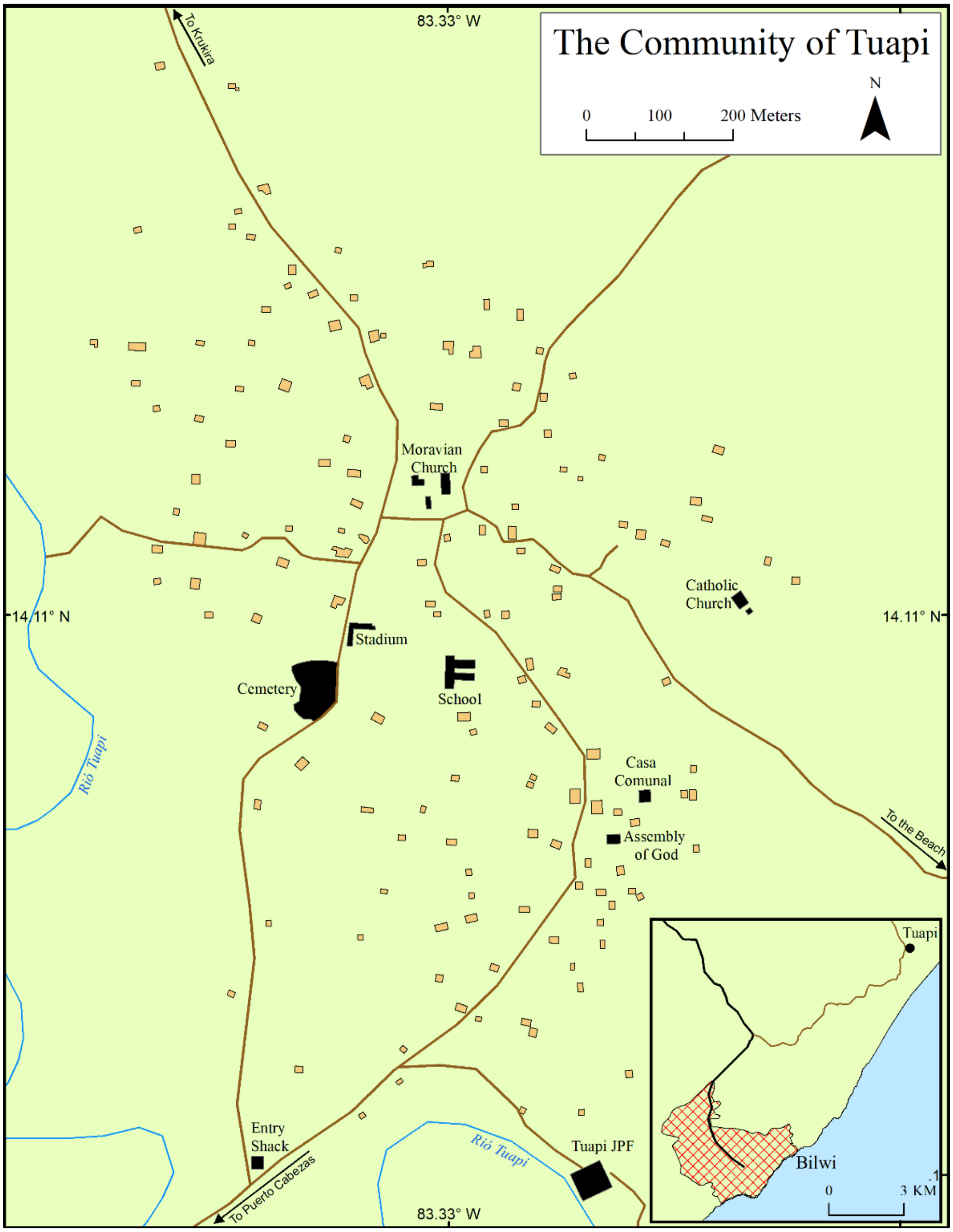

Figure 19: A map of the community of Tuapi, with structures, landmarks, rivers, and roads. (Source: Author 2017)

Tuapi likely predates the colonial period in some form, and it was the site of the first Moravian mission on the coast in 1886 (Taylor-Wittly 2007; Everingham and Taylor 2009). Between 1925 and 1929, before Bilwi rose to regional prominence, the community hosted the headquarters of the Moravian Church of Nicaragua (Everingham and Taylor 2009). During this period, the community was the commercial and transportation hub for the region. The Moravian Church operated a commissary where parishioners from Tuapi and surrounding communities could purchase goods imported from the U.S. (Taylor 2007, 44). With the rise of lumber and banana production in the region, Bilwi gained political and economic power. In 1929 the Moravian Church moved its headquarters to Bilwi, and Tuapi's importance faded.

Today, the regional importance of Tuapi is much diminished. There is still an active Moravian congregation and smaller Catholic and Seventh-day Adventist congregations, but the only buying/selling opportunities these days are a few small *pulperias* (convenience stores) and *acopios* (fish buyers) run out of private homes. Individuals looking to buy or sell goods now travel to the markets in Bilwi. The community does have a bus that runs four time per week, but it is also no longer a transportation hub. Persons traveling to and from coastal communities in the north now bypass the community and travel directly by panga to/from Bilwi, or they travel to Krukira by bus and then by panga from there.

Community Demographics

The household survey from my research recorded 128 dwellings (106 occupied) and 658 persons (28 percent adult male, 29 percent adult female, and 44 percent minors <18 years old). All individuals documented, except for two Mestizos, identified ethnically as Miskitu. Sixty-seven percent reported being married or in a common-law relationship, while 26 percent were single, five percent were widowed, and one percent declined to respond. The average person had 7.9 years of education (8 years for females and 7.8 for males). The mean number of persons per household was 5.5. The community population was very young, with almost half of the population younger than 20 years (Figure 20). The age distribution quickly declines as individuals reach adulthood because many choose to pursue better work and educational opportunities outside the community Taylor (2007, 40). Many families in Tuapi have members living in Bilwi, Bluefields, Managua, and in the U.S. and other Latin American and Caribbean countries (Taylor 2007).

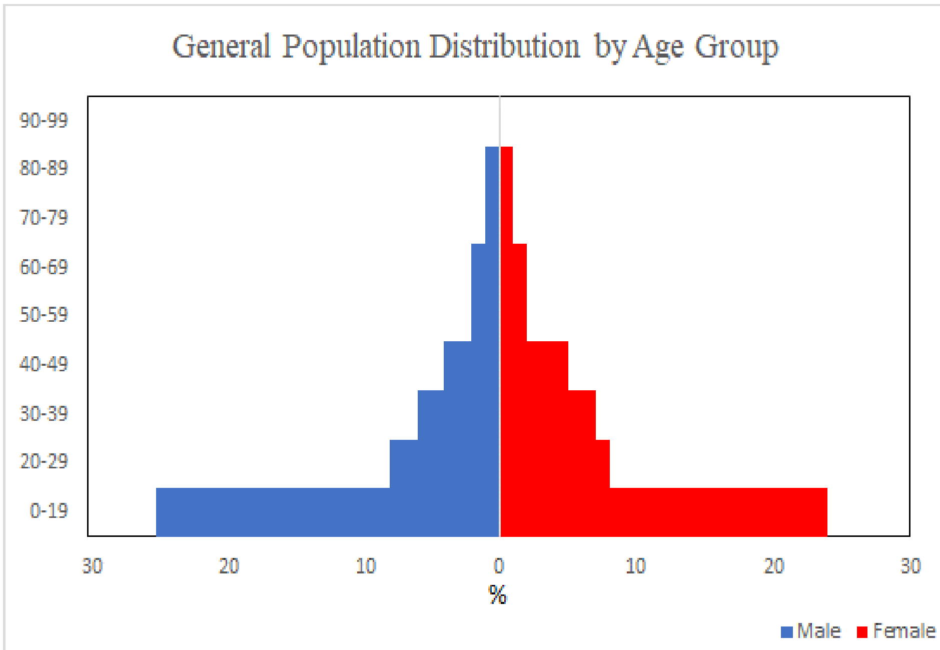

Figure 20: Population Pyramid for Tuapi. (Source: Author, Tuapi household survey, 2017)

Communal Government

The communal government of Tuapi, like other Miskitu communities, includes a Board of Directors (*junta directiva)*, a Council of Elders (c*onsejo de ancianos*), and a Communal Assembly (a*semblea comunal*). The junta directiva is composed of the *sindico* and *wihta(s)* who are elected by the Communal Assembly (Larson and Soto 2012). The sindico is the executive that handles the business of the community, including negotiating and administering contracts for the sale of natural resources, soliciting development projects, and ensuring the protection, conservation, and sustainable use of the community's territory and natural resources (Larson and Soto 2012; Larson and Lewis-Mendoza 2012).

Wihtas serve as justices of the peace and are responsible for litigating disputes within the community according to traditional customs. The Council of Elders is a group of elders chosen by the wihtas to advise them and help them settle conflicts and dole out punishment. In Tuapi and other communities, board positions are part-time appointments. In the case of Tuapi, officials receive a small stipend for their service, but the officials also maintained their primary employment. For example, the 2017/2018 Tuapi sindico, Fabio Richinal, was also the local school director. In addition to the wihta and sindico, Tuapi also has a Community Coordinator whose job is to coordinate the community with higher government initiatives. This position is decidedly partisan, and as of April 2018, it was held by the most prominent Sandinista in the community.

The Communal Assembly is the highest authority in the communal government structure, and it includes all adult members of the community. The assembly is convened to debate, approve, or decline potential projects or other proposed actions by the junta directiva. Traditionally, the communal assembly was called to a session to choose the sindicos and wihtas. As was the custom, the candidates would debate each other and address questions and concerns from the assembly before a voice vote would choose the winner. Like many communities, however, national politics have permeated to the communal government level. In Tuapi, most identify either with the national Sandinista party or with the regional indigenous organization YATAMA. Although traditionalists and YATAMA sympathizers support election via vocal consensus, the Sandinistas control the regional and territorial governments and have increasingly pushed for the use of secret ballot voting. As in other parts of the country, this has led to instances of conflict and accusations of election rigging and instances of dueling governments where Sandinista and YATAMA factions elect their own leaders. For now, Tuapi has not had to deal with dueling governments. At the time of this research, the sindico was a Sandinista, and the wihta and his council of elders were YATAMA supporters; however, the potential for future conflict still exists.

The Tuapi Economy

Tuapi residents take part in subsistence and cash-earning activities, and their economy is based primarily on agriculture and fishing. The soils in Tuapi are acidic and saline, so agriculture is limited. However, about two-thirds of households reported keeping a plantation of cassava, taro, and/or plantain, and nearly all had access to fruit trees, such as coconut and mango, both ubiquitous in the community. Many households also keep dooryard gardens where residents grow herbs and other fruits and vegetables such as tomato, nance, peppers, and *pejibaye* (peach palm fruit). Two-thirds of households raised domestic animals such as pigs and chickens for meat/eggs and cash sale. Only ten percent reported owning cattle.

Fishing, however, is the main economic activity and is considered to be the bedrock of communal subsistence and the cash economy (Taylor 2007). Three-quarters of the 119 households surveyed reported fishing for subsistence, cash-sale, or both. The community relies heavily on market goods in addition to subsistence products. Almost two-thirds of respondent households said that they purchased the majority of their food from a market. From my observation of Tuapi residents' diets, most households regularly consume rice, beans, vegetable oil, sugar, coffee, powdered juice mix, and wheat flour, all non-local products imported from other areas of Nicaragua or abroad.

In terms of fishing, the slowest time is at the height of *invierno* in June and July when intense storms and heavy rain restrict fishermen to shore (Nietschmann 1973). The period of highest production, according to Tuapi fishermen, occurs in November and December (Table 3). During these months, in one night, a fisherman can catch 90kg of fish in their *trasmallos* (gill nets), worth ~C7,000 or $230 (~C77/kg) (Tuapi Focus Group, December 2017). Some days during my fieldwork, when the shrimp were running, it was not hard for a *chinchorro* (small fishing net) team to pull in 10 to 20kg of shrimp that sell for about C260/kg in Bilwi; resulting in earnings of C2,400 to C6,000 in just a few hours.

Product/Month	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Sea Food Products												
Scale Fish												
Crab												
Surf Clams												
Shrimp												
Lobster												
Sea Cucumber												
Conch												
Jellyfish												
Fruit or Ag. Products												
Mango												
Nance+												
Icaco (Cocoplum)												
Beach Grape												
Lemon+												
Coconut												
Cashew+												
Orange and Grapefruit+												
Cassava+												

Table 3: Annual cycle of commodity production in Tuapi. Sources: Taylor 2007; author's participant observation; INPESCA records (+ = production severely reduced by Hurricane Felix in 2007).

Tuapi does have several other sources of economic activity, including a water treatment plant operated by the Nicaraguan Water and Sewer Company *(Empresa Nicaragüense de Acueductos y Alcantarillados SanataRíos: ENACAL*) that supplies Bilwi with fresh water. The plant employs several Tuapi residents and is the single largest source of community income (about C 30,000/month). According to 2017/2018 sindico, Fabio Richinal, this pays the junta directiva's stipends, for community projects, and to help the community's sick and elderly (Richinal 2017). A small aggregate/concrete block business also periodically employs individuals to dig aggregate from the Tuapi River that is used to make concrete blocks for sale in Tuapi and Bilwi. The community also has two tourism centers on the Tuapi River at a nearby site called *Brakira*, where drinking, entertainment, and river-swimming are enjoyed mostly on weekends and holidays.

The household survey asked household members to identify their profession (Table 4). This was a difficult task for many because they did not have one, or they had multiple. One-quarter of respondents reported being an *ama de casa* (housewife). These individuals concentrate on their home's domestic economy, including cooking, cleaning, and tending the family's agricultural plot. Still, some also participate in commercial activities such as processing and selling seafood and agricultural products.

Profession	**Number of Respondents**	**Percent of Respondents**
Domestic	96	26
Fishing	81	22
Student	58	16
Chambero	38	10
Professional	34	9
Retired	28	8
Trades/ Services	19	5
Sales	10	3
Agriculture	4	1
Mining	2	1

Table 4: Self-identified Professions of Tuapi Residents by Kind.

Approximately one-quarter of respondents identified exclusively as fishermen. These individuals may fish locally with their own equipment, with family/friends with equipment, or they may work as *buzos* (divers) or *naceros* (trap fishermen) catching lobsters, conch, and sea cucumber in the Miskitu Keys. Sixteen percent of respondents identified as students either in secondary school or college. Many of these individuals still participated heavily in the household economy. Except for the colleges, the secondary school only holds classes in the afternoons, leaving the morning open for the students to help around the house. For girls, cleaning and laundry are done, and food is prepared in the morning before school and the day's heat. For boys, this is also when plantation work is done, wood is chopped, or fishing nets are pulled.

Nine percent of respondents reported being in a professional position defined broadly to include teachers, school administrators, nurses, water treatment plant technicians, and government officials that receive an established salary for their work. Eight percent reported being retired. These individuals were difficult to define as some previously worked for companies and now receive monthly retirement stipends from the government. In contrast, others rely on the working family, subsistence activities, or both for their needs.

The remaining 15 percent of respondents either reported working in the trades and services such as carpentry, masonry, and clothing/shoe repair or reported being *chamberos*. A chambero is a hired hand or unskilled laborer who is temporarily hired to work on a project, be it a construction project, cutting weeds, or chasing down loose cattle. Although some respondents self-identified specifically as chamberos, almost 90 percent of the adult population of Tuapi operates in the informal economy defined by projects and seasons. Most residents *chamba* throughout the year because of seasonal downturns in their professions or to supplement their incomes.

THE ORIGINS OF THE MISKITU COAST JELLYFISH FISHERY

The First JPF: Moon Group International and the Community of Tuapi

The first JPF was built on the Miskitu Coast in 2008 by Pesquera Bilwi S.A. (PBSA) in the community of Tuapi. PBSA was a subsidiary of Moon Group International, a Korean-Mexican multi-national firm based in Sonora, Mexico (Ubieta 2008; Álvarez-Tello 2017/2018).[14]

[14] Established in 1991, Moon operates several processing plants in Mexico and Central America and has satellite offices in Los Angeles and Qingdao, China. In Mexico they operate under the name Pesquera México S.A. (PMSA).

According to former Moon biologist and PBSA manager, Javier Álvarez-Tello, Moon began processing cannonball jellyfish from the Gulf of California in 2001 after learning of the market from a Malaysian jellyfish processor in the Mexican state of Tabasco (Álvarez-Tello 2017/2018). Officials from the Malaysian firm were vacationing in Sonora and noticed that cannonball jellyfish were much more abundant there, and they subsequently contracted with Moon and became their first customers. Over the next few years, Moon experimented with value-added products and expanded their clientele to buyers in Korea, Japan, and China (Álvarez-Tello 2017/2018).

By 2005, however, the Gulf of California fishery was dominated by Chinese buyers who were only interested in minimally processed jellyfish, and fishing pressure was quickly increasing. Álvarez-Tello recounted the changes he witnessed in the fishery during his time with Moon,

> "Initially, we exported [jellyfish] to Malaysia, Korea, and Japan, but from 2005 everything was marketed with a mandatory clause to China. While in the first years we tried to develop products with added value [ready to eat], from 2005 the process began to be shortened until it was restricted to four days (from 20 days) and there was no attempt to develop products of added value…Fishing also changed drastically. Initially, few companies had the experience to process jellyfish, so the fishing was self-regulated… Subsequently, Chinese entrepreneurs made deals with fishermen's associations directly and brought in their own technicians to direct the processing. The result was that thousands of boats went fishing, and the fishing season was reduced from a few months to a few days… in 2017 the fishing season here in Guaymas [Sonora] lasted one day! [~5,000 tons]" (Álvarez-Tello 2017/2018).

Moon began looking to expand its jellyfish operations into Central America in 2007 due to increasing competition and a poor jellyfish season in the Gulf of California (Álvarez-Tello 2018/2017). Moon first sent a team to explore in the Department of Gracias a Dios in Honduras; however, the team quickly determined that there were too many logistical challenges, including transportation costs, distance from suppliers, and too many processors already in the area. Gracias a Dios is not connected to the greater Honduran road network, and supplies have to be delivered via cargo ship or plane.

In 2008, the team shifted their exploration to Nicaragua (Álvarez-Tello 2018/2017). Moon approached INPESCA in early 2008 about developing a jellyfish fishery on the Miskitu Coast. With INPESCA officials, a team from Moon sampled jellyfish in the RACCN to determine if the jellyfish population could meet Moon's goals. Despite many logistical challenges, the transportation network and infrastructure were better than those in Honduras, and there was no competition from other firms. Moon decided to proceed and formed PBSA as a local subsidiary. With the help of INPESCA, they decided to build a JPF in Tuapi (Álvarez-Tello 2018/2017).

Under Law 445, PBSA had to secure consent from the communal assembly of Tuapi to construct the JPF. On March 2, 2008, PBSA officials and technical advisors from INPESCA and SERENA traveled to Tuapi to present the project. At first, many residents were perplexed and skeptical; there was no history of jellyfish exploitation on the coast and many wondered why anyone would want to eat a jellyfish (Tuapi Focus Group, December 2017). Some elders, who remembered past boom-and-bust projects, were skeptical and concerned about the impacts that jellyfish exploitation might have on other fisheries and the environment (Tuapi Focus Group, December 2017). Unfortunately, the INPESCA and SERENA advisors could do little to assuage these concerns as they also lacked knowledge of jellyfish processing, fisheries, and markets

(INPESCA 2016; Tuapi Focus Group, December 2017). Despite this, the project was approved and the JPF was constructed later in the year.

Production in the Tuapi JPF began in September of 2008 and lasted about two months. Production was good and at times exceeded the JPF's capacity; however, Moon shut down PBSA and abandoned the JPF shortly after 2008, citing improved production in the Gulf of California, higher than expected logistical costs, and lower than anticipated product quality (Ubieta 2008; Brotz, Schiariti, Lopez-Martínez, et al. 2016; Álvarez-Tello 2018/2017). PBSA only exported about 57 MT of jellyfish (Brotz, Schiariti, Lopez-Martínez, et al. 2016). Although imperceptible compared with global production that year of 443 thousand MT, PBSA established a precedent for jellyfish processing on the Miskitu Coast in the minds of the local population, INPESCA officials, and other jellyfish processors (FAO n.d.b; Ubieta 2008; INPESCA 2011; Álvarez-Tello 2018/2017).

INPESCA's Mandate and the Jellyfish Fishery

The Miskitu Coast jellyfish fishery developed during a particularly tumultuous period for the coast and for INPESCA. The economies of the littoral communities of the Miskitu Coast depend chiefly on artisanal fishing, especially those that are distant from political-economic centers (INPESCA 2008; Henríquez and Webster 2010; Mendoza-Lewis, Davis, and Narváez 2012; González, Jackson, and Zapata 2014). The coast accounts for 59 percent of the nation's artisanal fishermen, and fishing income supports nearly two-thirds of coastal households (INPESCA 2008, 2011). In 2016, 95 percent of the scaled-fish and 59 percent of the lobster caught on the coast were caught by artisanal fishermen (INPESCA 2008, 2011, 2019b). Despite the importance of the work, artisanal fishing has largely been ignored by the government and excluded from development efforts in favor of industrial fishing (INPESCA 2008; González 2018).

Artisanal fishermen operate on extremely tight margins and often struggle to cover operating and living expenses for themselves and their families. They work with no social security, medical coverage, or pension, and each time they go out, there is no guarantee that they will catch enough to cover their costs (INPESCA 2008; Henríquez and Webster 2010; González, Jackson, and Zapata 2014). Constant overexploitation, poor infrastructure, and a six percent annual devaluation of the Cordoba have meant that fishermen and their families face shrinking incomes and increasing expenses each year (Nietschmann 1997; Henríquez and Webster 2010; González, Jackson and Zapata 2014; Stevens, Frank, and Kramer 2015).[15]

The already poor situation of artisanal fishermen was exacerbated in September 2007 when Hurricane Felix, a monster Category-5 storm, slammed into the coast. The storm buffeted the region north of Bilwi with 250 km/hour winds and storm surges over five meters causing massive destruction to ecosystems and the lives of over 200 thousand people (World Bank 2008). Of the 119 households I surveyed in Tuapi, only about one-fifth of their homes existed before the hurricane, and the fruit orchards that Taylor (2007) reported as making up about one-quarter of the community's economic activity were also heavily damaged. Along the coast, 350 boats and 48 thousand units of fishing equipment were lost, dealing a heavy blow to artisanal fishermen and their families (World Bank 200).

[15] Between 2007 and the end of the jellyfish boom in 2015, the consumer price index in Nicaragua, based on a set of 53 basic goods (called the *canasta basica*), like oil, corn flour, rice and beans, has increased by 59 percent (Banco Central de Nicaragua n.d.). Over the same period, the change in Caribbean coast fisheries export value by unit ($/lb) only increased by 7.5 percent (INPESCA 2016). Fishermen have had to absorb most of this loss through austerity and increased effort; over the same period, seafood exports by weight increased 77 percent (Henríquez and Webster 2010; González, Jackson, and Zapata 2014; Stevens, Frank, and Kramer 2015; INPESCA 2016).

Considering these disastrous conditions, the importance of artisanal fishing to the national and local economies, INPESCA was tasked with developing new opportunities for artisanal fishermen. In their July 2008 Strategy for Sustainable Development of Artisanal Fisheries, Food Security, and Poverty Reduction of Related Families: 2008-2015 (*Estrategia para el Desarrollo sostenible de la Pesca Artesanal, La Seguridad Alimentaria y la Reducción de la Pobreza de las Familias Viculadas: 2008-2015*), INPESCA pledged to take a more active role with artisanal fishing including the identification and development of commercially viable species not yet exploited (INPESCA 2008, 11, 30; Gonzalez 2018).

INPESCA was also under pressure, at the time, to phase out the practice of lobster diving. As highlighted in Chapter 2, lobsters have been a significant part of the coastal economy for several decades. Still, because of chronic overexploitation and increased use of scuba equipment at greater and greater depths, there has been an epidemic of decompression related deaths and injuries and increased political pressure to halt diving (Farrell 2010; Wolff 2012; Álvarez 2017). After the passage of Law 613 in 2008 and the signing of OSP-02-2009 in 2009, INPESCA was tasked with developing alternatives for divers, their employers, and support workers (Asamblea Nacional de Nicaragua 2008). INPESCA saw Moon International/PBSA as an opportunity to develop a new fishery for lobster divers and artisanal fishermen. During the boom, 100 percent of jellyfish landed was by artisanal fishermen (INPESCA 2015).

After the PBSA failure, no jellyfish was exported between 2008 and 2012 (INPESCA 2008, 2014). Nevertheless, INPESCA was still interested in the fishery as part of its broader development strategy for the coast and its efforts to phase-out lobster diving. One of the first mentions of jellyfish processing in INPESCA policy came in the 2011 Technical and Occupational Labor Reconversion Plan for Lobster Divers (*Plan de Reconversión Laboral Tecnica y Ocupacional para* *los Pescadores que Utilizan la Tecnica del Buceo en la Pesca de Langosta*) (INPESCA 2011). Despite the inactivity of the fishery in 2011, INPESCA specifically identified jellyfish processing as one of several viable alternatives for lobster divers and their support workers and proposed to promote the development of the fishery in the following years (INPESCA 2011).

The Boom-and-Bust

At the same time that INPESCA was looking to promote the defunct jellyfish fishery, the Gulf of California fishery in Mexico experienced another downturn similar to 2007. In 2012, the fishery in the upper Gulf of California near the community of El Golfo de Santa Clara experienced a massive bloom of cannonball jellyfish that allowed fishermen to land 20 thousand MT worth $3.5 million (Girón-Nava, López-Sagástegui, and Aburto-Oropeza 2015). In 2013, however, the failure of the blooms sent the fishery into economic turmoil (Girón-Nava, López-Sagástegui, and Aburto-Oropeza 2015). Although it is unclear how active or influential the INPESCA promotion was, or what role the 2013 bust in the upper Gulf of California had, jellyfish production reemerged on the Miskitu Coast in 2013 and expanded quickly.

Between 2013 and 2017, 2,661 MT of jellyfish were exported, and nine additional JPFs were built on the Miskitu Coast (Figure 21). In 2013, 519 MT worth $392 thousand were exported, 811 percent higher than PBSA's production in 2008 (INPESCA 2014). The Tuapi plant was reopened and expanded, and a new JPF was built south of the community at a site called Poza Verde. Two additional JPFs were also built in the communities of Haulover and El Bluff in the RACCS.

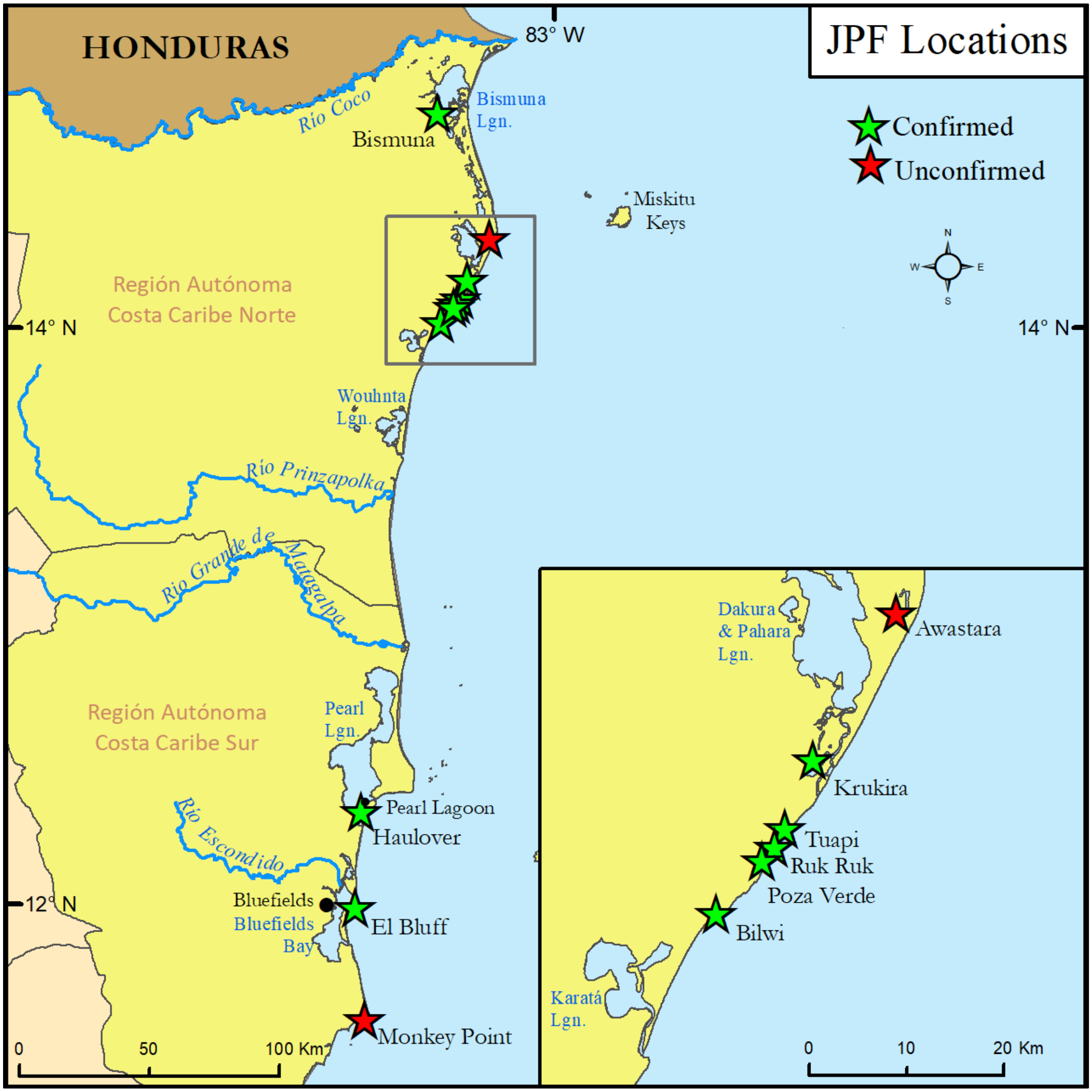

Figure 21: A Map of JPFs on the Miskitu Coast. Confirmed JPFs were directly observed or confirmed to exist through secondary documentation. Unconfirmed JPFs were reported to exist by local informants but have not been visited or confirmed by secondary documentation. (Source: Author 2017)

The peak of the jellyfish boom occurred in 2014. Jellyfish exports that year increased another 164 percent to 1,370 MT worth $1.15 million; over half of the jellyfish exported between 2013 and 2017 was exported this year (INPESCA 2015, 2019a). Two additional JPFs were built, one in Bilwi and one in the community of Bismuna near the Honduran border, and by 2015 six different processors were exporting jellyfish (INPESCA 2016). In Tuapi, residents recounted that the JPFs operated 24 hours a day at some points, and boats were lined up a kilometer or more down the river waiting to offload (Tuapi Focus Group, December 2017; Fahrenbruch 2018). That year, jellyfish was highlighted on the cover of INPESCA's annual report, and the fishery was explicitly lauded for the "large numbers of direct and indirect employment opportunities" the fishery created and for "helping to diversify the nation's fisheries" (INPESCA 2015, 20). However, the authors of the report also cautioned that the fishery was unpredictable and prone to fluctuation based on broader environmental factors (INPESCA 2015). This became painfully obvious in 2015 when the jellyfish fishery began to bust.

In 2015, exports plunged 57 percent to 583 MT worth $495 thousand, and INPESCA officials voiced concerns about the fishery's viability as an alternative for artisanal fishermen because of its high level of unpredictability (INPESCA 2016). Nevertheless, four additional JPFs were built on the coast that year. A third JPF was built just south of Tuapi at the mouth of the Río Ruk Ruk, another was built in the community of Krukira north of Tuapi, and JPFs were reportedly built in Awastara near Sandy Bay and in the RACCS community of Monkey Point. These were the last JPFs to be constructed on the coast as of 2018.

The jellyfish fishery continued to unravel after 2015. In 2016, exports fell another 70 percent to 175 MT worth $105 thousand. In 2017, exports fell to only 14 MT worth a mere $7 thousand, and jellyfish was no longer listed as a stand-alone fishery in the INPESCA annual report (INPESCA 2019a; INPESCA 2019b). By early 2018, many of the JPFs were abandoned or had diversified into other product lines such as scale-fish, conch, sea cucumber, and fish byproducts. Late 2018 did see a rebound in jellyfish production with exports growing to 292 MT worth $174 thousand; however, by this time, the bust had shaken out most processors, and only one company was still exporting jellyfish (INPESCA 2020).

Despite the hype surrounding the fishery's operation, jellyfish was never a significant player in the Miskitu Coast economy. At its peak in 2014, it only accounted for about 1.3 percent of the region's seafood exports by value; in 2013 and 2015, it was closer to 0.5 percent, and between 2016 and 2018, it represented 0.15 percent or less (INPESCA 2019a; INPESCA 2019b). In comparison, the primary export product, lobster, accounted for half to two-thirds of seafood export value during the same period (INPESCA, 2019a; INPESCA 2019b; INPESCA 2020)[16]. However, the impacts in the individual communities were more notable, and in the following sections, I zoom-in and examine the operation and governance of fishery at this level.

THE JELLYFISH FISHERY IN TUAPI

New Processors and Community Participation

After PBSA failed of in 2008, jellyfish processing stopped in Tuapi for about five years; however, in 2013, new processors began arriving. The first processor to arrive was called Jiang Seafood. The origins of Jiang and how they knew about Tuapi are unknown, and they do not appear in the INPESCA reports from this time (INPESCA 2014). Nevertheless, with the community's approval, Jiang reopened the Tuapi JPF and expanded it by about 1,250 sq. meters (Figure 22). Jiang's tenure was short-lived, however, as the Tuapi JPF and those in Haulover and El Bluff were assumed by a new company, Mariscos Central y America del Sur S.A. (MCASSA), in 2014. According to the MCASSA Facebook page and now-defunct website, the firm, like PBSA, was a local subsidiary based in Bilwi but connected to international offices in southern China and California and had other operations in Honduras, Costa Rica, and Mexico (MCASSA n.d.).

[16] INPESCA records do not use the term "Miskitu Coast," but instead use the term "*Costa Caribe*" or (Caribbean Coast.

Figure 22: The Tuapi JPF in Early November, 2017 (Author 2017; inset from Google Earth).

In addition to the activities of Jiang and MCASSA in the Tuapi JPF, a new 700 sq. meter JPF was built in late 2013 south of the community at a site call Poza Verde (Figure 23). The processor, Golden Island International S.A. (GISSA), was a local subsidiary of Golden Island International LLC of Darien, Georgia (U.S.) which was started in 2002 by an experienced jellyfish master from Taiwan (Golden Island International n.d.). In an interview with a former manager of the Poza Verde JPF in March 2018, he explained that GIISA had become aware, through its business networks, of the developing jellyfish fisheries in Mexico and Central America and decided, like Moon, to expand their operations. They first started in Mexico, but they quickly moved on to Nicaragua and Honduras because of heavy competition. According to the manager, they located the JPF in Tuapi to be close to the infrastructure of Bilwi, and because the population was already familiar with JPF operations from their earlier work with PBSA and Jiang. In fact, no other community developed the competency with JPF operations that Tuapi did, and during the boom, the community became a source of trainers for several JPFs along the coast.

Figure 23: The Poza Verde JPF in March, 2018. (Source: Author, 2018; inset from Google Earth 2019)

In the household survey conducted in Tuapi in December 2017, almost 82 percent of Tuapi households reported that at least one member had participated in the jellyfish fishery at some point during its operation; a total of 186 individuals or 28 percent of all individuals recorded by the survey (Table 5). About 55 percent of the participants were male and 45 percent were female. The participants' ages ranged from 15 to 74 with an average of 32 years, lower than the general adult population surveyed which was 38.5 years (Figure 24). The participant population was younger because the work was physically demanding, and many older residents chose not to participate. Also, many minors participated. About 18.3 percent of the participants were less than 18 years of age (Tuapi Focus Group, December 2017). There was no difference in years of education (7.9 years) or estimated income at the survey time between the participant population and the general survey population.

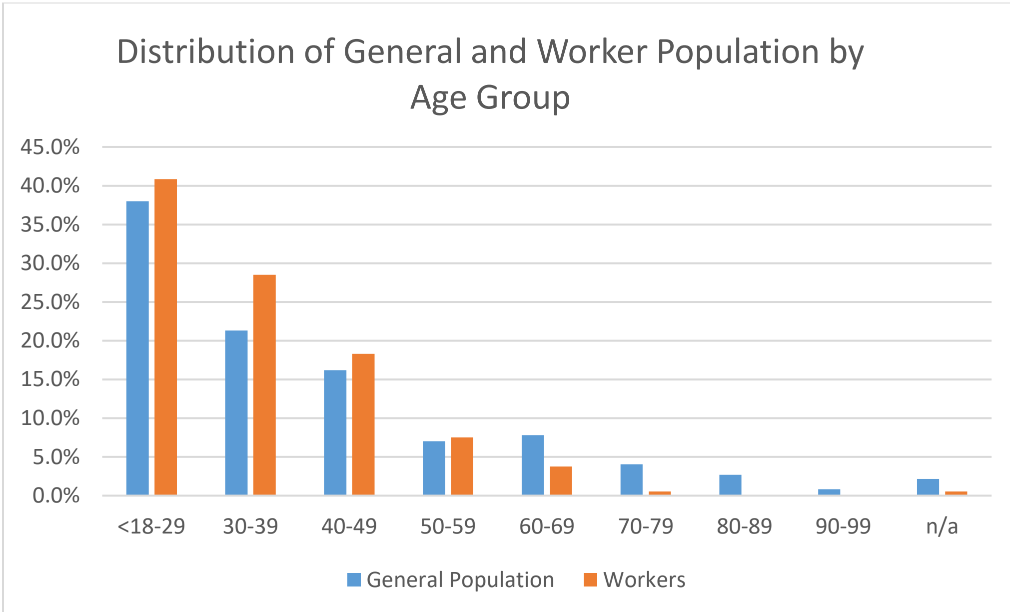

Figure 24: General Population and Jellyfish Fishery Participants by Age Group (Source: Author, Tuapi household survey, 2017).

The jellyfish fishery in Tuapi was extremely gendered in terms of participation. The average jellyfish fishermen age was 34 years, and all were male. In Tuapi and other Miskitu communities, fishing is considered men's work exclusively (Nietschmann 1973; Jamieson 2002). Because of long-held superstitions, women's role in fishing focuses primarily on the home processing of the day's catch, including the processing of fish, shrimp, crabs, and other seafood. Many women in the JPFs reprised this processor role. Almost 93 percent of separators (the workers responsible for the initial processing and cleaning of the jellyfish) were women, while the remaining positions, minus one cook, were men (Table 5). In the JPFs, no women reported participating as salters or guards, and the female supervisor positions were for the management of the female separators. In the following sections, I describe in detail the different positions and their roles in the fishery.

Position	Total	Percent	Male	Percent	Female	Percent	Av. Age (2015)
Fisherman	58	31.2	58	100.0	0	0.0	34
JPF Workers	128	68.8	45	35.2	83	64.8	32
Separator	*83*	*44.6*	*6*	*7.2*	*77*	*92.8*	*32*
Salter	*16*	*8.6*	*16*	*100.0*	*0*	*0.0*	*25*
Packer	*15*	*8.1*	*13*	*86.7*	*2*	*13.3*	*25*
Admin./Supervisor	*8*	*4.3*	*5*	*62.5*	*3*	*37.5*	*44*
Guard	*5*	*2.7*	*5*	*100.0*	*0*	*0.0*	*47*
Cook	*1*	*0.5*	*0*	*0.0*	*1*	*100.0*	*22*
Total	186		103		83		32

Table 5: Tuapi resident participation in the jellyfish fishery by position and gender

Catching Jellyfish in Tuapi

In Tuapi, about one-third of the fishery participants were fishermen. Fishermen typically captured jellyfish within two kilometers of the coast using watercraft and hand-held dip nets (Tuapi Focus Group, December 2017). The dip nets were custom made out of wooden sticks, old bike tires, scrap metal, and pieces of fishing net. Net rim sizes averaged 40 to 50 cm in diameter with a mesh size of 4 to 5 cm and were mounted on handles of 1.5 to 2 meters in length (Figure 25B). Depending on the net and the jellyfish's size, a scooper could collect 2 to 5 at a time.

Figure 25: Examples of Standardized Jellyfish Basket (A) and Dip Net (B). (Source: Author, Tuapi, 2017).

About 53 percent of Tuapi fishermen reported using a 3 to 5-meter long dugout cayuco. A cayuco is an open-air hand paddled boat similar to a canoe carved out of a tree trunk by artisanal boat makers and is sometimes augmented with additional wood to increase the height of the gunwale and small sails to increase speed (Figure 26). Forty-four percent of Tuapi fishermen reported using a panga (an open fiberglass boat about eight-meter long) with an outboard motor of 70 to 75 horsepower, and 3 percent reporting using a sailboat or *pompin* (similar to a panga but with an inboard motor).

Figure 26: Examples of Cayuco Boats in Tuapi (Source: Author, 2017)

A typical cayuco crew included two persons, a rower and scooper, while a typical panga crew of four consisted of a captain, who manages the engine and navigation, and three scoopers. Regardless of the kind of boat, the same profit-sharing agreement was used. After operating expenses were paid, proceeds were divided equally between the participating fishermen and the boat owner (if the owner was not a participant). The boat owner also received an additional share for boat maintenance, referred to as the 'boat's share'. About two-thirds of Tuapi fishermen reported either owning the boat they used or being directly related to the boat owners.

Despite the greater prevalence of cayucos among Tuapi fishermen, pangas dominated the jellyfish fishery. In the initial season, 63 percent of the participating boats were pangas, but they accounted for 84 percent of the jellyfish delivered to the Tuapi JPF (INPESCA 2011, 82). According to a former administrator in the Tuapi JPF, 180 distinct panga crews were recorded delivering jellyfish to the Tuapi JPF alone in 2014 (Tuapi Focus Group, December 2017). The key to the panga's dominance was speed and volume, the same critical factors of jellyfish fisherman success mentioned in Chapter 5.

Cayucos are restricted in their range, the number of trips they can take per day, and the amount of jellyfish they can carry per trip. Cayucos do have significant benefits, however. They cost a fraction of the price of a panga, and they do not require fuel and mechanical maintenance for a gas engine. In an impoverished region like the Miskitu Coast, a cayuco is a more viable option for the typical artisanal fisherman who earns his money primarily through catching scaled fish near the community with drift, gill, or set nets. Typically, these fishermen paddle out to the fishing area, set their nets, and return later in the day to collect their catch; speed is not a factor, and if they catch more than the boat can carry, they simply reset the net with the trapped fish and make a second trip. Volume is also not as crucial because the dock price for scaled fish, about C80 to

C110/kg (~$3-4), is about 30 times that of jellyfish. Cayuco fishermen can thus afford to go slow and carry less. This was not the case in the jellyfish fishery.

Cayuco fishermen reported that they typically took one trip per day and could haul about 15 baskets worth of jellyfish (Tuapi Focus Group, December 2017). In comparison, panga fishermen reported that they typically made at least two trips per day and average between 80 to 100 baskets per day when the blooms were good. With a dock price range of C80 and C100/basket, a cayuco fisherman working with a partner would have earned between C400 and C500 for 15 baskets, including the boat share, while a fisherman on a four-man owner-operated panga crew could earn two to four times as much (Table 6)! A cayuco fisherman could make money if the jellyfish blooms were close, but they could not travel far to search for them if the blooms were not, nor could cayuco fishermen supply the JPFs with the volumes they needed to operate.

	Cayuco (Crew=2)	**Panga (Crew=4)**	
Income			
Volume (baskets)	15	60	120
Trips/Day	1	1	2
Dock Price/basket	----------------------C80-C100----------------------		
Daily Gross Income	**C1,200-C1,500**	**C4,800-C6,000**	**C9,600-C12,000**
Fuel Expense			
Fuel Gallons	n/a	2.3	3.6
$/Gallon	n/a	C150	C150
Total Fuel	**n/a**	**C339**	**C534**
Daily Net Income	C1,200-C1,500	C4,461-C5,661	C9,066-C11,466
Shares + Boat	3	5	5
Fisherman's Take	**C400-C500**	**C892-1,132**	**C1,813-C2,293**
Initial Boat Cost	**~C7500**	**~C150,000 (w/motor)**	

Table 6: Tuapi-based fishermen income: panga versus cayuco. (Source: dock price ranges and panga and cayuco capacity were derived from fisherman and panga operator interviews in 2017 and 2018. Figures calculated using distance and fuel burn data are calculated in Table 1.

The dock price in Tuapi varied considerably during the jellyfish boom because of competition between the multiple JPFs in the area. All the JPFs I visited purchased jellyfish with the same standardized 32 x 48 x 23 centimeters basket that held 30 to 40 kilograms of jellyfish (Figure 25A). In 2013, when Jiang Seafood reopened the Tuapi JPF, they negotiated with the community to pay fishermen C80/basket. When GIISA opened the Poza Verde JPF later that year, however, they offered C100/basket to draw fishermen away from Jiang. Fishermen were more than happy to do so as Poza Verde was three kilometers closer to the sea than the Tuapi JPF which meant less travel time and fuel. When MCASSA took over the Tuapi JPF in 2014, they matched GIISA's prices, and in response, GIISA upped their prices again, kicking off a price war that eventually drove dock prices to C120/basket in 2014; higher than in any other JPF community. However, the typical dock price range in Tuapi ranged between C80 and C100/basket (Tuapi Focus Group, December 2017).

In addition to high dock prices, fishermen operating in the Tuapi fishery benefited from the proximity of the Tuapi and Poza Verde JPFs to the sea, about 3 km and 0.5 km respectively. Compared with other JPF communities discussed below, these short distances meant lower operational costs and made it much easier to earn a daily profit above the minimum acceptable level of C2,500/crew (based on an owner-operated four-person crew; C500/person and C500 for the boat share). At a dock price of C80 to C100/basket, delivery to Poza Verde, and the best-case scenario for pangas defined in Chapter 1 (calm seas, thick blooms close to shore, one hour fill times, well-maintained engines), two-thirds of the basket/dock prices combinations resulted in a profit above the minimum acceptable level for Tuapi-based fishermen taking one trip, and all combinations resulted in a profit for two trips (Table 7).

Tuapi JPF		C$/Basket								
	Tuapi	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**
# Baskets	**120**	4266	5466	6666	7866	9066	10266	11466	12666	13866
	110	3866	4966	6066	7166	8266	9366	10466	11566	12666
	100	3466	4466	5466	6466	7466	8466	9466	10466	11466
	90	3066	3966	4866	5766	6666	7566	8466	9366	10266
	80	2666	3466	4266	5066	5866	6666	7466	8266	9066
	70	2266	2966	3666	4366	5066	5766	6466	7166	7866
	60	2061	2661	3261	3861	4461	5061	5661	6261	6861
	50	1661	2161	2661	3161	3661	4161	4661	5161	5661
	40	1261	1661	2061	2461	2861	3261	3661	4061	4461
	30	861	1161	1461	1761	2061	2361	2661	2961	3261
	20	461	661	861	1061	1261	1461	1661	1861	2061

Table 7: Cost-benefit analysis for Tuapi panga fishermen participating in the Tuapi fishery between 2013 and 2015. The yellow line signifies the cut-off between one trip and two. The bolded box represents the typical range of dock prices reported by informant fishermen. Red shaded boxes mean that the dock price/basket combination does not yield the minimum acceptable of C2,500 for a crew of four, including boat share. Negative values in red signify that fishermen would lose money based on the best-case scenario. (Source: dock price ranges and panga capacity were derived from fisherman and panga operator interviews in 2017 and 2018. Cells are calculated using distance and fuel burn data calculated in Table 2 as well as the formula reported in Chapter 2.)

Even fishermen based in Bilwi or Krukira, who had to commute several kilometers to Tuapi before they could even collect jellyfish, could make an easy profit. Given the best case scenario, these fisherman would have realized an acceptable income for over half of the combinations for one trip, and for situations where a second trip was possible, all the combinations would have resulted in a profit above the acceptable level (Tables 8 and 9). Large blooms or small blooms, it was easy for panga crews to make money collecting jellyfish in Tuapi, primarily because of the proximity of the JPFs to the sea. One Bilwi fisherman characterized jellyfish collection in an interview as “scooping money out of the sea” because it was so easy (Fahrenbruch 2017; Fahrenbruch 2018, 224).

Tuapi JPF		C$/Basket								
	Pto. Cab.	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**
# Baskets	**120**	4098	5298	6498	7698	8898	10098	11298	12498	13698
	110	3698	4798	5898	6998	8098	9198	10298	11398	12498
	100	3298	4298	5298	6298	7298	8298	9298	10298	11298
	90	2898	3798	4698	5598	6498	7398	8298	9198	10098
	80	2498	3298	4098	4898	5698	6498	7298	8098	8898
	70	2098	2798	3498	4198	4898	5598	6298	6998	7698
	60	1893	2493	3093	3693	4293	4893	5493	6093	6693
	50	1493	1993	2493	2993	3493	3993	4493	4993	5493
	40	1093	1493	1893	2293	2693	3093	3493	3893	4293
	30	693	993	1293	1593	1893	2193	2493	2793	3093
	20	293	493	693	893	1093	1293	1493	1693	1893

Table 8: Cost-benefit analysis for Bilwi panga fishermen participating in the Tuapi fishery between 2013 and 2015. The yellow line signifies the cut-off between one trip and two. The bolded box represents the typical range of dock prices reported by informant fishermen. Red shaded boxes mean that the dock price/basket combination does not yield the minimum acceptable of C2,500 for a crew of four, including boat share. Negative values in red signify that fishermen would lose money based on the best-case scenario. (Source: dock price ranges and panga capacity were derived from fisherman and panga operator interviews in 2017 and 2018. Cells are calculated using distance and fuel burn data calculated in Table 2, as well as the formula reported in Chapter 2.

Tuapi JPF		C$/Basket								
	Krukia	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**
# Baskets	**120**	3666	4866	6066	7266	8466	9666	10866	12066	13266
	110	3266	4366	5466	6566	7666	8766	9866	10966	12066
	100	2866	3866	4866	5866	6866	7866	8866	9866	10866
	90	2466	3366	4266	5166	6066	6966	7866	8766	9666
	80	2066	2866	3666	4466	5266	6066	6866	7666	8466
	70	1666	2366	3066	3766	4466	5166	5866	6566	7266
	60	1461	2061	2661	3261	3861	4461	5061	5661	6261
	50	1061	1561	2061	2561	3061	3561	4061	4561	5061
	40	661	1061	1461	1861	2261	2661	3061	3461	3861
	30	261	561	861	1161	1461	1761	2061	2361	2661
	20	-139	61	261	461	661	861	1061	1261	1461

Table 9: Cost-benefit analysis for Krukira panga fishermen participating in the Tuapi fishery between 2013 and 2015. The yellow line signifies the cut-off between one trip and two. The bolded box represents the typical range of dock prices reported by informant fishermen. Red shaded boxes mean that the dock price/basket combination does not yield the minimum acceptable of C2,500 for a crew of four, including boat share. Negative values in red signify that fishermen would lose money based on the best-case scenario. (Source: dock price ranges and panga capacity were derived from fisherman and panga operator interviews in 2017 and 2018. Cells are calculated using distance and fuel burn data calculated in Table 2, as well as the formula reported in Chapter 2.

JPF Operation in Tuapi

The production of salted jellyfish in Tuapi and other communities was similar to that of other JPFs worldwide (see Chapter 5). After the jellyfish were offloaded at the JPF, they were transferred to the separators (*preparadoras)* to be cleaned and separated into bells and oral arms (Figure 27a-d). As highlighted above, almost all of the separators were women with an average age of 32. Separators enjoyed a good deal of flexibility in their work, which was attractive to the women and secondary students of Tuapi. Other JPF workers, most of whom were men, were paid a set wage and were expected to work regular eight-hour shifts and even overtime when production was high. In contrast, the separators were 'flex' employees who were paid by the number of baskets they filled with bells and oral arms. A separator could go to the plant and separate a few baskets of jellyfish and earn a little money without sacrificing their domestic or school obligations (Tuapi Focus Group, December 2017).

Pay rates for the separators and other JPF workers, like the fishermen, were impacted by the competition between the JPFs. When Jiang Seafood reopened the Tuapi JPF in 2013, they negotiated with the community to pay separators C8/basket and other workers C150/day. When the Poza Verde JPF opened, GIISA offered separators C10/baskets and the other plant workers C180/day to draw them away from Jiang. Unlike the fishermen, Tuapi JPF workers did not want to go to Poza Verde because it was about a half-hour walk from town and not as convenient. When MCASSA took over the Tuapi JPF in 2014, they matched GIISA's pay, and in response, GIISA upped their pay and provided a truck to shuttle workers to and from Tuapi (Tuapi Focus Group, December 2017). As with the dock prices, competition eventually drove the separator pay in Tuapi to C25/basket, and the salaries for other plant workers to C200/day, the highest on the coast.

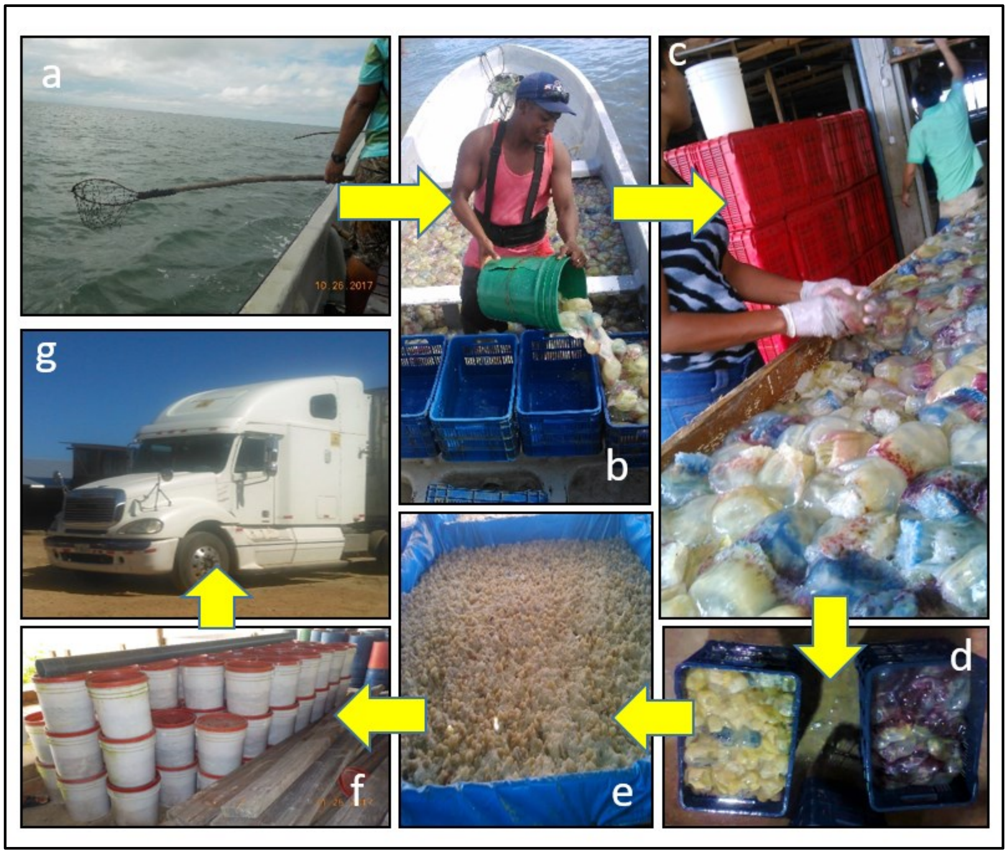

Figure 27: The JPF Production Process: a. capture of jellyfish at sea by fishermen; b. delivery of jellyfish to the JPF and payment to the fishermen for number of baskets filled; c & d. separation and initial cleaning of jellyfish; e. washing and salting of the jellyfish over the course of several days; f & g. packing of jellyfish in 18kg buckets and shipment to the Pacific Coast via semi-truck. (Diagram Source: Author (2017/2018) and Larry Finley (2014)).

Following the separation of the jellyfish, the bells and oral arms were loaded separately into large concrete basins and were washed with circulating water for approximately two hours. The jellyfish parts were then transferred separately to brining basins where they were treated with a mixture of salt and alum for about 12 hours (no soda was used). After this initial treatment, the jellyfish parts were moved to larger tanks where they were further cured with salt and alum for three to four days (Figure 27e). The physical tasks of moving the jellyfish through the phases of processing were done by the salters (*salteros)* while the curing process and the application of the salt and alum were directed by the jellyfish master (a foreign employee of the jellyfish processor who had expertise in jellyfish processing).

When the jellyfish master determined that a suitable flesh firmness and texture was achieved, the jellyfish were packed in plastic buckets with additional salt for shipping (Figure 27f). Each bucket was estimated to weigh about 18kg (Ubieta 2008).[17] After the buckets were packed, they were loaded onto semi-trucks by the packers (*empacadores)*. The salters and packers' work was most physically demanding, and most were men with an average age of 25 years, the lowest for all the positions. After the semis were packed, the buckets of salted jellyfish were hauled overland to the Pacific coast, where they were shipped abroad (Figure 27g).

JPF-Tuapi Relations

The operation of the fishery and working conditions in the JPFs, for the most part, were deemed acceptable to the fishermen, workers, and other community members. However, there were some complaints about workers' safety, verbal abuse by the foreign processors, and the use of non-local workers. In terms of worker safety, cannonball jellyfish secrete a pungent mucus when they are disturbed, which is thought to be a defense mechanism (Phillips, Burk, and Koener 1969). The mucus can cause skin rashes, and the smell can cause light-headedness and nausea, similar to seasickness. JPF workers in Tuapi recounted that they did not have personal protective equipment in the early days of the fishery, and some separators would get so sick that they would need to step away from the tables to vomit before continuing. They recounted that they would often return home after work with bad headaches and rashes covering their hands and wrists. In response, the community demanded the processors provide protective equipment for the workers. The processors responded by providing gloves, masks, and hair covers to alleviate the situation and increase the operations' overall hygiene.

[17] For additional information on the physical characteristics of cured jellyfish, see Rudloe (1992, 21-22).

A second common complaint was the language barrier between the foreign staff and the local workers. Some survey respondents mentioned that some of the foreign underlings in the Tuapi JPF were verbally abusive and became angry with the workers when they spoke Miskitu. None of the foreign JPF operators spoke Miskitu, and their Spanish was limited (Tuapi Focus Group, December 2017). Additionally, several respondents reported that the operators would solicit sex from women and sometimes underage girls in the community. This behavior appears to have been limited to certain "*mal-criado*" (poorly raised) individuals; however, this was not characteristic of the general working environment. Most of the time, the foreigners kept to themselves and did their cooking and cleaning in the JPF.

A third and possibly the most significant complaint among Tuapi residents was the use of non-local fishermen and JPF workers. Labor has historically been a limiting factor for extractive industries on the Miskitu Coast, and the jellyfish fishery was no different. During the boom, the JPFs could not fulfill their fishing and labor needs with the local Tuapi population alone, so they were forced to recruit outside the community. The JPFs advertised by radio and word of mouth, and many fishermen and JPF workers traveled in from surrounding communities to work.

Despite the heavy participation of Tuapi men in the fishery, there are only eight pangas in Tuapi that represented a fraction of the fleet of panga crews from other fishing communities within 40km up-and-down the coast from Tuapi (Figure 28). The communities that sent the most fishermen included Krukira, Bilwi, Wawabar, and those around the Pahra and Dakra Lagoons, and Sandy Bay. Still, there were also accounts of fishermen from Kip, 100 km to the north, and Wouhnta, 60 km to the south.

Many JPF workers, mostly women, also came from Krukira and Bilwi, but also inland communities along the Bilwi-Waspan road (Figure 28). Some outside panga fishermen also brought female family members to work in the JPFs while they collected jellyfish (Tuapi Focus Group, December 2017). These fishermen and workers would often stay with family in Tuapi, Krukira, or Bilwi during the season and return to their communities after (Tuapi Focus Group, December 2017). The majority of income generated by fishermen and JPF workers likely flowed out of the community with them, although some surely stayed in Tuapi.

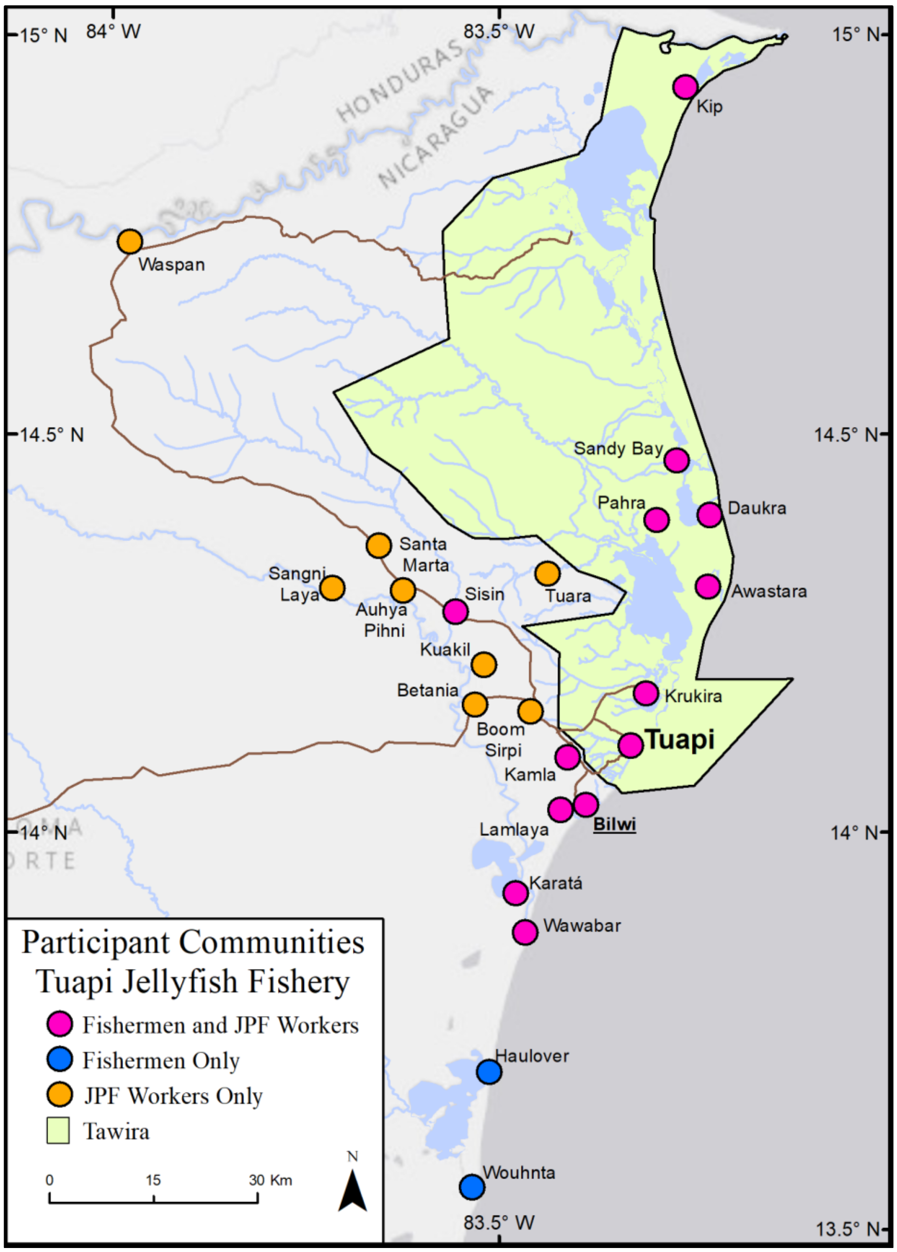

Figure 28: Map of Communities that Sent Fishermen and JPF Workers to Tuapi. People from these communities travelled to Tuapi to catch jellyfish or work in the JPFs. (Source: Tuapi Household Surveys and Interviews with Tuapi JPF Workers.)

Tuapi residents were not happy that non-local fishermen and workers dominated the fishery, but there was little they could do. One Tuapi Sindico did charge a fee of C150/day to outside fishermen in 2014; however, this appears to have been a one-time event that was not universally enforced. Fishing by outsiders is a contentious topic in Tuapi and other communities along the coast (Stevens, Frank, and Kramer 2015). Some fishermen fiercely oppose the intrusion of outside fishermen under any circumstances, while others take a more nuanced approach that accounts for the season, areas being fished, the number of outside fishermen, the kind of equipment being used, and the existence of any reciprocity agreements. In terms of the jellyfish fishery, most residents understood that the community did not have the pangas and fishermen to supply the JPFs alone without outside participation. If the JPFs were going to operate and provide employment for the residents, they needed outside panga crews to collect and deliver sufficient quantities of jellyfish (Tuapi Focus Group, December 2017).

The influx of non-local and primarily female workers caused quite a stir in the community, more so than the influx of non-local male fishermen. Tuapi women were jealous and afraid that the outside women would steal their men, and they resented that they had to wait to work behind non-locals (Tuapi Focus Group, December 2017). In an attempt to maintain favor in the community, both the Golden Island International S.A. (GIISA) and Mariscos Central y America del Sur S.A (MCASSA) JPFs gave preference to Tuapi fishermen and workers over non-locals. Tuapi, because of its experienced workforce, also became a source of trainers for other JPFs, and several Tuapi women were recruited to work as trailers in new JPFs in Bismuna and in Honduras (Tuapi Focus Group, December 2017).

Some concerns were also voiced about leadership positions in the JPFs. Both GISSA and MCASSA hired local administrators, supervisors, and guards who could speak Miskitu and

Spanish. Thirteen community members reported working in these positions. The average age of these individuals was 44 for the administrators and supervisors, and 47 for the guards, the oldest of all the positions. These positions were filled by community elders or other individuals who commanded respect, could be trusted, and in some cases, were nominated by the community. During the off-season, when the JPFs were idled and foreign operators left for Managua or abroad, much of the trust was put into these individuals' hands. In terms of operational leadership positions such as the JPF managers and jellyfish masters, however, these positions were universally reserved for non-locals, and there is no indication that Tuapi residents were trained on the broader operation of the JPF or jellyfish marketing.

Several respondents also complained that the JPFs did not pay enough. During the price war between MCASSA and GIISA, residents would play one company off the other. When GISSA raised its prices, fishermen and workers would turn around and pressured MCASSA to do the same. Fishermen didn't want to travel the extra distance to deliver to Tuapi JPF unless they got paid more to do it. On the other side, JPF workers wanted MCASSA to pay more because they didn't want to travel to the more-distant GISSA plant, even with a shuttle. Both GIISA and MCASSA began offering fringe benefits to garner community support. Both processors gave Christmas baskets to their workers and the community's elderly that included sugar, flour, oil, rice, and beans, and GIISA donated money for the Tuapi baseball and softball teams. Regardless, the price war caused a lot of turmoil in the community, including periodic protests that specifically hurt MCASSA's production and likely helped hasten the JPF's failure after 2015 (Tuapi Focus Group, December 2017).

Overall, while a few survey respondents expressed some concerns about working conditions, language barriers, and bad behavior, the gifts and employment opportunities endeared the JPFs to the community. About 88 percent of survey respondents agreed that the relationships between the JPFs and the community were good, and 93 percent said that the community benefited from the JPFs. The high dock prices and pay rates and fringe benefits that the community enjoyed, however, were largely fueled by high demand for jellyfish and outsized jellyfish blooms, especially in 2014. Unfortunately, the relationships soured when the fishery began to fall apart after mid-2015.

The Failure of the Tuapi Fishery: Conflicts and Contracts

The bust of the jellyfish fishery began in 2015. That year a third JPF was built by Alimentos de Central America S.A. (ACASA) just south of Tuapi at the mouth of the Río Ruk Ruk (Figure 29). Not much is known about ACASA. According to the landowner, the proprietor was Korean, but the manager for the operation was Cuban. The firm paid its land rent through the beginning of 2017; however, the JPF never processed a single jellyfish. As of March 2018, the JPF was abandoned and the landowner had not heard from the manager in some time.

Figure 29*:* The Abandoned Río Ruk Ruk/ACASA JPF in November, 2017. The JPF was built by the processor ACASA in 2015, but it never operated (Source: Author, 2017; inset from Google Earth, 2019).

GIISA also shut down and abandoned the Poza Verde JPF in 2015, in large part because of an internal conflict with a business partner. Nicaraguan law allows foreign companies to operate in-country through local branches, joint-ventures, and wholly-owned subsidiaries if the enterprise has a legal representative living there (Asamblea Nacional de Nicaragua 2000). Although some jellyfish processors chose to become legal residents themselves, GIISA worked with a local Bilwi partner. According to Tuapi residents and the former manager, the partnership worked well initially but things soured by 2015. The local partner tried to push GIISA out and partner with a different operator from Mexico. GIISA brought the dispute to the community and the community refused to permit the partner to operate the JPF (Tuapi Focus Group, December 2017). Nevertheless, in light of these problems, weak blooms, and declining demand, GIISA decided to pull out of Nicaragua at the end of 2015 (Tuapi Focus Group, December 2017)

After GISSA departed, the Poza Verde JPF was acquired by a new processor called MarChina. In a November 2017 interview with the proprietor's Nicaraguan partner in the Poza Verde plant, she explained that the proprietor is Chinese and has worked in jellyfish processing in East and Southeast Asia. He found out about Poza Verde from his brother, who was already working in Nicaragua outside of the fishing industry. Unfortunately for Mar China, the firm has processed little if any jellyfish since taking over. As of March 2018, they were looking to expand their capacity to process other species, including scaled fish, shrimp, fish maw, and sea cucumber.

In November 2017, the Tuapi JPF, the first JPF on the Miskitu Coast, was abandoned by MCASSA. MCASSA had signed a new five-year lease with Tuapi in early 2015, after the booming months of 2014. The contract stipulated that MCASSA would pay the equivalent of \$150/month land rent for the first two years, and then \$200/month until the end of the contract in 2020 (Richinal 2017). Unfortunately, there was no production in the JPF after late 2015. MCASSA nevertheless continued to pay their land rent month after month, but in August 2017, they reached out to community leaders and informed them that they would no longer pay rent for a JPF that was not operating. The community agreed to waive the rent through November in hopes that conditions would improve; however, they did not.

On November 22nd, MCASSA officials were supposed to meet with community leaders in Tuapi between 8:30 and 9:00 am to discuss the future of the JPF, but by about 9:30 am, it was clear that they were not coming. A local elder and former MCASSA supervisor called the MCASSA boss at 10:00 am. The boss, it turned out, was in Managua and had no intention of meeting them in Tuapi. He informed the elder that the firm would be breaking their contract and abandoning the JPF. Although the boss initially wanted to keep a portion of the metal roofing panels, MCASSA ultimately decided to leave everything to the community and wash their hands of it. In addition to the JPF structure, they left behind several hundred 36 and 45 kg bags of industrial rock salt and a lesser number of 25 kg bags of alum (Figure 30C and D).

On the day that MCASSA informed the community of its departure, the community leaders met to discuss what to do with the abandoned JPF. Some of the more enterprising members suggested that the community advertise the JPF locally or online to see if they could attract a different processor to come in and operate; this is a common practice among Chinese seafood traders (Fabinyi 2016; Fabinyi and Liu 2016). Others wanted to deconstruct the JPF and divide the materials among the community members. Now that the community knew the JPF was abandoned, some leaders feared that community members would loot the JPF, and they didn't want to have to hire and pay for guards.

The leaders called a meeting of the communal assembly the next morning to discuss the situation. In the meeting, a compromise decision was made; the bags of salt would be divided amongst the community members at a rate of about 15 bags per household; the metal roofing panels would be sold to raise money for the community's churches and elderly, and the wooden structure of the Jiang Seafood expansion, all the JPF's walls, and the separating tables would be disassembled and the lumber distributed to the community. The core of the original PBSA JPF, including the first processing tanks and the dock, would remain intact in case a processor could be found to operate it.

Despite the investments in the JPF by three different jellyfish processors, to the residents of Tuapi, the JPF was little more than concrete and plumbing covered by a sheet metal roof. There was no local market for jellyfish and no implicit value for households; jellyfish only had a value if and when the processors gave it value. Without the processors, local artisanal fishermen had no access to foreign markets or the means of production. Like any other specialty tool, the JPF became virtually worthless the minute those with the knowledge, financial resources, business networks, and processing expertise left. For most residents, there was more utilitarian value in the materials of the JPF than the hope of finding a new processor to operate it.

The community was mobilized over the next week disassembling the JPF, and dividing roofing panels, wood, and salt/alum bags (Figure 30A-B). The whole process felt like a fire-sale at times as residents jockeyed for their part and elders monitored and made sure that things were orderly and that any fights were quickly resolved (Figure 30F). Some people grabbed wood, purchased roofing panels, or both, and stuck them under their houses for later use; however, many used the materials to repair or augment their homesteads leading to a small but noticeable building boom in the community. Families patched holes in their walls or roofs, some constructed new *fagons* (clay ovens) or additions to their homes, and some used the wood to repair the fencing around their livestock pens or dooryard gardens. Some of the roofing panels were used to finish the roof on the

Moravian church's new kitchen and banquet area. Many of the large support timbers were cut up for firewood, which is still a primary cooking fuel (Figure 30E). As for the bags of salt, some fishermen had connections to the sea cucumber fishery and intended to sell their salt to them. Others outright refused to take any salt, not wanting the burden, and others took it just in case even if they had no immediate plans. Much of the salt was later sold in the first months of 2018 to sea cucumber fishermen who brought trucks in from Bilwi and went house to house buying the bags.

Figure 30: The Deconstruction of the Tuapi/MCASSA JPF. (A) Roofing panels were sold to raise money for the community churches and elderly; (B) Families were given 15 bags of salt; (C & D) MCASSA left about two thousand bags of salt, and lesser amounts of alum in the JPF; (E) Many of the support timbers were cut up for firewood; (F) Community leaders supervised the JPF's deconstruction to help keep things orderly. (Source: Author, 2017)

Figure 31: The Partially Deconstructed Tuapi/MCASSA JPF in Late November, 2017. (Source: Author, 2017; inset from Google Earth, 2019)

I talked to the Tuapi Sindico a few days after the call with MCASSA about their decision to pull out. He related that the community understood why they pulled out, “if there are no jellyfish, then they can’t operate… no product, no work.” Still, he said that many were upset that MCASSA broke their contract, saying, “I think some in the community feel used, MCASSA came in, used our labor and our jellyfish, and then just left” (Richinal 2017). The community had a five-year contract with MCASSA that required the firm to pay the community a monthly rent of $200 through 2020; in November 2017, about $5,200 remained in the contract. Fabio and others thought that MCASSA should have paid a least some of this money, but the community didn’t have the resources to litigate it in the courts. Therefore, the materials of the JPF were the settlement.

Unfortunately, the settlement meant the destruction of the productive value of the JPF and the reduction of a facility that had once connected the residents to consumers on the other side of the world to scrap and firewood (Figure 31).

ACCOUNTS OF THE JELLYFISH FISHERY IN OTHER COMMUNITIES

This dissertation focuses heavily on the jellyfish fishery's operation in Tuapi; however, I also visited three other JPF communities, including Krukira and Bismuna in the RACCN and Haulover in the RACCS (see map in Figure 1). Although the relationships between the JPFs and the workers, fishermen, and the general Tuapi community were positive, this was not the case in all communities. Competition between the Poza Verde and Tuapi JPFs drove up the pay rates and dock prices to the highest levels on the coast, and also encouraged the processors to provide fringe benefits. Other communities, however, only had one JPF, and their experiences were much different. Krukira, Haulover, and Bismuna had a unique experiences from Tuapi, and each provides a further look into the operation and governance of the fishery along the broader coast.

Krukira: Community Initiated Investment

A new JPF was built in 2015 about seven kilometers north of Tuapi in the community of Krukira by a processor called China Nicaragua S.A. (CHINICSA). As opposed to Tuapi and other JPF communities where the processers sought out community support, Krukira residents actively worked to find and solicit a processor to build a JPF (Morris 2018). When the JPFs in Tuapi were in operation, many Krukira residents traveled to Tuapi to work as JPF employees and as fishermen. Unfortunately, they had to pay the extra travel cost to get back and forth. According to the long-time Sindico of Krukira, Bulstram Morris, many residents began questioning why Krukira didn’t have a JPF of its own; after all, there were many jellyfish and a population that had experience with the fishery from their work in Tuapi (Morris 2018).

At the height of the boom in 2014, community leaders, JPF workers, and fishermen lobbied MCASSA officials in Tuapi to build a JPF in Krukira. MCASSA ultimately turned down the deal but referred the idea to a contact interested in getting into the business. The contact partnered with a local Nicaraguan from Managua and formed CHINICSA. The proprietor did not speak Spanish or Miskitu, so negotiations and relations with the community were handled by the Nicaraguan partner (Morris 2018).

The process of developing the JPF begin in early 2015. The Nicaraguan partner traveled to Krukira with SERENA and INPESCA to propose the project to the communal assembly. As in Tuapi, the advisers could not provide information to the community, and according to the Morris, the community did not have any interaction with them after the meeting. By this point, however, community members already had a good deal of experience working in the jellyfish fishery in Tuapi, and they knew they wanted a JPF in Krukira. The community agreed to lease CHINICSA a one-hectare plot a half kilometer south of town for five years for $3,500/year under the stipulation that the firm hire locals to build the road to the site and the 1600 sq. meter JPF (Figure 32). Unlike Tuapi, however, the agreement stipulated that CHINICSA would only have to pay half the rent if there was no production.

Figure 32: The Krukira/CHINICSA JPF in November, 2017. (Source: Author, 2017; inset from Google Earth, 2016)

The JPF was a significant boom for the community. Dock prices and pay rates were similar to those in Tuapi; fishermen received between C80 and C100/basket, JPF workers were paid C$150/day, and separators earned C20/basket. The JPF did not, however, provided any fringe benefits like Christmas baskets or sports team sponsorship, and without competition, they likely did not feel pressured to do so (Morris 2018). The situation was nevertheless better for the community because participants did not have to spend the money and time traveling to Tuapi. The Krukira JPF's construction boosted the overall percentage of dock price/basket combinations that yielded over the minimum acceptable income from 50 percent to 67 percent. The income from those combinations also increased, on average, 14 percent compared to working in Tuapi (25 percent for single trips) because they did not have to burn fuel commuting 33 kilometers round trip (Table 10).

Krukira JPF		**C$/Basket**								
		40	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**
# Baskets	**120**	3930	5130	6330	7530	8730	9930	11130	12330	13530
	110	3530	4630	5730	6830	7930	9030	10130	11230	12330
	100	3130	4130	5130	6130	7130	8130	9130	10130	11130
	90	2730	3630	4530	5430	6330	7230	8130	9030	9930
	80	2330	3130	3930	4730	5530	6330	7130	7930	8730
	70	1930	2630	3330	4030	4730	5430	6130	6830	7530
	60	1965	2565	3165	3765	4365	4965	5565	6165	6765
	50	1565	2065	2565	3065	3565	4065	4565	5065	5565
	40	1165	1565	1965	2365	2765	3165	3565	3965	4365
	30	765	1065	1365	1665	1965	2265	2565	2865	3165
	20	365	565	765	965	1165	1365	1565	1765	1965

Table 10: Cost-benefit analysis for Krukira panga fishermen participating in the Krukira fishery in 2015. The yellow line signifies the cut-off between one trip and two. The bolded box represents the typical range of dock prices reported by informant fishermen. Red shaded boxes mean that the dock price/basket combination does not yield the minimum acceptable of C2,500 for a crew of four, including boat share. Negative values in red signify that fishermen would lose money based on the best-case scenario. (Source: dock price ranges and panga capacity were derived from fisherman and panga operator interviews in 2017 and 2018. Cells are calculated using distance and fuel burn data calculated in Table 2, as well as the formula reported in Chapter 2.

The CHINICSA JPF was not spared, however, when the jellyfish boom began to bust in 2015. The JPF only operated for about three months in late 2015 and produced about three semi-trucks of product. During a visit to the JPF in March 2018, I observed about 100 buckets (~1,800kg) of salted jellyfish from the 2015 season still sitting in the JPF. The guard explained that a semi-trailer carries approximately 1,100 buckets and that the value of the remaining buckets (~$1,500) was too little to justify the cost of shipping them out. As of April 2018, there was still some hope in the community that the JPF would reopen in the future. Unlike the ACASA and MCASSA JPFs in Tuapi, CHINICSA was still paying its rent to Krukira and employing a young man from Matagalpa to watch over and maintain the JPF (Morris 2018).

Overall, the Krukira JPF is an excellent example of community-led development. Community members from Krukira participated heavily in the Tuapi fishery, and through this experience, they saw the benefits of the fishery and the job opportunities and logistical savings that a Krukira JPF could offer. Despite a lack of technical advice, the community took it upon themselves to solicit a processor to build a JPF, and they were successful.

Haulover: Distance, Dock Price Shifting, and Market Failure

A conflictive practice that was reported in all the communities I visited was the seasonal fluctuation in dock prices by the JPFs. Drastic price fluctuations in Haulover in 2015 led to a conflict between fishermen and MCASSA that helped precipitate the failure of jellyfish processing that year. During one of our research listening sessions in Haulover in March 2018, community leaders recounted that the 2013 and 2014 dock prices ranged between C80 and C100/basket, similar to Tuapi. In late 2015, however, jellyfish blooms were weak, and MCASSA was not processing enough to cover their costs. They tried to make up for their losses by cutting the dock price by nearly half to between C50 and C60/basket (Haulover Listening Session, March 2018).

Dock price shifting appears to have been a common practice among jellyfish processors. In a 2015 interview with Pearl Lagoon Fisheries Technician Xenia Gordon, she explained that dock price shifting is a common JPF strategy to cope with the uncertainty of jellyfish blooms. At the beginning of the season, when uncertainty about the size of the blooms is high, processors set their dock prices low to reduce their exposure to a bust season, but as production increases, dock prices increase to get fishermen excited and draw them away from catching other products (Gordon 2016). Dock price shifting is necessary because of the low-value/high-volume nature of the product; JPFs need to process large quantities of jellyfish to make a profit. As highlighted in

Krukira, CHINICSA's margins were tight enough that they left nearly 1,800 kg of finished product sitting in an idled JPF because they would have lost money shipping it out. This suggests that JPFs have a break-even point, below which production results in a loss. Minimizing investment in the form of lower dock prices early in the season limits JPF risk if blooms are weak and production is low. However, if blooms are large, JPFs need to raise dock prices quickly to mobilize fishermen before the blooms disappear.

Unfortunately, while this strategy can reduce JPF costs during weak jellyfish blooms, it can also create a negative feedback loop where weak blooms lead to low production, which leads to lower dock prices, which discourage fishermen from catching jellyfish, which further hampers production (Gordon 2016). The price cut in 2015 angered Haulover fishermen and created such a feedback loop. The fishermen argued with MCASSA that the C50-C60/basket dock price was not worth the time and fuel to get to and from the JPF. Unlike the JPFs in Tuapi, the Haulover JPF is about 12 km inland from the sea. Fishermen had to commute 20 to 30 minutes before they could even begin searching for jellyfish, and then they had to haul their catch back 12 km to the JPF to sell them. Even with a C80 to C100/basket dock price, this meant higher fuel costs and a 16.8 percent lower average profit compared with Tuapi-based fishermen (Table 11).

Despite the high operating costs, the situation was sustainable in 2013 and 2014 at a dock price of C80 to C100/basket. Assuming the best-case scenario, about half of the dock price/basket combinations for one trip and all the combinations for a second trip, in this range, would have resulted in a profit above the minimum level (Table 11). What was sustainable at a dock price of C80 to C100/basket, however, was unsustainable at C50 to C60/basket.

Haulover JPF		C$/Basket								
# Baskets		40	50	60	70	80	90	100	110	120
	120	3210	4410	5610	6810	8010	9210	10410	11610	12810
	110	2810	3910	5010	6110	7210	8310	9410	10510	11610
	100	2410	3410	4410	5410	6410	7410	8410	9410	10410
	90	2010	2910	3810	4710	5610	6510	7410	8310	9210
	80	1610	2410	3210	4010	4810	5610	6410	7210	8010
	70	1210	1910	2610	3310	4010	4710	5410	6110	6810
	60	1605	2205	2805	3405	4005	4605	5205	5805	6405
	50	1205	1705	2205	2705	3205	3705	4205	4705	5205
	40	805	1205	1605	2005	2405	2805	3205	3605	4005
	30	405	705	1005	1305	1605	1905	2205	2505	2805
	20	5	205	405	605	805	1005	1205	1405	1605

Table 11: Cost-benefit analysis for Haulover panga fishermen participating in the Haulover fishery between 2013 and 2015. The yellow line signifies the cut-off between one trip and two. The bolded box represents the typical range of dock prices reported by informant fishermen. Red shaded boxes mean that the dock price/basket combination does not yield the minimum acceptable of C2,500 for a crew of four, including boat share. Negative values in red signify that fishermen would lose money based on the best-case scenario. (Source: dock price ranges and panga capacity were derived from fisherman and panga operator interviews in 2017 and 2018. Cells are calculated using distance and fuel burn data calculated in Table 2, as well as the formula reported in Chapter 2.

In the best-case scenario, the cut to C50 to C60/basket would have cut profits almost in half, and only about seven percent of the basket-dock price combinations for one trip would have resulted in a profit above the minimum level. The rate does increase to 83 percent for a second trip, but it is questionable, in the case of weak blooms, if a second trip would have even been possible given the increased search and collection times. Additionally, profits would have likely been reduced more during weak blooms by increased fuel costs and decreased yields caused by more water loss and spoilage due to longer search and collection times.

As highlighted in Chapter 5, artisanal fishermen are generalists, and if they can’t make money catching jellyfish, they will go for something else. In 2015, MCASSA listened to the fishermen's concerns and promised to raise the dock price back up to C80 to C100/basket when production picked up. Unfortunately, this never happened. The blooms remained weak, the dock price stayed low, and the fishermen refused to collect jellyfish which led to the failure of local jellyfish fishery operations that year (Haulover Listening Session, March 2018).

The Haulover experience provides a view into the operational strategies of the JPFs and their vulnerability to weak jellyfish blooms. The dock price shifting strategy appears to have been a common practice, and it helped reduce JPF risk during weak blooms. In Haulover, however, it discouraged fishermen from participating. This account demonstrates the impact that distance has on fishermen's profits and their vulnerability to weak blooms. Longer distances mean higher fuel costs and travel times, and weak blooms mean increase search and collection times and fewer trips, all of which stress profit margins and make fishermen more vulnerable to low dock prices.

Bismuna: Conflict and Market Failure

Despite the dock price conflicts that hampered fishery operations in Haulover, the most contentious situation on the coast may have been in the community of Bismuna. In 2013, a small JPF was built in the community by a processor called King International Trading S.A. (KINTRA). In an interview with the former JPF manager in Tuapi in 2017, he explained that the proprietor, like Moon International, had started processing jellyfish in Mexico before coming to Nicaragua. The man came to Nicaragua in the mid-2000s to establish a seafood export business in Bilwi. He eventually obtained his Nicaraguan residency and work permit, and advertised on Facebook for investors! According to the manager, the man established a partnership with some investors from South Korea, and together they formed KINTRA S.A. At first, KINTRA focused on buying and processing sea cucumber, but the partners later decided to start a JPF.

The manager, a local Miskitu fisherman, helped KINTRA find Bismuna through his contacts in the fishing industry. Bismuna is near the Honduran border, but is still connected to the road network, and its concave coastline is known to create eddies that trap and aggregate jellyfish. The manager and KINTRA officials traveled to Bismuna in early 2013 to propose the project. According to Bismuna leaders, no government advisors attended the meeting, and in stark contrast to Tuapi’s experience, KINTRA dictated its terms with a take it or leave it attitude. If the community wanted the JPF, they could take KINTRA’s offer (Listening Session in Bismuna, March 2018). This was the beginning of what would be a contentious relationship.

The community did want the work, and they approved the construction of the JPF at the northern edge of town along the river (Figure 33). Unlike in Tuapi, there was no negotiating dock prices and pay rates. KINTRA dictated a dock price of C40/basket, a separator price of C7/basket, and a pay rate of C90/day for the other JPF workers, the lowest of any JPF I investigated. The firm justified the low pay rates by arguing that they had to pay higher transportation costs to ship the product; Bismuna is nearly 800 km from Puerto Corinto on the Pacific coast, Nicaragua’s main port, about 200 km farther than Tuapi (See map in Figure 1). Nevertheless, the C40/basket dock price was impractical for most Bismuna fishermen for reasons similar to those in Haulover.

Figure 33: The Bismuna/KINTRA JPF in March, 2018. (Source: Author, 2018)

Like Haulover, the Bismuna JPF was about 13.5 km from the sea, the furthest inland of any JPF I investigated. The use of cayucos was impractical, and panga-based fishermen had to travel a half-hour or more before they could even start searching for jellyfish. This meant that their fuel usage was more than twice as high per trip than panga fishermen in Tuapi. At the dock price of C40 and a best-case scenario, panga fishermen had to deliver over one and a half loads before earning the minimum-acceptable income (Table 12). This situation immediately limited panga fishermen to periods of large blooms. Some fishermen, especially those from the community of Kip, used sailboats which, while much cheaper to operate, were slower. Even these fishermen complained about the time it took them to get and from the JPF.

Bismuna JPF		**C$/Basket**								
		40	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**
# Baskets	**120**	2970	4170	5370	6570	7770	8970	10170	11370	12570
	110	2570	3670	4770	5870	6970	8070	9170	10270	11370
	100	2170	3170	4170	5170	6170	7170	8170	9170	10170
	90	1770	2670	3570	4470	5370	6270	7170	8070	8970
	80	1370	2170	2970	3770	4570	5370	6170	6970	7770
	70	970	1670	2370	3070	3770	4470	5170	5870	6570
	60	1485	2085	2685	3285	3885	4485	5085	5685	6285
	50	1085	1585	2085	2585	3085	3585	4085	4585	5085
	40	685	1085	1485	1885	2285	2685	3085	3485	3885
	30	285	585	885	1185	1485	1785	2085	2385	2685
	20	-115	85	285	485	685	885	1085	1285	1485

Table 12: Cost-benefit analysis for Bismuna panga-based fishermen participating in the Bismuna fishery between 2013 and 2015. The yellow line signifies the cut-off between one trip and two. The bolded box represents the typical range of dock prices reported by informant fishermen. Red shaded boxes mean that the dock price/basket combination does not yield the minimum acceptable of C2,500 for a crew of four, including boat share. Negative values in red signify that fishermen would lose money based on the best-case scenario. (Source: dock price ranges and panga capacity were derived from fisherman and panga operator interviews in 2017 and 2018. Cells are calculated using distance and fuel burn data calculated in Table 2, as well as the formula reported in Chapter 2.

Like Haulover, Bismuna fishermen protested that the C40/basket dock price was not enough. However, KINTRA would not increase the dock price, being of the mindset that if you wanted to work, you would work for their price (Listening Session in Bismuna, March 2018). This caused animosity between KINTRA and the community that erupted when the community threatened to strike. KINTRA relented slightly and increased the dock price to C50/basket, but this did little to change things; it still took over a load to meet the minimum acceptable income level. Furthermore, KINTRA officials became increasingly demanding and, if they were going to pay more, people had to work harder and deliver more jellyfish (Listening Session in Bismuna, March 2018). The firm further aggravated the situation by rejecting smaller jellyfish, which angered fishermen who spent time and money catching and delivering them (Listening Session in Bismuna, March 2018).

KINTRA eventually relented further and set up a way-station on the coast where fishermen could drop off their jellyfish without returning to Bismuna. Several pangas were employed by KINTRA to transfer the jellyfish from the coast to the JPF. The way-station helped reduce fuel consumption by about 17 percent for a single trip and 53 percent for two trips; however, panga fishermen still needed over a full load of 60 baskets to earn an acceptable profit (Table 13). This left them little margin to deal with bloom fluctuations or poor operating conditions.

Bismuna W.S.		**C$/Basket**								
		40	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**
# Baskets	**120**	3906	5106	6306	7506	8706	9906	11106	12306	13506
	110	3506	4606	5706	6806	7906	9006	10106	11206	12306
	100	3106	4106	5106	6106	7106	8106	9106	10106	11106
	90	2706	3606	4506	5406	6306	7206	8106	9006	9906
	80	2306	3106	3906	4706	5506	6306	7106	7906	8706
	70	1906	2606	3306	4006	4706	5406	6106	6806	7506
	60	1641	2241	2841	3441	4041	4641	5241	5841	6441
	50	1241	1741	2241	2741	3241	3741	4241	4741	5241
	40	841	1241	1641	2041	2441	2841	3241	3641	4041
	30	441	741	1041	1341	1641	1941	2241	2541	2841
	20	41	241	441	641	841	1041	1241	1441	1641

Table 13: Cost-benefit analysis for Bismuna panga fishermen participating in the Bismuna fishery with a waystation between 2013 and 2015. The yellow line signifies the cut-off between one trip and two. The bolded box represents the typical range of dock prices reported by informant fishermen. Red shaded boxes mean that the dock price/basket combination does not yield the minimum acceptable of C2,500 for a crew of four, including boat share. Negative values in red signify that fishermen would lose money based on the best-case scenario. (Source: dock price ranges and panga capacity were derived from fisherman and panga operator interviews in 2017 and 2018. Cells are calculated using distance and fuel burn data calculated in Table 2, as well as the formula reported in Chapter 2.

Production at the Bismuna JPF was understandably poor compared with that in Tuapi. According to the former manager, when KINTRA built the JPF, they wanted to produce at least 5,000 buckets (~90 MT) of jellyfish per month. According to INPESCA records, however, between 2013 and 2016 KINTRA only exported about 29 MT of salted jellyfish, approximately 1 percent of the total exported over this time (INPESCA 2014, 2015, 2016, 2019a, 2019b). Like MCASSA in Tuapi, KINTRA eventually stopped paying its rent, and in 2017 the firm disappeared from the INPESCA records (INPESCA 2019). As of March 2018, however, the original proprietor was still claiming ownership over the JPF and was paying a local man to look after it. Community leaders claim they have tried to open a dialog with the man, but he has refused to return to town in person (Listening Session in Bismuna, March 2018).

The situation has also been exacerbated by dueling communal governments in Bismuna. The community has both Sandinista and Yatama factions, and both have juntas directivas that claim to be legitimate. A few weeks before I visited the community, a new group of fishermen from Honduras arrived and began using the JPF. The group claimed that they were sent by the original proprietor, who was operating in Honduras, to catch scaled fish and process them in the old JPF. During a community meeting, the group claimed to have an arrangement with the Sandinista junta. This was news to the Yatama junta and many community members who thought that they were illegal poachers. The Yatama junta ultimately gave the group permission to stay and operate in the JPF. Still, it highlights the challenges that dueling governments pose to communal natural resources governance where one faction can give legitimacy to natural resources extractors without the other faction even knowing.

The Bismuna experience provides an additional example of the importance of distance between the JPF and the sea in a jellyfish fishery. Still, it also provides an contrasting account of JPF operation and natural resources governance on the coast. Although JPF-Community relations on the coast were, for the most part, amicable, the situation in Bismuna was not. KINTRA dictated the terms to the community and was rigid when faced with community pushback. As a result, relations were poor and this hurt production. The experience also provides an example of dueling governments and extractors' potential to ‘shop’ communal governments for legitimacy.

CHAPTER 7: A POLITICAL ECOLOGY OF THE JELLYFISH FISHERY

INTRODUCTION

My broad goal for this dissertation was to elucidate the multi-scale biophysical, political-economic, and cultural-historical processes that played a role in the development, boom, and bust of the jellyfish fishery on the Miskitu Coast. In this final chapter, I use the framework developed in Chapter 2 to place these processes within the historical context of the region's boom-and-bust economy (Parsons 1955a; Parsons 1955b; Helms 1971; Nietschmann 1973; Dozier 1985; Vilas 1989; Offen 2004b; Pineda 2006;**)** as well as in the broader literature on multi-level natural resources governance (Pinkerton 1989; Pomeroy and Berks 1997; Armitage 2008; Larson and Soto 2012) and boom-and-bust natural resource exploitation (Sauer 1938 [2009]; Innis 1940; Nietschmann 1973; Romero, Chilbert, and Eisenhart 1999; Williams 1991; Scales, Balmford, Liu, et al. 2006; Moore 2010a; Meyer 2013). I conclude by providing my outlook on the future of the Miskitu Coast jellyfish fishery, and I suggest actions needed to better the governance of the fishery and natural resources in general on the coast.

THE MISKITU COAST JELLYFISH FISHERY IN CONTEXT

Centralized and Development-Focused Natural Resources Governance

Weak Regulation and Community Consultation

The Nicaraguan state has historically promoted foreign investment in extractive industries as a top-down strategy to develop and exert sovereignty over the Miskitu Coast (Offen 2004, Gabbert 2011; Offen 2004b). The jellyfish fishery was a similar top-down effort led by INPESCA. The agency led efforts to develop and promote the fishery on the Miskitu Coast both in response to private sector interest and regional and national initiatives to support artisanal fishing and provide alternatives for lobster divers, and their supporters (INPESCA 2008; INPESCA 2011).

The development of the fishery differed from past extractive industries, however. Under both Law 445 and international conventions (ILO 169 and UNDRIP), the jellyfish processors were required to secure consent from the host communities before building the JPFs, and in all cases, did so. Although the relationships between the processors and the communities varied, I did not find evidence that a JPF was forced upon a community. All communities I visited indicated that they were excited to have the work (at least at first), and in the case of the Krukira, it was the community itself that initiated the establishment of the JPF.

One of the biggest concerns expressed by community leaders, however, was the lack of support they received from INPESCA and SERENA during the consultation and negotiation process with the jellyfish processors. Law 445 stipulates that the Autonomous Regional Councils (or central government in protected areas) shall provide technical assistance in the consultation, negotiation, and authorization of concessions for the rational use of natural resources (Asamblea Nacional de Nicaragua 2003 Ch. 2., Arts. 10, 16, 17, 27). In all cases, except Bismuna, INPESCA worked with SERENA to try to advise the communities about the projects. However, the officials were unable to provide basic information on jellyfish biology, the operation and environmental impacts of jellyfish fisheries, or jellyfish markets; information the communities needed to conduct negotiations and give informed consent.

There was no history of jellyfish exploitation in Nicaragua before 2008. INPESCA did not know how to regulate jellyfish exploitation and was ill-equipped to develop such regulation in a timely fashion. INPESCA (and its predecessors and fellow natural resources agencies) has long suffered from a chronic lack of funding and has struggled to effectively carry out its mission to sustainably manage Nicaragua's fisheries and aquaculture resources (Thorson 1982, Pfeiffer 1986; Rivas 2013). In a 2013 interview with *Wani Revista del Caribe Nicaragüense*, INPESCA Director Steadman Fagoth bemoaned the agency's paltry budget of C6 million ($226 thousand) and staff of only 34 to manage the nation's $130 million fishing industry (Rivas 2013, 23). INPESCA did not have the resources to independently study the fishery and had relied on the processors for data, similar to past extractive industries.

When the jellyfish fishery began in 2008, it started as a developmental fishery with an information-sharing agreement between INPESCA and PBSA. After PBSA shut down, INPESCA initiated similar agreements with the other processors that they permitted to operate. During a July 2015 interview with INPESCA's RACCN Regional Director Nadilla Padilla, and a February 2018 interview with National Director of Investigations Renaldi Barnutty, both related that INPESCA had hoped that the agreements would allow them to collect data and eventually develop regulations for the fishery. Unfortunately, the agreements ended when the JPFs shut down, and little progress was made. In a 2016 fisheries report, INPESCA stated that "to date, there have been no studies to permit the establishment of regulations for the jellyfish fishery" (INPESCA 2019: 30). This problematic still existed in 2018, a decade after the initiation of the fishery.

For communal authorities presented with the opportunity to cash in on the jellyfish boom, they had no idea what the market value was for jellyfish and whether they were negotiating a fair price. They also had no idea what the impact would be on the other fisheries they relied on. In a March 2018 listening session in Haulover, residents recounted how one of their most important fisheries of seabob shrimp (*X. kroyeri*) had noticeably declined during the jellyfish boom then rebounded after the cessation of jellyfish exploitation in 2015, although not to pre-jellyfish fishery levels. MCASSA was still maintaining the Haulover JPF at the time and residents were concerned about the potential impacts of the fishery. They questioned whether they should allow future exploitation, and they felt unsupported by INPESCA and SERENA (March 2018, Listening Session, Haulover). Bismuna residents also made similar comments about shrimp populations and a lack of support.

Tawira President Anderson Toby and former *Cuena del Laguna Perla*s (Pearl Lagoon) territorial President Kenneth Fox both criticized INPESCA's management of the coast's fisheries, specifically the consultation process. Toby lamented that most of the Tawira population depends directly or indirectly on fishing. Yet, despite decades of exploitation, no one really has a good idea of the fisheries' condition or how they are being impacted by pollution, overfishing, or climate change (Toby 2017). Former President Fox was more direct in his assessment and summed up the impressions of many on the coast:

> "The consultation process is superficial…INPESCA doesn't really care about the coast. They approve these projects, but they don't know or don't care about the impacts… they have a short view, they are interested in investment, jobs, and money now, not long-term resource management" (Fox 2018).

Implementation Gap with Law 445 Funds

The story is unfortunately similar when it comes to the proceeds from natural resources exploitation. Both communal and territorial leaders expressed concern over the lack of transparency in the accounting of the Law 445 funds. Law 445 gives the central government the authority to collect all proceeds from natural resources concessions in the Autonomous Regions, specifying 25 percent of the proceeds be allocated to the <u>community</u> where the resources were exploited. The JPF communities should have received proceeds from the exploitation of jellyfish in the form of cash funds or development projects. Unfortunately, I found no evidence that this was the case in any community I visited. No community leader could identify cash funds or a development project tied to jellyfish extraction. This is concerning and suggests that these proceeds are retained at higher government levels than allowed by law, or that communal authorities are not being forthright about how the funds are being used.

Other researchers have observed similar situations on the coast (Larson 2010; Finley-Brook 2016). Anne Larson, with the Center for International Forestry Research (CIFOR), found that Law 445 funds from logging concessions in the RACCN were retained at the territorial level and that in some cases, the funds were squandered by corrupt territorial sindicos that were accredited by the regional government (Larson 2010). In one case, the certification of the community sindico in Layasiksa was delayed for seven months, and the territorial sindico was granted access to the community's Law 445 funds instead. The territorial sindico subsequently withdrew the majority of the funds for an unknown purpose without the knowledge, nor apparently for the benefit, of Layasiksa residents.

Unfortunately, Layasiksa is not an anomaly; Larson points out that, "In practice, the regional government [RACCN] has granted territorial, rather than community level, authorities – specifically those sanctioned and registered by the regional government – the power to obtain tax funds from the bank that are designated for communities..." (Larson 2010, 1150). The FSLN controls the regional governments, which are charged with observing and certifying the territorial and communal elections. This power has been used to deny certification to non-Sandinista authorities and to certify un-elected Sandinista supporters instead (Asamblea Nacional de Nicaragua 2003, Art. 7, 8; González 2019). Politics may play a role in the authorization of territorial sindicos over community sindicos; however, many communities have Sandinista backed sindicos as well. It may also merely be logistics. There are far fewer territories than communities, and it is easier to issue funds to the territory and let them figure it out rather than keep track of what resources came out of what community.

Regardless of the state's logic, there needs to be more transparency and accountancy at all levels, as it appears that many communities don't know how much money is earmarked for them or how it is being spent. Law 445 dictates that proceeds are to be audited by the Comptroller General of the Republic. One step towards transparency could be to share these audits with the relevant territories and communities and possibly extend the scope of these audits, within the terms of Law 445, to lower levels of government so that the money can be traced to communities or development projects done on their behalf.

On the other side, the territories and communities need to establish their own accounting systems for resources exported out of their areas. During the jellyfish boom, both the territory and the communities lacked effective and independent institutional capabilities to monitor and account for the jellyfish (or any natural resource) leaving their areas. Generally, fishermen kept track of the number of baskets they caught, and local administrators and JPF workers kept some records about the number of semi-trucks sent out during the season. However, I did not find evidence that there was organized oversight by any communal government that could be used to reinforce or challenge the government's figures, even if the process was more transparent.

Communities can work now to establish a record-keeping system to keep track of the natural resources leaving their areas. Ideally, this would be a non-partisan committee established by the Communal Assembly that continues unimpeded regardless of leadership changes. The challenge for communities like Tuapi, however, is that communal leaders are part-time public servants. The 2017/2018 sindico in Tuapi was also the local school principal, and Krukira's sindico was also a bus driver. Another challenge is contentious communal politics. The frequent overturn of leaders (sindicos and wihtas) like in Tuapi, or dueling communal governments like in Bismuna, make it difficult to build institutional competence and for the community to present a united front to natural resource extractors and higher levels of government.

Boom-and-Bust Mentality in Communal Natural Resources Governance

To be fair to INPESCA officials, they were not the only ones interested in development, jobs, and money; these were also on the minds of many in the JPF communities. Communities, because of a lack of economic opportunities, proved willing to gamble on the socioeconomic and environmental impacts of the fishery in return for jobs despite a lack of information. Years of engagement with the boom-and-bust economies cause many to take a "shoot first and ask questions later" approach. When asked why Krukira actively solicited a JPF despite a dearth of technical knowledge about jellyfish fisheries, Krukira Sindico Bulstram Morris responded, "It's about the jobs and money. People saw the money and work that was being generated in Tuapi, and they wanted that for themselves… it's the same reason why people catch lobster or turtle during the offseason…people are thinking of the present, not the future" (Morris 2018).

No communal government official wants to be seen as impotent by their constituents, nor do they want their community to be the "bottom crab" on the coast that misses out on economic opportunities (Jamieson 2002, 281-282). Communal leaders are expected to bring in new projects and development for their communities, and if they don't, they are ridiculed, and their tenure is often short-lived. Furthermore, boom-and-bust industries are naturally unpredictable. An industry that is booming today might be bust tomorrow, and who knows when the next opportunity might come around. As Bernard Nietschmann's Tasbapauni informant remarked, "When the company there, got to get. When dey leave, dats gone blank; dey no looking you" (1973, 195). It is difficult for many of the poor residents of the Miskitu Coast to think about tomorrow when the jobs and cash are being offered today and tomorrow might not come. This is why many agreed to host JPFs despite a lack of information on the potential impacts.

Bismuna Yatama Sindico Nelson Chow (2017/2018) summed up well the difficult paradox that communities and their leaders face in terms of the consultation/negotiation process:

> "Projects come to Bismuna, but it is always the same; it's the investor and his [Miskitu or Mestizo] helper that show up. They dictate the terms and basically say, "take it or leave it." We are then unfairly asked to evaluate a project with the little information they give us without outside help or information… the community is left with no advocate and in the unfair position of having to decide on badly needed investment without understanding the risks… what do we do? If we don't accept the project, another community will, but if we do accept it, we don't know if we are getting a fair deal or how it will impact us in the future" (Chow 2018).

Many communities face the same challenge. Economic deprivation and a lack of institutional support leave them desperate and at a disadvantage in the consultations and negotiations process and in their relations with the extractors during operation. Except for Tuapi, where JPF competition gave residents more bargaining power, communities had to more or less settle for what the processors were offering if they wanted to work. Fishermen in Bismuna and Haulover did lodge protests against low dock prices, but the effect was limited, and they were never really successful in getting acceptable pay from the processors. Even in Tuapi, the community ultimately lacked the resources to challenge MCASSA for breach of contract and were required to scavenge from the defunct JPF as their financial settlement.

Dependence on Foreign Actors and Markets

All of the Miskitu Coast extractive industries discussed in this dissertation were heavily, if not solely, reliant on the forces of globalization and the ebb and flow of foreign markets, technology and politics. The jellyfish fishery was no different; It was part of a larger trend of jellyfish fishery expansion driven by economic development in China and increasing consumption of animal proteins and Chinese luxury seafood commodities (Hsieh, Leong, and Rudloe 2001; Barton, Chen, and Jin 2013; Fabinyi and Liu 2014). Like the mahogany, banana, green sea turtle, and lobster industries before, the Miskitu Coast jellyfish fishery served luxury consumer tastes abroad.

Similarly, none of the natural resources exploited on the Miskitu Coast were originally commodified on the coast. Exploitation began elsewhere and spread into Nicaragua through commodity frontier expansion as destructive exploitation or high competition (frontier maturation) reduced the profitability of resource production in other areas. As the demand for jellyfish increased in China, traditional fisheries could not meet demand (Dong, Liu, and Keesing 2014; You, Yongming, Caihua, et al. 2016). As a result, jellyfish traders increasingly looked to new foreign sources like Moon International and the Gulf of California (Álvarez-Tello 2007; Álvarez-Tello 2017/2018). As competition increased and fishing conditions worsened there, even companies like Moon began looking to expanding into new areas. This dynamic is similar to what traders did after the Jamaican and U.S. forests were exhausted, after the Cayman Islands' green sea turtles were decimated, or when restaurants were searching for cheaper alternatives to the overexploited North American lobster (Floyd 1967; Dozier 1985; King 1995; Bowett 1996; Woodward 2005; Offen 2020). In all these cases, only after these resources were degraded in other parts of the world did producers and traders move to the Miskitu Coast.

Foreign government policies and technological advances also played a major role in the fishery for better and for worse. Just as the scientists with the American rubber companies discovered the usefulness of the Panama rubber tree in the 1850s, the cannonball jellyfish' commodification was facilitated by U.S. research (Dozier 1985; Offen 2004b). The U.S. government-funded the food science research of Yao-Wen Huang and others at the University of Georgia Marine Extension Service and the market research of Jack Rudloe (1992, 1995) and the Gulf Specimen Marine Laboratory (Huang 1988; Rudloe 1992, Rudloe 1995). This work planted seeds in the minds of jellyfish traders that grew into several commercial jellyfish fisheries in the U.S. and Latin America over the following decades (Brotz, Schiariti, Lopez-Martínez, et al. 2016). Even with the increased demand for jellyfish, it is questionable if companies like Moon International or Golden Island International would have ever started processing cannonball jellyfish in the Americas without the above research.

Government policy, in this case in China, also proved detrimental to the fishery. There was little that the JPF communities could do to impact Chinese perceptions of American cannonball jellyfish after the Chinese National Center for Food Safety Risk Assessment (CFSA) issued their 2014 report on dietary aluminum. The report, and general government crackdown on tainted seafood at the same time, alarmed the Chinese public about shoddy/unprofessional operations, unsafe and negligent protocols, and jellyfish contaminated by excessive amounts of alum (Godfry 2013; Godfry 2014; CFSA 2015; Berwald 2017). Alum is a key component in jellyfish processing that has been used for centuries, but the CFSA report called public attention to jellyfish as a highly concentrated source of dietary aluminum. This was a fact that the typical lay Chinese person may have never considered before due to a lack of research on aluminum’s effects on the body and testing methods to detect aluminum concentrations in food (Wong, Chung, Kwong, et al. 2010; Yang, Jiang, Huang, et al. 2014; CFSA 2015; Zhang, Tang, Huang, et al. 2016).

The CFSA report and the weak blooms were likely the pins that popped the jellyfish bubble on the Miskitu Coast and forced many weaker processors out of business. The situation that JPF communities faced is not unlike that faced by the Cape Cod salt makers and Rio Coco rubber tappers after the cancelation of wartime subsidies in the United States, or by the green sea turtle traders after the adoption of CITES in Nicaragua (Nietschmann 1979; Offen 1998; Meyer 2013; Garland and Carthy 2010). In all these cases, political decisions made in other parts of the world ultimately dictated the ability of Miskitu Coast residents to make money with certain resources.

There was also little the JPF communities could do to revive the fishery after the pull-out of processors. Nicaraguans have historically been relegated to the lower rungs of the employment hierarchy in the various boom-and-bust industries and have relied on foreign operators for work. Foreign firms have elected to employ their own foreign managers and technicians and have neglected to train locals (Vilas 1989). As a result, when the bust came, and the firms pulled out, there was little local institutional capacity to rebuild and sustain the industries (Vilas 1989; Pineda 2006). The jellyfish processors did employed local administrators and partners; however, there is no evidence that there was a comprehensive transfer of the knowledge about the production and marketing of salted jellyfish that would allow locals to sustain the fishery independently. As demonstrated in Tuapi, the Tuapi JPF was virtually worthless after MCASSA pulled out, and besides some minor home repairs done with the scavenged wood and roofing panels, there was no perceptible long-term gain to Tuapi or any other JPF community from the short-lived fishery.

Problems of Nature

Natural resource extraction naturally hinges on the biophysical characteristics of the resource. Degradation of the resource base, or problems of nature that cannot be effectively controlled, can seriously hamper producers' ability to bring a product to market. The rates at which traders exploited the Venezuelan pearl oysters and Miskitu Coast mahogany, rubber (Rio San Juan), and pine, exceeded the natural reproduction rates of the resources and led to destructive exploitation and the failure of the industries (Parsons 1955a; Dozier 1985; Vilas 1989; Offen 1998; Romero, Chilbert, and Eisenhart 1999; Pineda 2006; von Humboldt and Bonpland 2012 [1818]; Gismondi and Mouat 2009). Because of a lack of foundational research on the jellyfish populations on the Miskitu Coast, it is unknown whether the decline after 2015 resulted from destructive exploitation, or more likely, natural bloom-and-bust-oscillations. Regardless, the jellyfish fishery did have a fair share of challenges that fishermen and producers needed to contend with.

A biological analysis of the cannonball jellyfish was not the primary objective of this dissertation; however, I reviewed the relevant jellyfish literature to contextualize the observations of local Miskitu Coast fishermen with the challenges that fishermen, processors, and regulators face in jellyfish fisheries worldwide. Like other jellyfish fisheries, Miskitu Coast fishermen and jellyfish processors contended with a great deal of variability in fishing conditions that strained already tight profit margins. The Miskitu Coast fishery experienced the same whiplash fluctuations in production as the fisheries in Mexico, China, and Vietnam (Rudloe 1993; Álvarez-Tello 2007; Nishikawa, Thu, Ha, et al. 2008; Girón-Nava, López-Sagástegui, and Aburto-Oropeza 2015). Large blooms in 2013 and 2014 likely fueled the fishery's rapid growth as excitement spread through the processor networks and among government officials and residents. As 2014 jellyfish landings quintupled over 2013, it likely seemed that the next miracle industry had arrived. All fishermen had to do was paddle or motor their boats a few hundred meters offshore and start "scooping money out of the sea" (Fahrenbruch 2017; Fahrenbruch 2018, 224). It must have been similarly exciting to the processors, some of whom had to expand their JPFs and operate 24 hours a day just to keep up. This excitement faded and turned to disappointment, however, as the blooms weakened after 2015.

The JPFs, faced with an uncontrollable resource and declining production, tried to lower their costs with limited success. In the maturing commodity frontier around Tuapi, competition between the JPFs made it difficult for them to lower dock prices and worker pay without fomenting protests. In the less competitive communities of Haulover and Bismuna, the JPFs attempted to cut their dock prices, or keep them low to begin with, but were rebuffed by the fishermen who starved the JPFs of their basic input when they refused to collect jellyfish. Despite a rebound in production in late 2018, there was only one jellyfish processor still exporting that year (MCASSA); down from six in 2015 (INPESCA 2016; INPESCA 2020). JPFs were either shuttered or abandoned (as occurred with MCASSA in Tuapi, CHINICSA in Krukira, and KINTRA in Bismuna), or they diversified into other products as occurred with Mar China in the Poza Verde JPF and MCASSA in Bilwi and Haulover. The high unpredictability of jellyfish biology was an insurmountable problem of nature that, combined with the local and international labor and market challenges highlighted above, was too much for many processors to handle.

LOOKING FORWARD

The Future of the Miskitu Coast Jellyfish Fishery

This dissertation contributes a valuable ethnographic account to the sparse, but growing, body of literature on jellyfish fisheries. In recent decades, commercial jellyfish fisheries have emerged around the world in places where there was previously no history of jellyfish exploitation. This rapid expansion has posed a challenge to fisheries managers and fishermen alike as they have rushed to understand the highly variable biological and market dynamics of jellyfish fisheries. The experiences in Nicaragua with the lack of regulation as well as the challenges of an unpredictable fishery reinforce the observations of other fisheries in China, Mexico, Vietnam, Pakistan, and India (Rudloe 1993; Álvarez-Tello 2007; Nishikawa, Thu, Ha, et al. 2008; Girón-Nava, López-Sagástegui, and Aburto-Oropeza 2015, Gul, Jahangir, and Schiariti 2015; You, Yongming, Caihua, et al. 2016). However, this dissertation also adds to this literature valuable insight into the relationship between the processors and artisanal fishermen, including the practice of dock price shifting as a method of risk reduction, and the importance of distance between the JPF and the sea to the resilience of JPF operations. It also provides valuable insight into the gendered dynamic within a JPF. Admittedly, these dynamics apply to a cannonball fishery in Nicaragua, but may not be applicable to jellyfish fisheries in different cultures that target higher value species in regions closer to the end market.

At this time, it is unclear what the future is for the Miskitu Coast jellyfish fishery. The general, demand for American cannonball jellyfish appears to be rebounding despite concerns about dietary aluminum intake. The Gulf of California fishery has seen a strong recovery with landings of 35 thousand MT in 2017 (Gobierno de México 2018). A similar rebound has been seen in the U.S. with 2017 jellyfish exports (~79 MT) nearly doubling from 2016 (~40 MT), but this is still only about 4 percent of 2014 exports (FAO n.d.b;). Even the Miskitu Coast fishery saw a rebound of production in late 2018, but nowhere near 2014 levels in terms of landings, exports, or the number of producers (INPESCA 2015; INPESCA 2020).

There are also other major headwinds. Across the Pacific, China's economic growth has been slowing in that last few years, and the Trump administration's recent trade war with China has only exacerbated the situation. The Chinese economy recorded its lowest growth rate in 30 years in 2019, and consumer spending and seafood imports are declining (Godfry 2015; 2016; Ingber 2019; Yeung 2019). In the first months of 2020, the situation worsened with the rise of the global Covid-19 pandemic. Fear and mandatory social distancing measures caused many Chinese consumers to avoid restaurants, banquets, and celebrations, leading to a collapse in imports for some Chinese luxury seafood products (Porterfield 2020; Banister 2020). Finally, in November 2020, Nicaragua was buffeted by two major hurricane, Eta and Iota, within the span of two weeks. The eyes of both hurricanes followed a nearly identical path over Bilwi and devastated the RACCN. At the time of writing this, the condition of the remaining JPFs is unknown, but given the tight margins of jellyfish processing, this may be a problem of nature that is difficult to recover from. Time will tell.

Looking to the future, however, some steps should be taken in Nicaragua to prepare for a resurgence of jellyfish production if it does occur. INPESCA needs to develop a robust knowledge base as well as regulations for the fishery. It was good that INPESCA was able to establish information-sharing agreements with the jellyfish processors. If the fishery had operated longer, they might indeed have been able to formulate regulations. Still, as an independent regulatory agency, they should not be reliant on foreign processors for data and regulation. INPESCA must receive sufficient funding to properly study and manage natural resources and provide lower levels of government (especially the communities) with the information they need to make informed decisions.

Developing a robust knowledge base, as well as regulations, will likely be difficult without help. As Lucas and Dawson (2014, 35) highlight, It is likely that jellyfish blooms result from the interactions between a complex suite of abiotic and biotic factors that are time and place-specific, making the accurate prediction of bloom size, duration, and location difficult if not impossible. To elucidate these factors and interactions would require complicated and expensive multi-year studies of individual ecosystems to develop long-term correlation relationships (Lucas and Dawson 2014). These kinds of studies would likely be cost-prohibitive in poorer countries like Nicaragua without outside assistance. With limited budgets and the small size of the jellyfish fishery overall, it is likely that this work will take a back seat to research on more valuable species like lobster and sea cucumber.

As Bismuna and Haulover demonstrate, INPESCA, communities, and processors need to accept that JPFs need to be built close to the sea to be viable. The farther from the sea a JPF is, the better the bloom conditions will need to be for the processor and the fishermen to make money. Some communities need to accept that they are not good candidates for JPFs. Furthermore, the conflictive practice of dock price shifting is essential to the JPFs to manage their exposure to risk from the variable and unpredictable biology of cannonball jellyfish. It is unlikely that this will change. As such, INPESCA and SERENA need to inform communities of this fact and advise against the establishment of JPFs that are not within a few kilometers of the sea unless there are plans to establish relay stations or fuel subsidies for fishermen.

JPF communities should also be made aware of the variable nature of jellyfish biology. They need to understand upfront that there may be years or a string of years where jellyfish fishing is not viable. In the case of Krukira, the contract with the processor recognized this and allowed the processor to pay half rent in down years. This fact needs to be recognized and negotiated in any contact moving forward. If jellyfish processing does return to the coast, it will likely only provide ephemeral income for fishermen and communities. A far cry from the viable alternative to lobster diving that INPESCA first touted in 2011, jellyfish may prove to be the ultimate boom-and-bust commodity for a boom-and-bust economy.

Concluding Statements

This dissertation carries forward the long Sauerian/cultural-historical tradition in geography and provides a valuable empirical and historically grounded case study for the growing body of literature in political ecology on multi-level governance regimes and their operation on the ground, especially regarding indigenous peoples in rural Latin American. One of the most encouraging policy shifts in recent decades has been the titling of traditional territories and the creation of semi-autonomous indigenous territorial jurisdictions (ITJs) in Latin America. States and multilateral organizations have lauded this shift as an important step towards providing indigenous groups with greater autonomy (Ortega 2004; Gonzalez 2015; Larson et al. 2016). However, in reality, under the auspices of neoliberal reforms, states have been reluctant to cede 'real' control of their natural resources and development regardless of indigenous claims or international outcry (Ortega 2004; González 2015).

Despite the sometimes radical use of the term 'autonomy', indigenous authorities are legally restricted, to varying extents, in their use and governance of their natural resources. Instead of granting sovereignty over natural resources, states have focused on the creation of multi-level governance regimes where indigenous authorities are placed in a subsidiary position to the state despite legal or implied ownership rights (Ortega 2004; González 2015). Multilateral declarations like the ILO 169 and the UNDRIP declare the rights of indigenous peoples to legally own, develop, manage, and control their traditional territories and natural resources, including the rights to free, informed, and prior consent, and just compensation for projects that impact them (ILO 1989, Art 15.1; UN 2007, Arts. 26,28,30). In reality, the value of indigenous 'rights' depends on what rights are actually conveyed and enforced through the multi-level regimes under which they exist (Pomeroy and Berks 1997; Castro and Nielsen 2001, Capistrano and Charles 2012; McNeish 2012). This has led political ecologists and others to question how these regimes actually function on-the-ground (Stevens 1997; Ortega 2004; Larson and Medoza-Lewis 2012; Finley-Brooks 2016; González 2015, 2019; Herlihy and Tappan 2019; Herlihy, Fahrenbruch, and Tappan 2020). The need to address these questions is particularly urgent in Central America where hundreds of thousands of hectares of territory have been titled to semi-autonomous ITJs in just that last decade.

While this dissertation only scratches the surface of the governance structures established by Law 445, it contributes to current scholarly understanding of multi-level governance and provides valuable insight into some of its challenges from the viewpoint of indigenous communities and natural resource agencies. Nicaragua's Law 445 was monumental in making communities the gatekeepers to natural resources exploitation on their lands and waters and by setting up a profit-sharing system to return extraction proceeds to the coast. But what are these 'rights' really worth on the ground? A ubiquitous challenge of indigenous policy in Latin America is the failure to conduct adequate consultation with indigenous communities. In many cases, when indigenous communities are presented with development projects, especially extractive projects, they are not provided with the resources to adequately understand the proposals (Ortega 2004, 15). In the case of the jellyfish fishery, communities looked to INPESCA and SERENA for guidance, but guidance wasn't there. Communities like Bismuna were left to weight "badly needed investment" against the uncertainty of jellyfish exploitation.

A second common challenge, likely by design, is that indigenous policies in Latin America lack precision and legal definition which creates a great deal of ambiguity (Ortega 2004). This was demonstrated on the Miskitu Coast by the conflict between INPESCA and Tawira over fishing permits, as well as the confusion surrounding the distribution of Law 445 funds. While Law 445 is progressive within the historical context of the Miskitu Coast, this dissertation and other similar works demonstrate that implementation gaps are undercutting the functioning of the multi-level governance regime and preventing a realization of indigenous and ethnic minority rights (Larson 2010, Finley-Brooks 2016, González 2018, 2019) .

Similar situations exist though out Latin America, and in reality, ‘rights’ are worthless unless states invests in the institutions and education to make them work (Ortega 2004; Bixler, Dell’Angelo, Mfun, et al. 2015; Wright and Tomaselli 2019). The battle facing indigenous peoples is to push for their rights to free, prior, and informed consent, their right to benefit from natural resources extraction, and for clearer and binding judicial opinions on what their rights actually mean. This is especially pertinent in cases like Nicaragua where ITJs hold state-issued titles to their lands and waters. While territorial titles lend an air of legitimacy to state pro-indigenous efforts, there needs to be legal clarification about what rights are actually conveyed by such titles. Without this clarification, there will surely be future instances where indigenous peoples are pitted against state agencies over natural resources. Given the inherently asymmetrical relations between states and indigenous peoples historically, forcing these changes and clarifications will likely require outside legal assistance similar to that seen in the case of Awas Tingni in Nicaragua that led to the passage of Law 445 (Anaya and Grossman 2002).

This dissertation, which focuses on the boom-and-bust exploitation of the cannonball jellyfish on the Miskitu Coast, also contributes a valuable case study to the geographic and political ecology literature on commodity frontier expansion and demonstrates the challenges of non-traditional resource extraction for natural resources agencies in developing states. Geographer and political ecologist Anthony Bebbington (2015) recently argued that extractivism in Latin America has been an understudied. He questioned whether we adequately understand the technologies, industries, capital, markets, and legal issues involved with extractivism, and he highlighted that the recent commodities boom in the region had "blindsided" the scholarly, NGO, and activist worlds (Bebbington 2015, 86-87). While Bebbington referred specifically to the mining and petroleum industries, I agree that there needs to be greater focus on extractivism, although I propose a broader definition that includes other, sometimes non-traditional, extractives that can equally 'blindside' the above groups as well as local communities and regulators.

For centuries, global production has been based on the cultural tastes of Western consumers, but the gravity of consumer demand is quickly shifting towards Asia. The challenges faced by INPESCA and the JPF communities are not unique. This dissertation contributes to a growing literature on boom markets in non-traditional commodities that have emerged out of this shift. This dissertation, as well as articles and reports on boom markets for Himalayan caterpillar fungus (Shrestha and Bawa 2013), Latin American and African donkey skins (Purvis 2017), niche seafood products (ex. live reef fish, shark fin, sea cucumber, fish bladder, and sea urchins) (Berks, Hughs, Steneck, et al. 2006; Erikson and Clarke 2015; Joyce 2016), and many others, demonstrate the power of these new consumer markets to redefine human-environment relationships and challenge local natural resource governance.

The need to identify and document these new markets, as well as adequately understand, as Bebbington (2015) put it, the technologies, industries, capital, markets, and legal issues involved, should be a particularly urgent task for academics, NGOs, and activists, so that they may support poorly funded state agencies and communities with timely information. At the same time, states like Nicaragua need to adequately fund their natural resources agencies and leverage the power of the multi-level governance regime they have built to engage with indigenous peoples, collect data, and identify and manage new, and possibly non-traditional, extractive projects. This will understandably require as great deal of institution-building that will take time, the willingness of states to mitigate implementation gaps, and also the assistance of outside groups, but it is necessary for the sustainable development of natural resources and the realization of indigenous rights.

In closing, the broad goal of this dissertation was to elucidate the multi-scale biophysical, political-economic, and cultural-historical factors in the development, boom, and bust of the jellyfish fishery on the Miskitu Coast and to compare the fishery to past boom-and-bust industries and the objectives of Law 445. This dissertation demonstrates that the jellyfish boom indeed shared many broad characteristics with past boom-and-bust industries, and despite a the progressive path charted by the passage of Law 445, many past challenges still haunt natural resource governance on the coast today.

The findings of this dissertation justify a certain measure of pessimism for the future, but also hope. Law 445 suffers from serious implementation gaps that need to be addressed, but it is a promising framework. The real promise, however, lies with local residents. Krukira residents successfully solicited a JPF independent of INPESCA and Tuapi was able to negotiate and play competing JPFs off one another to gain more benefits. These actions, I believe, demonstrate agency and the potential for local level natural resources governance if properly supported. Furthermore, the people of the Miskitu Coast are resilient. The failure of the jellyfish fishery was disheartening for the JPF communities, but not devastating. As the grandfather in my homestay commented, “As long as you have a fishing net, you will never go hungry in Tuapi.” (Figure 34). Case in point, the day after the MCASSA call announcing their departure, the residents of Tuapi were at work making the best of a bad situation. This is the story of the coast's history in a microcosm. Through one boom-and-bust industry after another, Miskitu Coast residents have demonstrated grit and persistence, and the failure of the short-lived jellyfish fishery will not change this.

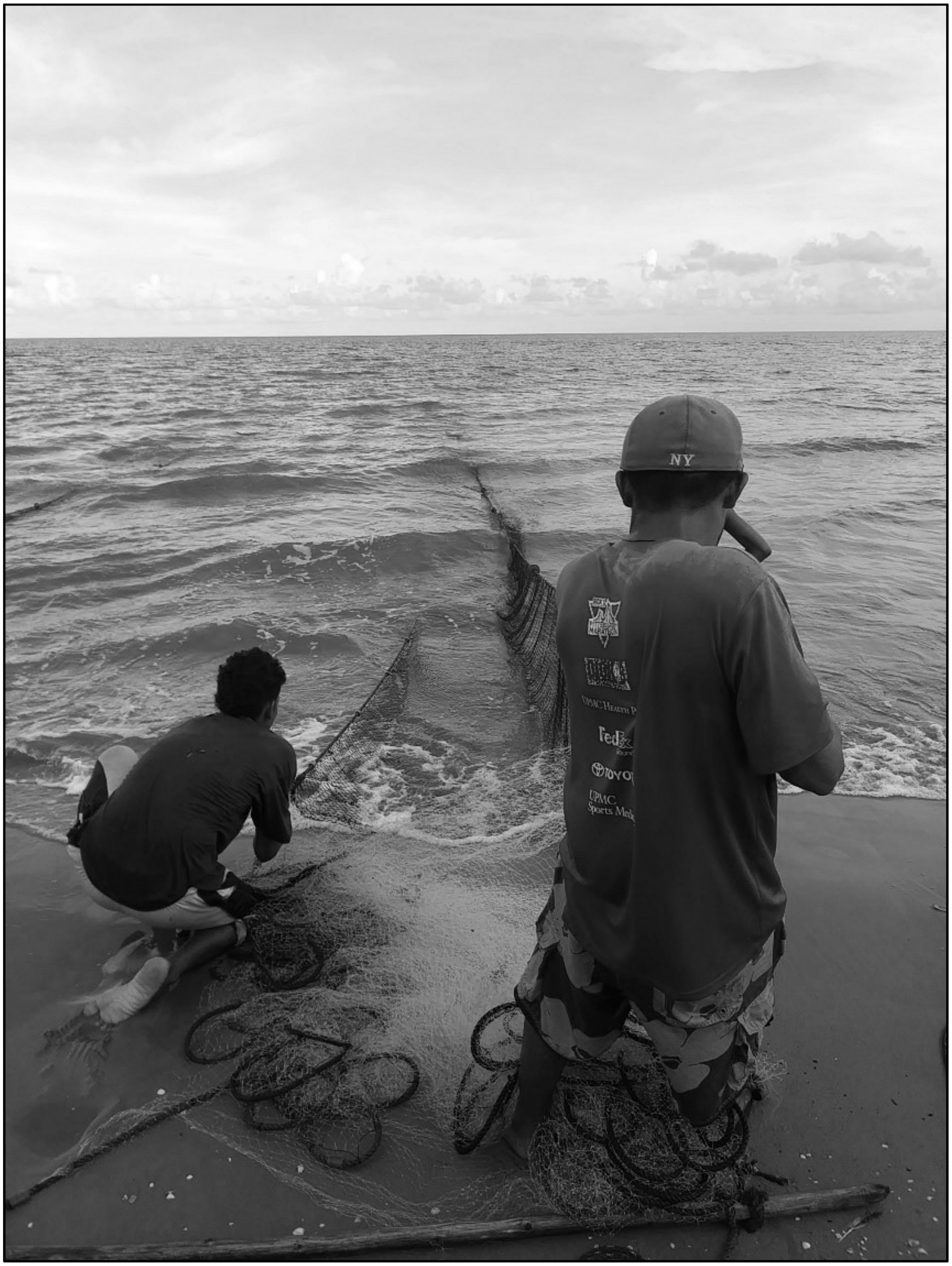

Figure 34: Two Tuapi Fishermen.

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APPENDIX: HOUSEHOLD SURVEY

PARTE 1: DATOS DEMOGRÁFICOS **Fecha__________** **Barrío___________________**

Adultos del hogar que viven en la casas ahora (18 Años De Edad O Más)

Nombre	SEXO M/F	EDAD	ETNICA	CASADO	Relación al Jefe(a) de la casa	¿Qué se dedica?	Nivel de Educación	¿Ha trabajado en la industria de medusas? ¿Si afirmativo, en qué papel?	¿Si afirmativo, en cuáles años trabajó en la industria?

Personas que viven fuera de Tuapi y apoyar económicamente el hogar. (Remesas)

Nombre	SEXO M/F	EDAD	ETNICA	Relación la Jefe(a) de la casa	¿Qué se dedica?	Años de Educación	¿Dónde vive?	¿Si se creado en Tuapi, en que año sale la comunidad?

PARTE 2: DATOS ECONÓMICOS

1) **Identifique las ACTIVIDADES ECONÓMICAS (Para Ganancia) que apoya el hogar y estimar el promedio ingreso mensual por cada actividad.**

ACT. DE CASA Y COMUNIDAD	Ingreso Mensual	ACTIVIDADES DE LA COSTA	Ingreso Mensual	ACT. CIVIL O PROFESIONAL	Ingreso Mensual
Alquila de Propiedad		Buso		Maestro de Escuela	
Artesanía		Nasero		Administrador de Escuela	
Corte Confección		Pescador del Mar		Enfermero	
Dueño(a) de Pulpería		Colector de Almeja		Doctor	
Lavadora de Ropa		Motorista		ENACAL (Bomba de	
Oficios Domésticos		Aquila un Barco		Abogado	
Partera		Comercio Regional			
Pastor de la Iglesia				**ACT. DE LOS OBRADORES**	
Policía Comunal		**ACTIVIDADES DEL CAMPO**		Albañil	
Reparación de Materiales de Casa		Venta de Productos de Agricultura		Aserrador de Madera	
Venta de Comidas y		Ganadería		Carpintería o Ebanistería	
Venta de Leña		Cria de otros		Obrador de Construcción	
Reparación de Barcos		Jornalero de Campo		Mecánico	
Oficios de la					
		OTRAS ACTIVIDADES			
TRABAJO CONTRATADO		Pensión o seguridad social			
Empleo con un ONG		**Remesas de Familia o Amigos**			
Empleo en Trabajos		Otra Actividad			
Motorista					

2) **Identifique las ACTIVIDADES SUBSISTENCIAS que apoyan su hogar. Haga un 'X' en las s que aplican.**

Agricultura-Plantación	Ganadería	Cría de Otras Animales
Arboles de Fruta	Productos del Mar (Pescado, almeja…)	Otra. Explicar.

3) **¿De dónde su hogar obtener la mayoría de sus alimentaciones?**
☐Actividades subsistencias ☐ Un mercado ☐ Igual los dos.

4) **¿Cuál de los siguientes tiene en su hogar? (escriba el número de cada cosa)**

	#	Año Compra		#	Año Compra		#	Año Comprado
Otra Casa			Computadora			Dori/velero		
Estufa de gas			Televisión/Satélite			Cayuco/canoa		
Refrigerador			Teléfono de casa			Panga o Pompín		
Bomba de agua (Casa)			Teléfono celular			Bicicleta		
Tanque para agua			Trasmallo/gill net			Motocicleta		
Estéreo			Chinchorro/siene			Carro o Camioneta		

5) **¿Cuántos cuartos tiene su casa? _______ ¿Cuantos Edificios tiene? _______ ¿Qué año construyo su casa? _______**

6) **¿Estilo de construcción:** □Cemento □Madera sin poste □ Minifalda □Madera con poste □Madera con poste de cemento □Otro, explicar: ____________________________

7) **¿Ha hecho algún remodelaciones o aumentaciones desde Huracán Félix 2007? Si afirmativo, que año hizo. ________**

PARTE 3: ACTIVIDAD DE LA INDUSTRIA DE MEDUSAS.

8) **¿Cuándo las plantas se funcionamiento, aproximadamente cuanto fue el ingreso semanal de su hogar de trabajo de la planta?**

□Menos de 1000 C. □1000 a 3000 C. □3000 a 6000 C. □6000 a 9000 C. □9000 a 12000 C. □Más de 12000C

9) **¿Cuándo las plantas se funcionamiento, aproximadamente cuanto fue el ingreso semanal de su hogar de pescar de medusas (pescadores)?**

□Menos de 1000 C. □1000 a 3000 C. □3000 a 6000 C. □6000 a 9000 C. □9000 a 12000 C. □Más de 12000C

10) **¿Utilizan una panga, cayuco, velero o pompin para sacar medusas? (marque todo lo que corresponda):**

□panga □cayuco □velero □pompín □nadie utiliza □nadie saca medusa

11) **¿Utilizan un gillnet o seine para sacar medusas?** □trasmallo/gill net □ chinchorro/seine □nadie utiliza □nadie saca

12) **¿Si utiliza una panga, cayuco, velero o pompin, para sacar medusa, de dónde lo consigue?**

□ Somos los propietarios □ Trabajar con Familia o Amigo que tiene □ Prestar de Familia o Amigo (Sin Pago de Dinero) □ Alquilar (Pago de Dinero) □Trabajar para el propietario (SalaRío) □Otra:________□No usa

13) **¿Si utiliza una gillnet o seine para sacar medusa, de dónde lo consigue?**

□ Somos los propietarios □ Trabajar con Familia o Amigo que tiene □ Prestar de Familia o Amigo (Sin Pago de Dinero)
□ Alquilar (Pago de Dinero) □Trabajar para el propietario (SalaRío) □Otra:________________ □No usa

14) ¿Si utiliza, donde vive el propietario de la panga, cayuco, velero, o pompín?
Comunidad______________________________

15) Por favor, responda a las siguientes afirmaciones. Marque una "X" en el espacio que mejor se aplique.

	Totalmente de Acuerdo	**Estar de acuerd**	**Neutral**	**Estar de Desacuerdo**	**Totalmente en Desacuerdo**	**No Opinión**
Las relaciones entre las plantas y la comunidad han sido bien y justo.						
Creo que la industria ha dañado el medio ambiente.						
La industria de medusas ha sido beneficio a la comunidad						
La industria de medusas ha sido benéficio para mi hogar						

Notas:____

16) ¿Produce regularmente miembros de su casa algunos de estos productos del mar para vender?

□ Langosta □ Buche de pez □ Pepino □ Aleta de tiburón □Tortuga □ Pescado □ Almeja □ Chacalín □Caracol

17) ¿Sí venden productos de mar, donde vender y a quién?____

18) ¿Saben de trabajadores de otras comunidades que trabajaron en las plantas en Tuapi? ¿Si afirmativo, qué comunidades?

____
____

19) ¿Saben de pescadores de otras comunidades que vendieron medusa en las plantas en Tuapi? ¿Si afirmativo, qué comunidades?

____
____
____