The Sea Urchin Fishery in Grenada:
A Case Study of Social-Ecological Networks

by

Roxann Lee Nayar

A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

in partial fulfilment of the requirements of the degree of

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Clayton H. Riddell Faculty of Environment Earth and Resources

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Of

Master of Natural Resource Management

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Abstract

This thesis explores the white sea urchin (*Tripneustes ventricosus*) or the "sea egg" fishery in Grenada prior to its closure in 1995. It is a case study examining the social-ecological networks of the fishery to identify the participants and their networks with consideration for the multitude of challenges and issues facing small-scale fisheries and their subsequent management. Improving governance and using social network analysis to understand social structure and features may improve the likelihood that an alternative to the prevailing centrally-controlled management strategies can be found and be more effective.

The sea egg in Grenada is most commonly found in near shore habitats along the east and southeast coasts from River Antoine to Calliste. The sea egg fishery was closed in 1995 after it collapsed following a period of increasing harvest aimed at meeting local and export demand.

The research was undertaken in Grenada during the summer of 2008 using a methodology that began by meeting with dive fishermen and conducting participatory observation while accompanying them in reef fishing. This was followed by semi-structured interviews with divers, fisheries officials and marketers. Data were also obtained through a review of fisheries documents and by participating in a survey of sea egg fishing areas undertaken by Grenadian fisheries officials and dive fishermen.

Prior to closure, the commercial sea egg fishery in Grenada was mainly comprised of young men ages 15-35 who dove with snorkel, fins and mask, using rowboats to reach productive sea egg grounds. Sea eggs were sold locally along the roadside roasted in the shell or raw packed in plastic bags. They were exported by plane, packed raw in containers or plastic

bags through a small number of agents based in southern Grenada and whose major market was Barbados and Martinique.

The study shows that while obtaining comprehensive network data was difficult from issues stemming from memory recall, there were social network features that were significant and have implications for managing the fishery in the future. The participant groups were noticeably distinct both when the fishery was still open and still today. While the two groups had little interaction, there were common actors or "brokers" (Bodin et al. 2006) who linked the groups by buying sea eggs for export from various fishing communities.

Should the fishery be reopened without adequate provision for management and improving governance, its sustainability may be threatened by harvesting and marketing networks that could facilitate rapid resource depletion. The identified network features, among others indicate that there is potential for an alternative approach to managing the fishery, including the potential for co-management and the inclusion of the divers in a management strategy.

Acknowledgements

This thesis would not have been possible without the guidance and support of so many friends, family and people that I've met over the last year. First, thank you to my advisors, Iain Davidson-Hunt and Fikret Berkes who made this whole experience possible by providing their knowledge, insight and funding for this research. I would like to thank my committee for helping develop such an interesting research project, I could not have asked for anything else. Thank you to Brian Davy, Patrick McConney and Derek Johnson for all of your advice, editing and pushing me to continuously improve this thesis.

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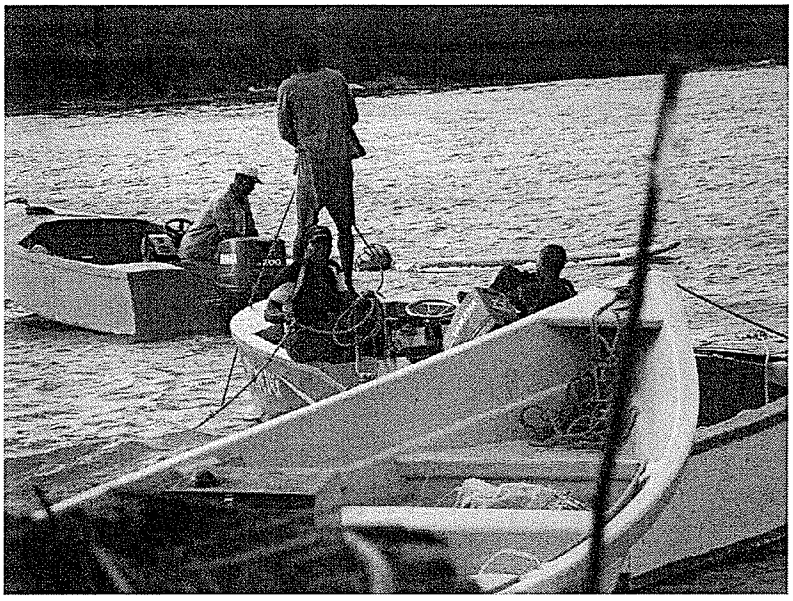
List of Acronyms

ACM	Adaptive co-management
CAS	Complex adaptive systems
CFO	Chief Fisheries Officer
FAO	Food and Agriculture Organization
FOs	Fisheries Officials
GCFI	Gulf and Caribbean Fisheries Institute
SES	Social-ecological systems
SSFs	Small scale fisheries

CHAPTER ONE- Introduction and Context





Introduction

Small-scale fisheries are an important livelihood for fishermen and for communities around the world and in the Caribbean. Near shore species like the white sea urchin (*Tripneustes ventricosus*) or the "sea egg" was enjoyed as a delicacy, providing employment and income in several Caribbean countries including Grenada, Barbados, and St. Lucia (McConney et al. 2003).

The sea egg fishery in Grenada thrived in the 1980s and the early 1990s but local and regional demand for this delicacy quickly outpaced the ability of the population to withstand the increase in harvesting pressure and it collapsed in 1994. The government responded by closing the fishery from further harvesting in 1995. It has not been reopened however increasing public pressure to reconsider the closure has required the Grenada Fisheries Division to survey the best known sea eggs grounds for signs of recovery.

This study is contributing to the growing body of literature and research about the sea urchin fisheries in the Caribbean. Grenada's experience had not been well documented and this research will focus attention on this small-scale fishery. Using a social networks perspective to understand the structural properties of the fishery will provide new insight and contribute to improving fisher participation in the management of the fishery. Enabling fishers to organize and supporting their efforts to participate in management has the potential to improve compliance while utilizing their knowledge to overcome the challenges involved in managing this fishery from a conventional management approach. Hopefully this approach will contribute to the development and implementation of a new governance that effectively addresses the challenges and uncertainty facing Grenada's sea urchin fishery.

Background

Fishing is a livelihood activity that takes place in a highly dangerous environment; it has a high level of uncertainty and it is very complex (Acheson 1981). Small-scale fisheries (SSF) are most commonly found in tropical, less-developed, coastal communities (Berkes et al. 2001; Salas et al. 2007), where its contributions to national gross domestic products (GDP) are relatively low but it remains an important livelihood; it is a significant source of employment, income and food for a large number of the world's fishers (Salas et al. 2007). While SSFs may not contribute significantly to national GDPs and operate on a scale that is local relative to commercial fishing (Berkes et al. 2001), they are still commercial enterprises and have a large impact on global fisheries and biodiversity (Bailey and Jentoft 1990). This is because small island developing states (SIDS), like those found in the Caribbean, utilize a large amount of the ocean, relative to land size, population and economy (Mahon and McConney 2004). The predominance of SSFs in less-developed countries also has implications for fisheries management because such countries often have a limited amount of resources to implement capital intensive and centrally controlled models of marine resource management (Smith and Berkes 1991; Berkes et al. 2001, Mahon and McConney 2004).

SSFs are characterized for being small operations that target multiple species, for using simple and multiple gear types, and requiring low levels of capital investment (Brown and Pomeroy 1999; Berkes et al. 2001; Salas et al. 2007). This makes entrance to the SSF sector relatively accessible for the unemployed, the landless, the poor and those with a high degree of labour mobility (Bailey and Jentoft 1990). Fishing communities in the Caribbean exhibit many of these characteristics; however, while their heterogeneity and complexity is well known it is not well understood (Breton et al. 2006). Caribbean small-scale fishers target multiple species, use

different gear types and are highly mobile as they will frequently move to different areas to follow particular fish stocks (Breton et al. 2006).

The heterogeneous nature of SSFs changes the way relationships are formed and maintained in daily interactions. Functional communities develop between fishers in SSFs and are based on shared activities such as common target species or gear types (Jentoft et al. 1998). This is in contrast to the traditional formation of communities whose network relationships are formed by the social interactions related to common history, place and/or identity (Jentoft et al. 1998). The relationships in functional communities are contractual and constantly changing (Jentoft et al 1998), furthering the complexity of small-scale fishery dynamics.

The features of SSFs that create the complexity that exist in SSFs and the limited capacity of governing authorities to effectively manage fisheries in less-developed countries (Berkes et al. 2001) suggest that an alternative theoretical and policy framework may be more suitable for fisheries management in SIDS like Grenada (Berkes et al. 2003, McConney and Mahon 2006).

Complex Adaptive Systems (CAS) and Social-Ecological Systems (SES) theories and concepts may provide the theoretical framework appropriate for modeling governance and management for SSFs (Berkes et al.2003, McConney and Mahon 2006). Fisheries governance has multiple dimensions, occurring at all levels of scale and includes all the interactions that occur to address societal issues and opportunities related to the fishery (McConney and Mahon 2006, FAO 2009). An emerging trend in SSF governance has been the decentralization of resource management and decision making and redirecting these responsibilities to the resource user (Townsend and Shotton 2008, FAO 2009).

The delegation of management responsibility falls within the conceptualization of resource management using CAS and SES thinking whereby CAS theory emphasizes shifting away from a centrally-controlled management system to one that is better equipped to deal with

complexity and change (McConney and Mahon 2006). Incorporating SES thinking is important as it emphasizes the idea that social and ecological systems are interconnected so that any separation is arbitrary (Berkes and Folke 1998).

Including these concepts into governance will address the challenges that stem from the decentralized nature of SSFs through the redistribution of power, enabling resilience, encouraging learning and adaptation, all of will contribute to a system that is more participatory for the stakeholders. Including stakeholders, resources users, their knowledge, perspectives and expertise motivates resource users and provides incentive to participate in the development and enforcement of managing the resource while simultaneously compensating for the limitations of the managing agencies (McConney and Mahon 2006).

Challenges of Sea Urchin Management

The management of Caribbean marine resources is directly impacted by social and economic forces (Breton et al. 2006), which have placed increased pressure on fishery resources and have placed many at risk (McConney and Mahon 2006). Many stocks are threatened because they do not fall under coordinated management plans, they are overexploited, or they have experienced severe habitat degradation (McConney and Mahon 2006). This trend has been illustrated by the decline of the white-spine sea urchin (*Tripneustes ventricosus*) in the Eastern Caribbean. Social, economic and ecological factors have placed pressure on this fishery in the Caribbean including in St. Lucia, Barbados, Martinique and Grenada. There have been attempts made to address these declining sea urchin populations with varying results.

To address the shortcomings that stem from the limited budgets and resources, the Department of Fisheries (DOF) in St. Lucia attempted to manage the sea urchin fishery with an approach that incorporated resource user participation (McConney et al. 2003) in data collection,

stock monitoring and license allocation (Warner 1997, Smith and Koester 2001). The sea urchin fishery in St. Lucia had been a community and family based enterprise in the 1950s and 1960s; consumption and sale was primarily at the local level (Warner 1997; Smith and Koester 2001). The market demand from Martinique that expanded in the 1970s created a new source of cash income for St. Lucian sea urchin harvesters. Buyers from Martinique approached harvesters for the sale and export of sea urchin gonads and created a shift in the sea urchin fishery, away from the family-based activity to more of an individual business opportunity that pursued this new market (Warner 1997; Smith and Koester 2001). Traditional management strategies that helped conserve sea urchin populations were gradually abandoned and it has been suggested that a combination of the increased harvest pressure, environmental degradation and extreme weather events caused the collapse of the sea urchin fishery (Scheibling and Mladenov 1987; Warner 1997; Smith and Koester 2001) and resulted in the harvest bans implemented by the DOF throughout the late 1980s and 1990s in St. Lucia.

It was found the compliance with harvesting restrictions was not uniform, despite harvester participation in the data collection and stock monitoring (FAO 2006). Certain communities were seen violating harvesting bans more than others (FAO 2006) and illegal harvesting was witnessed by other harvesters (Warner 1997). The factors influencing community compliance is not entirely certain, however shared social background and community homogeneity is thought to influence information exchange, interactions, compliance and ultimately effective participation in collaborative management strategies (Crona and Bodin 2006). In St. Lucia, there were notable differences between the communities and the physical location of the sea urchin beds being managed and some characteristics may have been more conducive to successful co-management (Smith and Berkes 1991). This is illustrative of several

complicating features characteristic in SSFs, highlighting the need for reform in fisheries governance in the Caribbean (Brown and Pomeroy 1999).

The introduction of fisheries management in the Caribbean is relatively recent and has had limited success; many species are already fully harvested or have already been overexploited (Brown and Pomeroy 1999). The poor record of fisheries management has been partially attributed to the centralized approaches introduced by former colonial governments which did not include resource users or the informal management strategies used by local fishers (Brown and Pomeroy 1999). SSFs are defined by the policy that regulates its operations and in some regions they are not given thorough consideration or else they require too many resources for proper management (FAO 09). Co-management is "essentially any governance alternative to centralized command-and-control regulation" (Townsend and Shotton 2008:1) and it may be an alternative approach that addresses these previously mentioned problems. It can address these problems by delegating decision-making responsibility and developing closer partnerships between government agencies, communities and resource users to decentralize the management of fisheries resources (FAO 2009).

Applying co-management, CAS and SES to fisheries management may be more effective in the Caribbean than conventional approaches to resource management because it recognizes the complexities within the SSF communities. It can facilitate identifying and understanding network and community interactions that impact marine resource use as well as resource user participation. It could also strengthen fisher participation in governance and contribute to the development of a management strategy that creates a sense of ownership and incentive for compliance (Jentoft 2000).

Overview of Grenada

The fieldwork research for this project was conducted on the island nation of Grenada. Grenada is located in the eastern Caribbean, located between the Atlantic Ocean and the Caribbean Sea, just north of Trinidad and Tobago. Grenada consists of twenty low-lying islands of which the three largest are Grenada, Carriacou and Petit Martinique (Mohammed and Rennie 2003).

The fisheries sector is an important contributor to employment, food security and foreign exchange for the approximately 2500 people estimated to be involved in fishing or fishing related activities in Grenada (FAO 2003). Approximately 6% of Grenada's labour force is involved in the fisheries sector and 2100 of the estimated 2500 workers within the sector are directly employed by the commercial fishing industry (FAO 2003). There has been a gradual shift away from the subsistence fishing that was prevalent prior to the 1950s to government- supported commercial fishing operations. However, Grenada's fishing sector is still described as artisanal, characterized as involving fishing households with limited capital and small vessels that take relatively short trips, and whose catches are mostly sold for local consumption (FAO 2008).
The Grenada fishing sector has also been described as "distinctly multi-species" (FAO 2000), while the landing sites have been characterized for their rural nature (FAO 2000). To summarize it has been described as being small-scale, multi-species, seasonal, multi-gear and multi-occupational (Breton et al. 2006).

By engaging in a multitude of different activities fishermen are able to lessen the effects of the uncertain and unpredictable nature that is always present while involved in a fishing livelihood (Salas and Gaertner 2004). The active involvement in so many different sectors makes obvious network connections and communication patterns difficult to identify. This heterogeneity has produced the emergence of a different form of functional network group that

diverges away from the classic family or location-based network typical of other communities (Breton et al., 2006). These shared characteristics create networks that extend beyond local community and kinship connections and provide opportunity for increased social networking and information exchange beyond typical geographic connections (Breton et al., 2006). These features have direct implications for the sea urchin fishery and other fisheries that are linked to sea urchin harvesters' livelihood activities in Grenada.

Current Status of the Sea Egg Fishery in Grenada

Sea eggs were harvested for personal consumption by men, women and children of all ages. Commercial diving emerged with the growing market demands of the late 1980s and early 1990s and primarily young men would go out to dive with snorkel, fins and masks and later, with scuba, to harvest sea eggs for local and export sale (Isaac 1990).

Although this fishery emerged as an important livelihood activity, it was never formally managed (Isaac 1990) and remained an activity that had social and economic benefits by providing income, food and employment as an informal economic activity (Floodman Becker 2004). During this time, the fishery had experienced heavy harvesting pressure from divers who were selling sea eggs locally and to exporters for sale to other islands such as Barbados and Martinique. At this time there were no seasonal, harvesting or gear restrictions in place to control the quantity of sea eggs being taken.

Currently, the ban is still in place but illegal harvesting is occurring. The Fisheries Division had been able to prosecute some poachers who have been caught, however, poaching is ongoing (Isaac, pers. comm., 2008) There is also increasing anecdotal evidence and reports from fishermen that the sea egg stocks are recovering and have returned to numbers that many feel could sustain a limited amount of harvesting. The Fisheries Division is starting to feel pressure

from fishermen to consider lifting the ban so that some harvesting can take place. However the Minister would like scientific evidence that proves that the fishery is ready to be opened and the Fisheries Division has begun a project to assess whether the primary sea egg grounds have in fact recovered. Part of this project is a sea egg survey where the Fisheries Officials in Grenville coordinated and executed a sea egg population survey along the east coast of Grenada. Using input from local fishermen, these Fisheries Officials traveled to the primary sea egg grounds identified prior to the project and used scuba and snorkel gear to dive the sea egg grounds and conduct transects, counting the amount of sea eggs and assessing the density of clustering occurring at each site.

By mid-August, nine sea egg grounds off Grenville's coast and three sites off the coast of Carriacou had been surveyed. In October, the Fisheries Division revealed that the government is considering opening the sea egg season for four weeks in 2009 (Isaac, pers. comm., 2008).

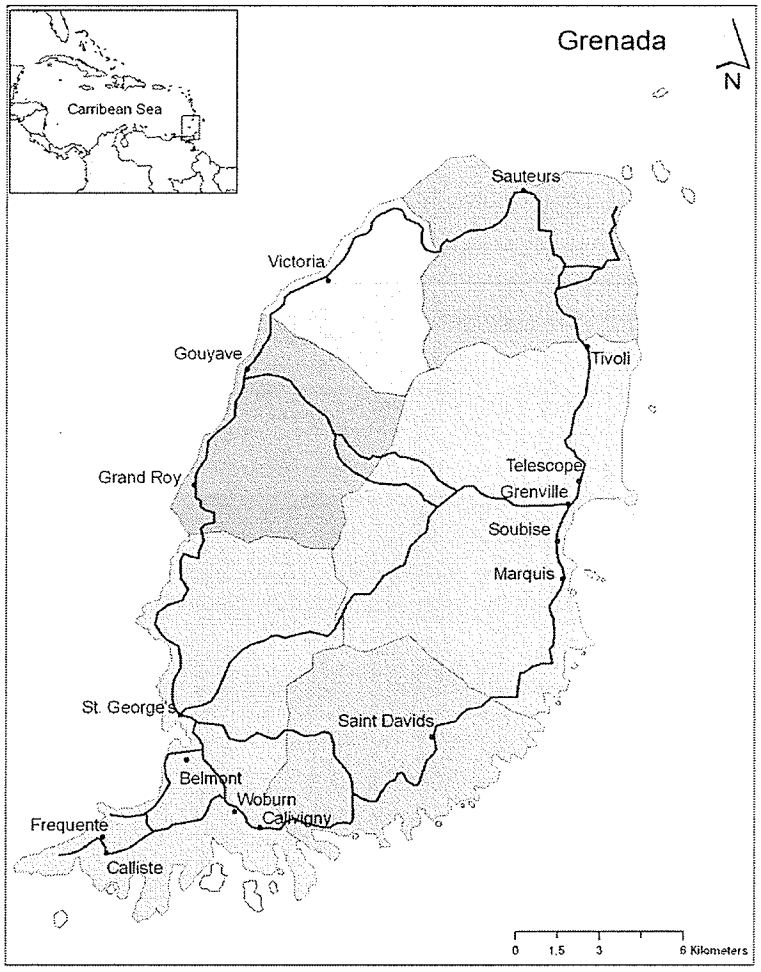


Figure 1: Map of Grenada

Purpose

The purpose of this study was to identify the formal and/or informal organization of Grenadian sea urchin harvesters through an analysis of their social-ecological networks. This analysis was to provide the basis for suggesting the role such networks might provide for the possible co-management of the sea urchin fishery.

Research Objectives

The following objectives were used to organize the research:

1. Identify the actors that were in the sea urchin harvester network.
2. Analyze the linkages amongst the actors.

3. Describe the shared sites of interaction and exchange amongst the actors.
4. Determine the implications that the social-ecological network has for sea urchin co-management.

General Methods

A socio-ecological networks approach was used for this study to identify the network actors and linkages of a Grenadian sea urchin harvester network. A single-case study approach as described by Yin (2003) was used to guide this study because it is an appropriate means of addressing the research objectives as a comprehensive research strategy that includes phenomena, context, data collection and analysis (Yin 2003). Case studies are able to contribute to the understanding of individuals, groups, organizational features, social and political phenomena that allows the researcher to retain meaningful characteristics within a "real-life" context, while incorporating the flexibility necessary to collect data for this type of study (Yin 2003: 2). The single-case study approach was used to study the different units within the networks (Yin 2003) as this provided an effective means of analyzing the networks and communication connections between harvesters.

The case study as a research strategy provides the opportunity to use the wide range of data sources (Yin 2003). Yin (2003) lists six approaches for data collection which include: documentation, archival records, interviews, direct observations, participant observations and physical artifacts. Several of these methods were used throughout the data collection process to ensure consistency and reliability of the data collected (Yin 2003). This multi-method technique is also referred to as triangulation, where by using different sources of data that converge in a "triangulating fashion" allows the investigator to identify corroborating evidence, or inconsistencies in the data (Yin 2003: 97). For this study, to gain insight into network

connections between fishermen and those related to the sea urchin fishery, the main research methods that were applied included: document review, interviews, participant and direct observation.

Scholarly and Practical Significance

This study will contribute to the research of the Marine Resource Governance in the Eastern Caribbean (MarGov) project which looks to understand, "governance related to small-scale fisheries in the eastern Caribbean mainly through network analysis" (McConney and Mahon 2006:1). These results are used to determine how marine resource governance projects can be made more adaptive and resilient for stakeholders at different scales. The MarGov project objectives are:

1. Construct a conceptual framework for applied research on marine resource governance in the Caribbean using CAS and SES perspectives.
2. Investigate governance in the context of small-scale fisheries in the eastern Caribbean primarily using cross-scale network analyses with emphasis on features that enhance resilience and adaptation.
3. Increase the capacities of partners to undertake their own research and use the results by involving them in the participatory applied research.
4. Facilitate, through outreach and information, the incorporation of the research results into initiatives related to marine resource governance for fisheries
5. Establish applied research into marine resource governance as a new demand-driven program (McConney and Mahon 2006: 17)

This research will provide data to help these objectives, with special consideration for objective 4 of the project while also providing a practical contribution to the current discussion on how to manage the sea urchin fishery in Grenada. A paper (Nayar et al. 2008) that described the fishery and gave a general overview of the results was presented at the 2008 Gulf and Caribbean Fisheries Institute (GCFI) conference in Guadeloupe. It will also contribute to a working report on the sea urchin fishery in the Eastern Caribbean, being compiled by the Food and Agricultural Organization.

By describing the social-ecological network through the identification of actors, linkages and sites of information exchange this study provided insight into the implications that the informal and/or formal patterns of organization will have for potential sea urchin co-management. It is hoped that after this summer's government review of historical harvesting and marketing arrangements and the population survey that was conducted in August, the goal of creating a new management strategy for the sea urchin fishery will be realized (Isaac 2007, pers. comm.).

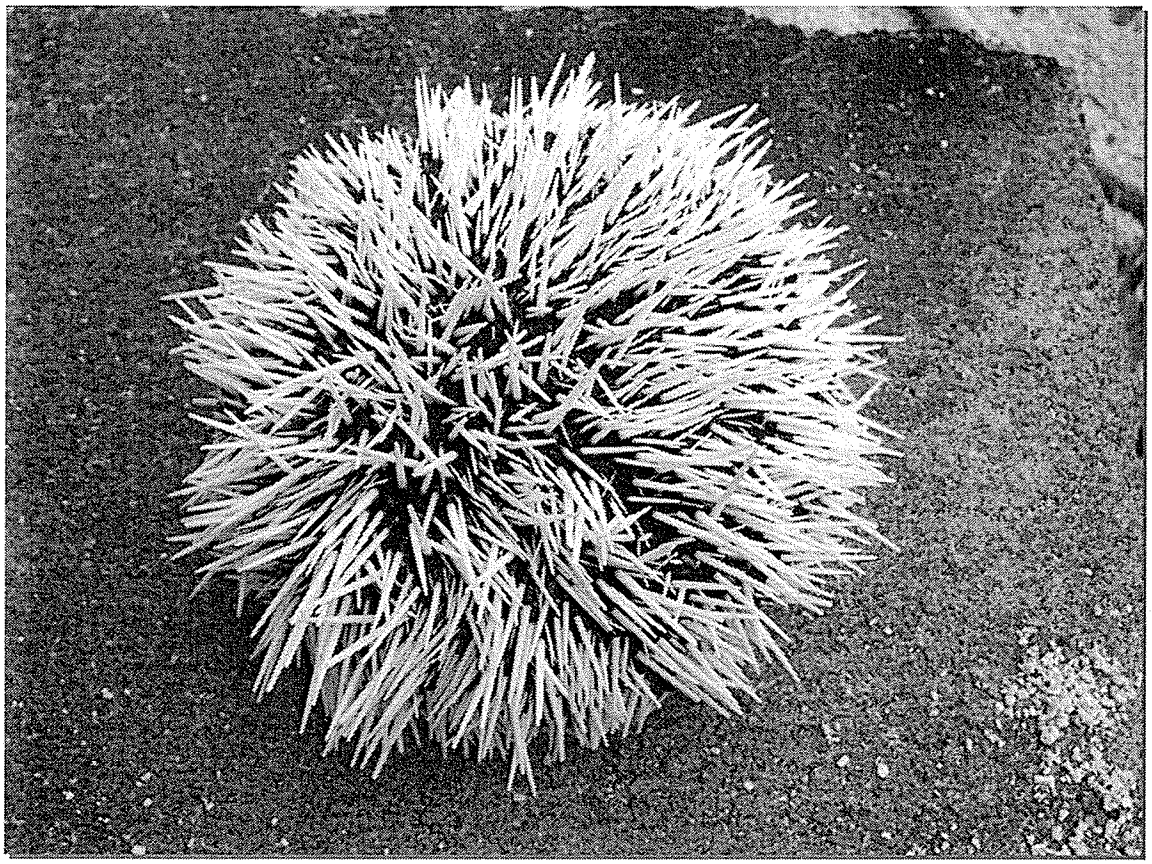
The use of the social-ecological networks approach is a developing area within the study of co-management that draws upon concepts and theories from Complex Adaptive Systems and Social-Ecological Systems research. As in all instances where theory is being built building empirical knowledge through case study research is necessary. This case study has set out to provide empirical data in order to contribute to the middle range theories regarding adaptive co-management (Armitage et al. 2007).

Organization of the Thesis

This thesis is organized into 6 chapters followed by references and appendices. Chapter 1 provides the introduction and background to the project and the sea egg fishery. Chapter 2

presents a literature review further detailing the background of the theory and concepts related to this study. Chapter 3 describes the methods and methodology used for the fieldwork conducted in Grenada. Chapter 4 presents the results from the fieldwork conducted with the participants of the sea egg fishery. Chapter 5 provides discussion on the results and the implications the findings have for the fishery and its future. Chapter 5 concludes with examining how the research objectives were met and summarizing the recommendations for managing the fishery.

CHAPTER TWO: Literature Review



Introduction

Sea urchin biology, ecology and harvesting activities have contributed to the current problems facing this small-scale fishery in the Caribbean. This chapter reviews the literature regarding the white sea urchin, co-management, livelihood diversification and social network analysis to introduce the reader to these concepts and approaches and draws with the underlying theme of uncertainty through various section. The presence of uncertainty is an indication that adaptive co-management, livelihood diversification and understanding the network features of the fishery are necessary to develop an effective governance system and a management strategy for this fishery.

Sea Urchin Habitat, Ecology and Harvesting

Sea urchins are an important herbivore in seagrass ecosystems, their foraging activity and interactions with algae and macrophyte communities have been well documented by Lawrence (1975) and Tertschnig (1989). They are a significant part of seagrass ecosystems and play an important role in determining community structure and function (Tertschnig 1989; Lawrence 1975, Lawrence 2001). While there are many species of sea urchin occurring throughout the world very few species are eaten. Possible reasons for the preference of some species over others include accessibility, palatability and cultural values that vary for each species (Lawrence 2001). There are three members of the *Tripneustes* species, which are all very similar. *T. ventricosus* is the species of white sea urchin, locally referred to as sea eggs, which are harvested in the Caribbean.

Description

The white sea urchin (*Tripneustes ventricosus*) is considered large for sea urchins. It is hemispherical in shape and its test can reach up to 150 mm (Weintraub 2003). Kehas et al. (2005) has documented two types of *T. ventricosus* in the Caribbean and distinguishes them as

"wild types" and "albino". "Wild-type" sea urchins have white spines with dark brown or purple pigmentation in the epidermis, podia (tube feet) and pedicellaria. "Albino" sea urchins are lacking the dark pigmentation and live in shallow waters while "wild type" urchins are found at increasing depths.

Habitat and Feeding

T. ventricocus is found in relatively shallow waters, on average in depths from 1-10m (Smith and Koester 2001), however they have been found at depths of 30m (Mortensen 1943, cited in Lawrence 2001). They are distributed throughout the world, in the Caribbean, southern Florida, Brazil, Trinidad to the west coast of Africa (Mortensen 1943, cited in Lawrence 2001). *T. ventricocus* habitat is primarily in turtle seagrass ecosystems (*Thalassia testudinum*) and they also occur in algal beds, sandy bottoms; around reefs, coral rubble and/or rocks (Kehas et al., 2005) and population density has been found to decrease with increasing distance from reefs (Tertschnig 1989). *T. ventricocus* can grasp substrate tightly, allowing it to inhabit "high energy habitats" (Weintraub 2003), where hydrodynamics are strong (Weintraub 2003).

The main food source for *T. ventricosus* is turtle seagrass (*Thalassia testudinum*), and they have been observed feeding on seagrass blades both during the day and at night (Tertschnig 1989). Other sources of food may include algae and sand, which Lewis (1958) found in the stomach contents of *T. ventricosus* (Lawrence 2001).

Reproduction and Development

T. ventricosus has separate sexes and reproduction occurs when male and female urchins spawn. While spawning occurs all year, the majority of spawning occurs between the spring and summer months (Lewis 1958, cited in Lawrence 2001). In Barbados, they have been seen moving into groups from the surfaces of rocks or from grassy, flat surfaces to under rocks and ledges

(Lewis 1958 cited in Lawrence 2001); it is thought that these are reproductive groupings (Scheibling and Mladenov 1987).

Fertilization occurs as the eggs float in the water and the larvae will float in currents for up to four weeks but need to settle on substrate to develop. Ocean currents play an important role in the dispersal of developing larvae, where they can be carried great distances away from the parent population or can remain in the same area. Juvenile development that follows the April to August spawning season occurs in September and October. *T. ventricosus* have a lifespan of approximately three years. Recruitment and population sizes are extremely variable, and little is known about the causes of the population cycles, making it difficult for any predictions about future population to be made for management programs (Smith and Koester 2001).

Growth in *T. ventricosus* is relatively rapid, they grow 60-80mm in the first year and they reach 50mm in the first five months of life (McPherson 1965 cited in Lawrence 2001). Growth slows in early summer (Lewis 1958, cited in Lawrence 2001) and larger individuals will experience little or no growth during the summer months (McPherson 1965 cited in Lawrence 2001). Reasons for this are unknown but are thought to be caused by transaction costs associated with their high mobility rates or food availability (Tertschnig 1989).

Environmental Responses and Mortality

Sea urchins have numerous adaptive responses to different environmental triggers. The *T. ventricocus* exhibits covering, dispersal and aggregation behvaviour depending on the situation. Sea urchins that live in shallow waters, including *T. ventricosus,* demonstrate covering behaviour during the day (Kehas et al., 2005). They use their podia (tube feet) to gather and hold materials taken from the substratum onto their aboral surface. Materials that will be used include turtle grass fragments, shells and rubble and at night the materials are removed. Kehas et al. (2005) has noted that the albino *T. ventricosus* covers itself more frequently and rapidly than the wild-type;

indicating that perhaps this behaviour provides protection from solar radiation, as there is no evidence that covering reduces predation risk.

T. ventricosus is considered to be highly mobile and a wandering species of sea urchin. While they do not typically form groups, they have been seen to aggregate in groups around food. However, when confronted by predation risk, for example, in the presence of spiny lobster, helmet conch (*Cassia tuberosa*) (Tertschnig 1989) and starfish (*Oreaster reticulus*) (Scheibling 1982, cited in Lawrence 2001); or when they receive damage-alarm cues from the coelmic fluid released by another damaged sea urchin (Lawrence 2001), they exhibit a flight reaction and disperse away from the threat (Vadas and Elner 2003).

T. ventricosus is sensitive to changes in water temperature and experience high mortality if water is too low or too high. They become sluggish if water temperatures reach 33C and will die if the water reaches 40C (Colon- Jones 1993 cited in Lawrence 2001). Other causes of mortality are the risk of being swept ashore from rough wave action or storm surges; large numbers of kills have been found following intense storms (Lilly 1975, cited in Lawrence 2001).

Sea Urchin Interactions in Seagrass Communities in the Caribbean

Studies regarding sea urchin grazing and population abundance in kelp and turtle grass beds on the Pacific coast of British Columbia, Canada and California, USA; the Atlantic coast of Nova Scotia, Canada; and along reefs in the Caribbean have largely been focused on a few causes for sea urchin population proliferation that has led to overgrazing (Tegner and Levin 1983). While the creation of the urchin-dominated barren grounds (Lawrence 1975) is considered fairly widespread in areas off the coast of California and Nova Scotia, the overgrazing of seagrass beds has only been officially documented one occasion in the Caribbean (Camp et al., 1973, cited in Tertschnig 1989) but it is not the only time it has been witnessed. These barren grounds take the form of "halos"; bare sand that separates reefs from seagrass beds.(Hay 1984). In areas of high

sea urchin densities and seagrass grazing there was also high fishing pressure on reef fish. These reef fish were also important herbivores in the seagrass communities and their absence may have contributed to an unusually high abundance of sea urchin populations (Hay 1984).

The increased pressures placed on nearshore species by the fishing industry impacts both sea urchin predators and competitors in their respective communities. It is apparent after the examination of predator-prey and environmental factors, that fishing pressure is a significant contributor to sea urchin population abundance and potential for overgrazing. This indicates that the continuously increasing pressure placed on various fisheries not only impacts the target species but also impacts herbivorous species like the sea urchin and their ecosystem structure.

Sea Urchin Harvesting in the Caribbean

The white sea urchin harvest is an activity that occurs throughout the Caribbean (Smith and Koester 2001). Since white sea urchins are found in shallow waters, usually no deeper than 10m, it is a resource that is readily accessible without requiring much investment in equipment for harvesting (McConney et al., 2003).

Harvesting sea urchins did not provide full time employment for divers in Grenada (Isaac 1990) however it supplements incomes while in other places, like Barbados, it may have contributed in drawing people from a variety of backgrounds into the fishery (McConney et al. 2003). McConney et al. (2003) distinguished between four categories of divers in Barbados: seasonal fishers who targeted other species throughout the rest of the year; casual divers who would dive opportunistically; full-time divers who dove for a variety of demersal species and finally holiday divers who dive on their vacation to supplement their incomes. In Grenada, sea urchin divers were mostly male, ages 16-35 and who were already involved in fishing or were otherwise unemployed (Isaac 1990).

Divers will use masks and snorkels (to free or bare-wind dive) or scuba diving equipment to harvest sea urchins. In Barbados divers generally reached sea urchin grounds by motorized boats, picking urchins by hand or using pieces of iron ("rakes") to extract urchins from crevices. While harvesting is conducted, harvested sea urchin are kept in floating crates or net bags and then placed in netted bags or old sugar bags for transport back to shore (McConney et al., 2003).

Historically, the harvesters in Barbados had used several different indicators to assess the readiness of the sea urchin population for harvesting. Five techniques have been documented by McConney et al. (2003) and were used to manage the sea urchin population:

1. Testing for ripeness: harvesters would select a few individuals from a sea urchin patch and cut them open to see if they were "ripe". If they were not, the harvesters would leave the area and return at a later time.
2. "Cutting the edge": harvesters knew that generally sea urchins on the edges of clusters were riper than those in the centre. The ones on the edges would be harvested, giving time for the urchins in the centre to ripen.
3. Leaving large individuals ("chubbing"): exceptionally large individuals would be left to reproduce.
4. Relocating sea urchins: harvesters would relocate urchins from one area to another that had been overharvested.
5. Burying urchin husks: harvesters bury the empty sea urchin husks on the beach with the belief that sea urchins will not inhabit areas where there are broken shells in the water.

Harvesting the white sea urchin has been an important livelihood activity, source of food, employment and a source of cash income for harvesters in the Caribbean (Warner 1997). The first documented case of sea urchin management in Barbados was in 1879 where the government

closed the fishery to harvesting between May and August in efforts to conserve the species (Scheibling and Mladenov 1987). However it was the co-management of sea urchin harvesting in St. Lucia that has brought the most recent attention to this fishery's problems and the efforts that have been taken to prevent its collapse across the eastern Caribbean. In both St. Lucia and Barbados, illegal harvesting has been documented and while the causes for the decline in urchin in abundance has not been confirmed, it is likely there are multiple factors involved and the persistent illegal harvesting may be contributing to the slow recovery of the fishery (Scheibling and Mladenov 1987, Smith and Koester 2001).

Co-management of Fisheries Resources: Introduction and Challenges

Historically, fisheries in the Caribbean have not been the focus of management strategies; currently many fisheries, especially nearshore fisheries, have already been heavily harvested or overexploited (Brown and Pomeroy 1999). Fisheries management had been modeled after the central, top-down approach introduced by former colonial governments and is commonly used around the world today. This method has not adequately addressed the complexity or the socio-economic importance of Caribbean fishing communities and the fisheries sector, especially in the small-scale fishery sector (Brown and Pomeroy 1999). Caribbean fishermen and the fishing sector are characterized by being small-scale; utilizing multiple gear types; targeting multiple species; minimal investment in equipment and capital; for the high level of spatial mobility and the seasonal nature that is dependent on resource availability (Salas et al. 2007; Breton et al. 2006). The combination of these characteristics along with the transboundary nature of tropical fisheries species, the frequent inability for many governments to regulate access to harvest areas and the limitations to enforcement make centrally managed fisheries relatively ineffective. In addition, the limited number of personnel and resources needed to monitor, manage and enforce

management in the Caribbean, further challenge the management capacity of governing authorities (Brown and Pomeroy 1999, McConney et al. 2007).

An alternative to conventional resource management that is becoming increasingly common in fisheries management is collaborative or co- management where stakeholders and government work together to solve resource management problems (Silver and Campbell 2005). Adaptive co-management is defined as, "a long term management structure that permits stakeholders to share management responsibility within a specific system of natural resources and to learn from their actions" (Ruitenbeek and Cartier: 8, cited in Armitage 2007). Adaptive co-management creates partnerships among government, stakeholders and resources users; power is shared and resource management problems are dealt with in a problem-solving process (Carlsson and Berkes 2005). Adaptive co-management is better equipped to deal with multiple interests and sources of knowledge while able to make provisions for ecological uncertainty and changes to social and economic circumstance by being flexible and able to deal with change and make adjustments as need (Carlsson and Berkes 2005).

However, the success of adaptive co-management and conventional management institutions is not guaranteed, Ostrom (1990) outlines eight conditions or design principles that are conducive for successful co-management of common-pool resources. These eight design principles are features that were documented by Ostom (1990) in long lasting common-pool resource management strategies and are said to be necessary if co-management is to be successful.

Understanding co-management systems as networks that consists of a variety of actors (Carlsson and Berkes 2005) is relevant for this discussion given the diverse range of relationships amongst the sea urchin networks and between fishermen and others in the fisheries sector. The number of different actors in the sea urchin fishery, including, divers, fisheries officials, exporters

and consumers, create networks that link a variety of people, allowing information to move through different groups.

An important component to developing co-management systems is the inclusion of knowledge provided by fishermen. This often gives detailed information about cultural and social values but also information about specific fisheries. Continuous interaction and learning with the environment has been proven to be a source of information that complements scientific knowledge (Johannes 1998, Johannes et al., 2000) and can help improve decision making in management strategies (Bergmann et al., 2004; Silvano and Begossi, 2005). Including fishermen and stakeholders is an important component of co-management and is a critical requirement if a fisheries management strategy will succeed (Jentoft 2000). If fishermen do not feel a management strategy is legitimate or in their best interests, obtaining compliance is very difficult. This may occur when fishermen were not fully included in all stages of the planning process; if they feel their interests are not fully addressed (Jentoft 2000), if project objectives were unclear (Clark et al., 2002, cited in Lundquist and Granek 2005); a proper understanding and consideration of social and cultural values is not included (Bailey and Jentoft 1990), or they do not feel that their input is sufficiently included in the management plan (Silver and Campbell 2005).

Another criterion for successful co-management is voluntary compliance, which must be gained in many adaptive co-management situations for success, especially if resources are limited for government enforcement (Cinner et al., 2005, Granek and Brown 2005, Lundquist and Granek 2005). Another design principle identified by Ostrom (1990) finds this as well. Ostrom (1990: 90) stipulates that there must be conditions that allow for active monitoring and mechanisms in place for "graduated sanctions". Enforcement of management policies is limited in the Caribbean because governments often lack sufficient funding, resources and staff to

thoroughly monitor many areas that already may be remote or inaccessible (Brown and Pomeroy 1999). Having a system in place that allows for the resource users to organize and participate in conflict resolution will compensate for the shortcomings of governing authorities while also providing incentive for resource users to participate in a management system that can persist over time (Ostrom 1990)

Using participant input and knowledge from fishermen, in fisheries management has been recognized as a necessity for the success and compliance with a management strategy (Brown and Pomeroy 1999, Lundquist and Granek 2005, Silver and Campbell 2005). The invaluable information fishers possess about socio-economic and cultural values; interactions between fishers and others involved in the fishing sector, knowledge about species and the fisheries, and knowledge about traditional management strategies will help make fisheries management strategies more effective in the long term (Silver and Campbell 2005). Simply soliciting this information is not enough to earn compliance from the fishermen; incorporation of the knowledge they contributed into management decisions is necessary to acknowledge that their interests are recognized and to retain their support and future participation in fisheries management (Silver and Campbell 2005).

Adaptive co-management as a management strategy can facilitate the complex requirements of fisheries management by creating a platform where information is exchanged between researchers, resource users and government, and where the complex network structure of the relations between these actors is included in the problem-solving process (Carlsson and Berkes 2005). It will also be well suited to deal with the uncertainty of the biology and variability of sea urchin populations each year. While adaptive co-management is well equipped to deal with the inherent complexity of the Caribbean fishing industry, it will not necessarily work if the right mechanisms are not in place (Ostrom 1990). Additionally, strategies must still

be legitimized from the perspective of the fisheries by applying local knowledge to make decisions relevant to local needs and interests (Jentoft 2000; Silver and Campbell 2005).

Small Scale Fisheries and Livelihood Diversification

Small scale fisheries (SSFs) are difficult to define outside of their immediate context and location, however, they share many characteristics no matter if they are commercial, subsistence, traditional or artisanal (Berkes et al., 2001). While most small scale fisheries involve some level of commercial activity, where at least the surplus catch is sold, subsistence fishing is also included in the category of small scale fishery (Berkes et al., 2001).

The small scale fishing industry provides employment opportunities for a variety of people from different socio-economic backgrounds including the landless and those with few assets and little capital. In the Caribbean fishermen are often an example of the seasonal poor (McConney et al. 2003) and since there is minimal investment required for the fairly unselective gear types used to fish a variety of species, entering the fishing sector is relatively accessible allowing for greater mobility to and from and within the sector, compared to other livelihood activities (Bailey and Jentoft 1990, Berkes et al. 2001).

The mobility, the multi-gear and multi-species characteristics of small scale fishers are all methods of diversification. Diversification is the creation and participation in a range of activities to earn a living, which is most easily measured in terms of income (Ellis 2000). While the motivations for diversification of livelihood activities may be out of necessity or by choice (Ellis 2000), it is an important strategy for small scale fishers to alleviate some of the high levels of uncertainty and variability associated with the physical and social environments of which they are a part of as fishermen (Acheson 1981). In addition to the local variability associated with physical and social processes, small scale fishers have little control over, input into, the external

forces that influence their industry such as marketing, processing and pricing which are often determined by a third party not directly involved in the harvesting activities (Bailey and Jentoft 1990).

Addressing this uncertainty can be achieved within fishing activities, by diversifying the range of capture techniques (Acheson 1981) or this can be exhibited by the diversification of livelihood activities (Ellis 2000). The diversification of livelihood activities is a strategy by which where people participate in alternative activities to generate additional income (Ellis 2000). By being multi-occupational, a common characteristic of small scale fishers (Breton et al. 2006), fishers are able to: diversify their sources of income; increase their resilience; and, decrease their sensitivity to changes and uncertainty (Ellis 2000). This adaptation also creates institutions that connect fishers, creating networks that spread the risk of natural or economic fluctuations to others in the fishing industry (Acheson 1981). By creating partnerships within crews or establishing relationships with middlemen, fishers are able to reduce the negative impacts from the uncertainty of being in fishing by sharing costs and having the middlemen invest in capital upgrades (Acheson 1981). The tendency of small scale fishers to pursue multiple target species and engage in multiple occupations connects them to a diverse range of networks that are functional; based on shared activities over larger geographical scales than traditional networks based on kinship or community ties (Jentoft et al., 1998).

This has particular importance for the sea urchin harvesters, who would have presumably been forced to seek an alternative source of income after the fishery collapsed in Grenada in 1994. The collapse of a fishery has significant economic and ecological impacts on small scale fishing activities. Overharvesting of a target species leads to changes in the species composition of catches, where commercially valuable species are replaced by less-valuable species that are still plentiful. This creates catches that are of the same quantity, but of less value (Bailey and

Jentoft 1990). Following the collapse of the Barbados sea urchin fishery, Schiebling and Mladenov (1987) found that renewed pressure was placed on the flying fish stocks compensated for lost income. This is illustrative of an adaptation technique in which adaptation is defined as a type of livelihood diversification that is under continuous change, either to increase wealth and security or to decrease poverty and vulnerability (Ellis 2000). The harvesters were able to adapt to the sea urchin fishery collapse, reducing the impact by supplementing their income with increased catches of flying fish (Scheibling and Mladenov 1987).

Whether fishers are engaging in different occupations, targeting multiple species, or adapting to fluctuations in the marine environment, livelihood diversification is an integral adaptation strategy needed to survive and cope with uncertainty (Grant 2006). Livelihood diversification is an important characteristic of small scale fisheries as it contributes to the heterogeneous and diverse nature of fishing communities and the small scale fishing industry it furthers the complex social and occupational networks that are inherent to this sector.

Introduction to Social Network Analysis

Social structures, which affect behaviour and opinions (Degenne and Forse 1999, Bodin 2006) can be described as networks of relations between people (Bodin 2006). The Social Network Analysis methodology tries to understand, "the actors and the relationships between them in a specific social context" (Clark 2006: 4) and increases the understanding of how an actor's position in a network influences their access to information, resources and opportunities (Clark 2006).

Social Network Analysis (SNA) can be used to describe social structure and phenomena like information diffusion (Bodin 2006, Clark 2006) and social power (Hanneman and Riddle

2005). These social structure features are reflected by an actor's position within a network and effects how they access information and the access of others (Clark 2006).

Understanding and identifying informal social networks, their complex interactions of communities and their subgroups can be critical for the success of the co- management of natural resources (Carlsson and Berkes 2005, Bodin 2006). This is key to understanding how information flows, whether it can move or if it is obstructed from reaching others in the network (Clark 2006). It also identifies which actors hold positions of power within a network in relation to others, which directly influences information diffusion (Hanneman and Riddle 2005, Bodin 2006, Clark 2006) and those who act as intermediaries between different groups, affecting what information reaches those who are less-connected (Clark 2006).

Social Networks and Resource Management

In some locations, fisheries resources are vulnerable to overexploitation because there are no formal controls in place that limit participant entry into the sector and because there are generally no controls that regulate the quantities caught by individual fishers (Acheson 1981). However, there have been documented cases of informal institutions that have been in existence for centuries that limit access to marine resources and regulate the rate of harvesting (Christie and White 2007).

It has been suggested that the structural properties of social networks are one important factor that determine whether successful resource management can be achieved (Abrahamson and Rosenkopf 1997, Bodin 2007). Structural properties of social networks impact how information is distributed and shared (Crona and Bodin 2006, Bodin 2007). These interactions occur at various sites of information exchange, where actors interact to exchange information, socialize, gain emotional support and to exchange stories (Bernard 2006, Grant 2006). In Gouyave,

Grenada, specific site of information exchange have been identified at fish landing sites, on the beach and at local rum shops (Grant 2006). Marketplaces are another site of interaction that allows harvesters, traders, sellers and anyone else involved in a network to interact (Cunningham 2002). Sites of information exchange provide insights into the formal and informal social institutions that the harvesters may belong to (Grant 2006) and these locations in turn, will have impact to what degree and how information is exchanged. These factors will impact the ability of a community to take collective action and the strength of their adaptive capabilities (Crona and Bodin 2006 and Bodin 2007).

The implementation of co-management is made possible through social networks (Tompkins and Adger 2004). It is the informal or formal leadership within a network that builds group cohesion, enables the production of consensus towards a common goal (Johnson et al. 2003) and it facilitates collaboration on resource management efforts (Bodin et al. 2006). Social network analysis is a way to study social structure (Bodin et al. 2006) and because individuals cannot be studied independently of their relationships with others. Studying social structures provides the insight necessary to understand the foundation of an individual's opinions and behaviour (Degenne and Forsé 1999).

Varying features of social structure, such as the position of an individual within a network, has varying effects on other aspects of social structure and consequently on potential resource co-management (Bodin et al. 2006). For example, the social position of the Deep Sea fishermen in a small Kenyan fishing village studied by Crona and Bodin (2006) gave them a great deal of power and left them in the best position to initiate change within the community; however, they did not perceive a need for change and thus did not initiate collective action on behalf of the community. This lack of leadership inhibited the community of resource users from

initiating resource management because the absence of the Deep Sea fishermen constrained the group as a whole from mobilizing and taking action.

Another network feature, betweeness, measures the tendency of a network to form multiple groups (Bodin et al. 2006) and this becomes relevant to this discussion. The degree of modularity that can exist can link different groups or isolate them, effecting the development of knowledge, the ability to perceive changes in the ecosystem, the mobility of actors to change political positions and the ability of the group to reach consensus (Borgatti and Foster 2003 cited in Bodin et al. 2006). Measuring betweeness in a social network is also important in the identification of actors who link or bridge groups that would be otherwise separated (Freeman 1979, Gould and Fernandez 1989 in Bodin et al. 2006). The people in this "broker" (Bodin et al. 2006: 17) position hold a great deal of power, having access to a variety of information from each group; knowing who to contact or make connections with; and most notably, they can control the flow of information to and amongst groups within the network (Bodin et al. 2006).

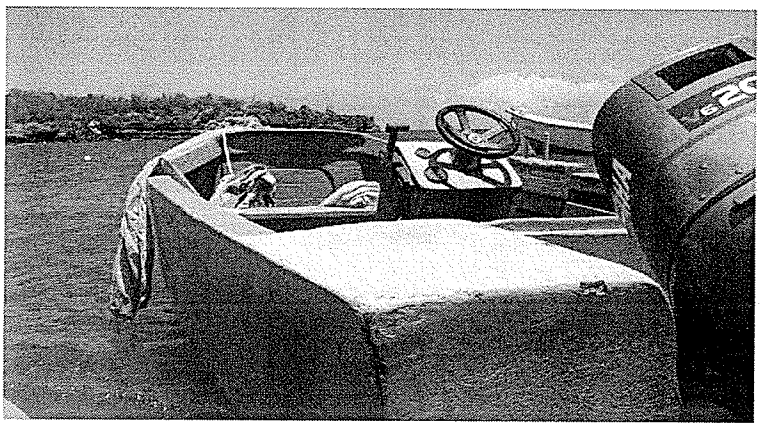
Additionally, co- management requires a community of resource users (Carlsson and Berkes 2005) and whether there are any cohesive groups currently in existence who could share the management of the fishery is important to identify. The management of fisheries resources usually involves granting access rights to some fishers, to the exclusion of others, in order to maintain harvesting and economic efficiency (Acheson 1981). Since the benefits of fisheries regulations directly benefit those granted access rights, support for regulations that reflect existing informal institutions that may have been in place receive greater support from the fishing community than regulations that do not consider existing informal social institutions (Acheson 1975 cited in Acheson 1981). By using a network approach, which involves identifying a system's components and patterns of interactions (Bodin 2007), and understanding social networks as part of social-ecological systems (SES), the identification and increased

understanding of key social structures that will enable resource managers to design and implement resource management plans that are conducive to co-management (Bodin et al. 2006). The success of resource co-management is highly dependent on network structures and understanding these features will be critical for the successful implementation of sea urchin management in Grenada.

Summary: The Social-Ecological Networks of the Grenadian Sea Urchin Harvesters

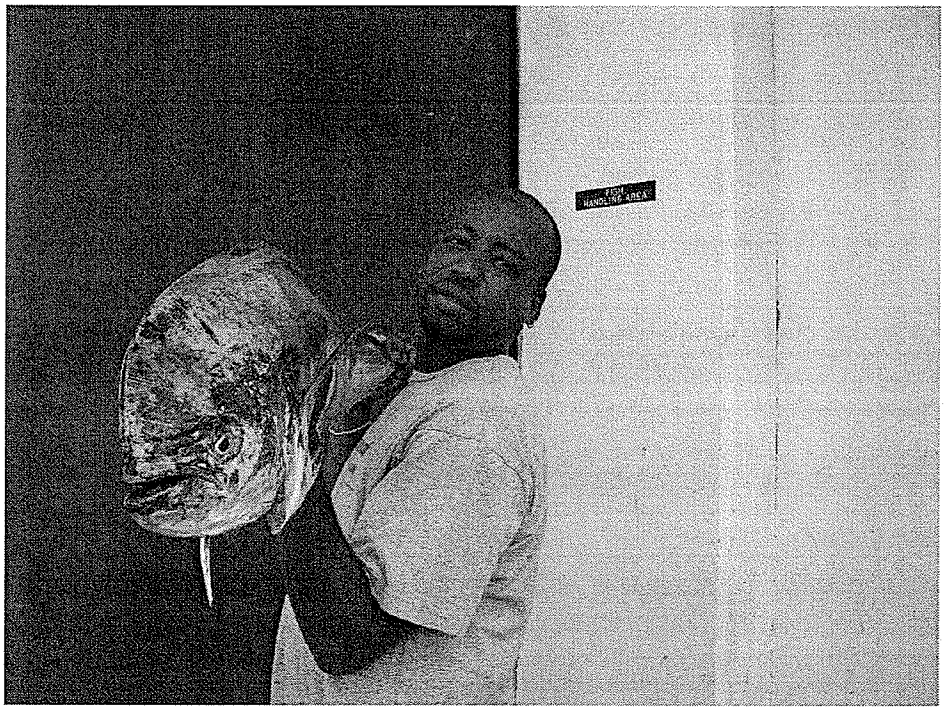
Sea urchin population dynamics are variable and unpredictable. The fluctuations in sea urchin abundance and distribution create high levels of social and economic uncertainty for harvesters. Since they cannot depend on the year-to-year availability of this resource and they then turn to livelihood diversification to compensate. In Grenada, this fishery shared many of the characteristics commonly used to describe SSFs, increasing the complexity and posing several challenges to managing the fishery.

Because of its flexible nature, an adaptive co-management approach may be one method of governance that could incorporate many of the fishery's ever changing features that need to be considered for management. In this case, identifying a group to assign resource harvesting rights to co-manage with may be necessary for a decentralized management strategy that creates partnerships between communities and government agencies.



CHAPTER THREE: Research Methods





Introduction

This chapter outlines the methodological approach, the preparation, implementation and the limitations of this study. I first discuss the theoretical approach and the research methods that were used. A description of the methodological aspects used in the data collection process follows and includes: preparation; data collection with participants; additional research conducted to assist the Fisheries Biology Unit; and, data verification. A summary and reflection on the challenges and limitations to the research concludes this chapter.

Methodological Approach

The case study is an empirical approach used to study phenomena in its "real-life context" (Yin 2003: 13). Using the case study approach provides depth and context to the formation of networks and the interactions that occur between harvesters. By using multiple methods to collect the data, reliability is increased and also provides insight and context to the complex interactions occurring between the variety of people that were involved in Grenada's sea egg fishery. One drawback to the case study approach is that it requires a great deal of time to establish relationships with the participants (Grant 2006). However, to be able to fully appreciate the context, this investment was necessary and proved to be invaluable in establishing contacts and relationships with the participants.

A guiding protocol outlining the general methods that were used in the data collection process has been attached as Appendix 1.

Research Techniques

Participant Selection

To get a holistic understanding of the variety of people involved in the sea egg fishery participant selection was not limited exclusively to divers. Exporters, divers, breakers and

fisheries officials were all approached and included in this study to gain a better appreciation of how the fishery functioned from multiple perspectives.

Twenty three participants gave semi-formal interviews; including, fisheries officials, exporters and divers from Calliste, Soubise and Grenville. Eleven participants gave informal interviews, including academics, divers, breakers and the major importer/exporter of seafood on the island. Additionally, to increase the number of perspectives and the variety of information I received, I had countless informal conversations about sea eggs, this study and the sea egg fishery with Grenadians who were interested in the study. It was the informal conversations I had that really helped me gain a better understanding of how commercial and non-commercial sea egg diving occurred and how I should approach my data collection.

It became clear early in my fieldwork, through the informal conversations I had with the divers, that a lot of "sea egg experts", or those who were heavily into harvesting and would have been recommended for the study, had left Grenada or were otherwise unavailable. Still, I relied on peer referrals from key informants, fisheries officials and recommendation from the participants to meet and interview new participants.

While all the divers caught other species in addition to sea eggs, my criteria for selecting divers as participants were whether they harvested on a regular basis and whether they had sold sea eggs commercially before the harvesting ban was imposed. I intentionally chose to focus on commercial sea egg harvesters because sea egg harvesting for personal consumption seemed to be very widespread and common. I felt that gaining a proper understanding of the networks involved would be too broad if I included all the Grenadians who dove for sea eggs in their spare time. However, it should be noted that harvesting sea egg for personal consumption was common and not limited to full-time fishermen and that commercial diving and sales were not the only fishing activities that occurred in Grenada.

Interviews

A combination of informal, unstructured and semi-structured interviewing techniques was used for this study. Informal interviewing, which is characterized for its lack of structure and control (Bernard 2006) was the initial method of interviewing at the start of the data collection period. Informal interviewing consisted of informal conversations that occurred at any time in daily activities, such as waiting at bus stops, while shopping, during walks (Bernard 2006) and waiting at various landing sites. This method was useful at the beginning of the fieldwork, allowing me to gradually build rapport and familiarity within the community and to identify important areas, sites of information exchange and actors of interest that were unknown prior to arrival (Bernard 2006). While the intent of my motivations for engaging in these informal conversations was not hidden in order to maintain a casual relationship data from informal interviews were recorded following the conversation, from memory, to minimize unease with the participants (Bernard 2006).

Semi-structured interviewing was conducted with participants and fisheries officials to make the most efficient use of their time (Bernard 2006).

For all interviews, the informants were given the choice as to whether they would prefer the conversations to be recorded with an audio recording device or if they would rather notes be taken during the conversation. Meanwhile, confidentiality and anonymity was assured to minimize discomfort and increase participation. In the end, I found most of the participants were consistently uneasy with the suggestion of recording the interviews and preferred not to have their interviews recorded and so I took notes during my interviews instead.

Participant Observation

Participant observation was an integral component of the research activities. Living in the village of Calliste and participating in diving and community events there and in Grenville and Soubise provided invaluable perspective for improved understanding of those participating in the study (Yin 2003). Participant observation also provided opportunities for social interactions and opportunities to access people and events that may have been otherwise inaccessible to the typical observer (Yin 2003). It allowed me to have a constant presence in the community while participating in various aspects of the participant group's lives. Invitations to cook-ups, fetes, Fisherman's Birthday celebrations and weddings were some of the occasions I attended and this allowed me to both participate and also record it openly as a researcher.

One criticism of the participant observation approach is that it reduces the ability of the researcher to be a detached observer without bias (Yin 2003). For this study, especially since I had been in Grenada before, being completely unbiased was not possible. I took personal effort to be aware of this and tried to address potential bias whenever possible.

Participant observation is advantageous because it increases the validity of the data collected by reducing "reactivity" where participants modify their behaviour because they are aware that they are being studied (Bernard 2006). By maintaining a constant presence within the Calliste and with the St. Andrews groups I was able to build trust and rapport. This reduced reactivity and gradually allowed me to gain access to activities, behaviour and opinions that may be personal or privileged in nature. Doing so provided the best way for gaining a general understanding of how social institutions and organizations operate (Bernard 2006).

For the purpose of this study, participant observation contributed to the holistic understanding (Yin 2003) of the actor and network linkages within the sea egg fishery. It was used to enhance the context of the study (Yin 2003) as well as contributed to building rapport and

contacts that I needed for interviewing later in the study. I also lived in the fishing village of Calliste, a community identified as having a notable number of sea egg harvesters and that was central to the sea urchin fishery prior to the ban (J. Finlay, pers., comm., 2008). Site selection followed the principles outlined by Bernard (2006), including choosing an area that was relatively accessible and using personal contacts and referrals to select the sites.

Direct Observation

Yin (2003) recommends utilizing direct observation, where the researcher is actively present for the observation of certain types of behaviour within the context of the study area. Direct observation provides additional dimension to the context of the data being gathered, helping retain the meaningful interactions and characteristics of the participants in the study (Yin 2003).

Direct observation was conducted at a variety of sites that included: out at sea; at landing sites in Grenville (Grenville Fish Market); rum shops in Soubise; and, at Calliste Beach. Efforts to attend meetings that the participants were in attendance as well as any social events were also taken to see the participants in a wide variety of settings.

Preparation and Project Selection (getting ready to go)

This study was developed in collaboration with my committee members, whose interests and expertise lay in small scale fisheries, networks, governance and co-management. This study also grew out of a wider need for a detailed description of Grenada's sea egg fishery and insight into its organization for improving governance and using co-management. Compared to St. Lucia and Barbados, there has been little published data about the fishery or details about any management initiatives that may have been undertaken.

After making contact with the Grenada's Chief Fisheries Officer (CFO) and a former CFO that had since retired and by assessing what was already known about the sea egg fishery, the research questions were developed to meet the academic interests of those involved but also to help contribute to future governance of the fishery, using a networks perspective.

Readings and Literature Review

Before leaving for the field research season, I conducted a detailed review of published literature about sea urchins, small scale fisheries and fishermen, networks, governance and co-management. Once in Grenada, I searched for documents at the library in St. George's, however I found little related to the study, despite searching through newspaper archives and enlisting library staff to help me with my search. I also went through the Fisheries Division records and reports for information about the fishery and found a few unpublished, internal reports about the fishery from various years. There were gaps in the years for which data was available but it was the best information I could find that had been written by fisheries officials at the time.

Meeting the Divers: Liming in Calliste and Grenville

Before arriving in Grenada, contacts and meetings were arranged through one of my committee members with a retired fishery official and the current Chief Fisheries Officer so that I could be briefed and introduced to the current situation regarding the fishery as well as to potential participants.

My first meeting was with the retired CFO who recommended that I include the Calliste divers in the study. This retired CFO had prior experience and contacts within the group because he had conducted a socio-economic study that profiled the Calliste fishermen. Some of the divers had been heavily involved in sea egg harvesting and exporting and were diving off the southeast

coast around Calliste. He took our group to the landing site at Calliste Beach and introduced me and the study, asking the divers for their cooperation if it were required.

The following day we attended a workshop in Grenville that was organized by the current CFO. Local divers and fishermen interested in the sea egg fishery and its reopening were invited to attend. There were divers from villages in the parish of St. Andrews including Soubise and Telescope as well as representatives from the Calliste Divers Association. An overview of the history of Grenada's sea egg fishery was presented; a presentation on the history and management of the Barbados sea egg fishery was delivered and then I introduced myself, gave a quick introduction to my study and what I was hoping to do.

The participants were then given the opportunity to contribute, voicing opinions, memories, suggestions and knowledge about sea eggs, the fishery and what needs to be done to prevent it from collapsing if the season should be opened.

Living and Liming in Grenada

Within the first week upon my arrival, I moved into the village of Calliste. It met the criteria set out by Bernard (2006: 356), it was easily accessible and gave me opportunities for regular interactions with the divers just from living on the road and by being so close to their landing site. Reaching the Calliste landing site was more difficult than reaching the Grenville Fish Market and it gave me consistent presence in the community. Calliste was also recommended by a few personal contacts that had helped me find an apartment to rent in April.

Once I established my home base, I ensured my presence was known in Grenville and Calliste and that there was a semi-regular routine so that the divers would know I would be hanging around their landing sites a couple of times a week. This was to facilitate my acceptance and to make them comfortable with my presence, while building a good rapport for when it was

time to conduct interviews. I soon was known as the "white girl" that was hanging around the Fish Market or the beach, the one who would go diving in Grenville or the part of a running joke since I was continuously seasick when I went out to sea. As my connections grew, friendships were built and the divers began inviting me out to fetes, concerts, weddings, funerals, regular liming spots and cook-ups. This gave me the privilege of participating in a variety of local social events that most foreigners on the island never get to experience. This enhanced my understanding of the various social interactions that occur beyond the beach and in the community as a whole.

It should be noted that my key informants from St. Andrews had a lot of influence in their peer group and while they provided me invaluable introductions, experiences, and information, they did influence who I was able to contact and meet, especially in the beginning. This ensured that I was not given a hard time and was treated respectfully but I am sure this resulted in an informal level of screening with who I was interacting with around the Market. Once I realized that this was happening, I tried to visit the market at times when I knew they would be out to sea so that I could become more approachable to a wider variety of people.

I think it was from all the liming (participant observation) that got me accepted by the leaders within both groups. These men became my key informants and gave me access and credibility to the wider community and other divers and fishermen. While I was somewhat reliant on the key informants for peer referrals, I did try to actively use direct observation to make sure that they were well respected within their villages and among their peer groups to confirm that they were respected and reliable.

Interviewing Respondents

A total of 22 semi-structured interviews and 9 informal interviews were conducted with divers, fishermen, fisheries officials, exporters, academics from St. George's University and one breaker. Ten of those semi-structured interviews were conducted with divers from Calliste, 10 with divers and fishermen from Grenville and Soubise; 1 diver from Happy Hill and 1 from Westerhall; 2 exporters and fisheries officials.

The interviews with the Calliste divers were conducted individually and most frequently at the divers' homes. I let the participants decide when and where the interview would take place so that I was not encroaching or inviting myself unwelcomed into their homes or personal space.

The interviews with the participants from St. Andrews, who were mainly from Grenville and Soubise, were conducted around the Grenville Fish Market or at the shop in Soubise. Most of the interviews were conducted individually but several had occasional input from passing fishers who were listening to the interview. This created some interesting discussions and debate when the subject of opening and managing the fishery was raised. I made note of the inputs from these other participants for future reference to see if there was consistency in the ideas and facts being suggested.

Interviews were typically 1.5- 2 hours long with variations really depending on how much time the participant had and how focused the interview was. I tried to keep the interviews flexible so that they could express and develop their ideas and memories freely without too much interruption.

Data Collection at the Grenada Fisheries Division

I went to the Fisheries Division to review reports and data that had been written or collected about the sea egg fishery over the years. I received assistance from a Fisheries Official who loaned me his file on sea eggs, with reports and documents he had collected since the 1980s.

I also searched through their file room but found little else about the fishery, landing reports or export data.

Data Verification

Effort was made through-out all phases of this study to verify the information and data as it was being collected. For example, respondents would be asked to clarify any responses that were unclear in the interview. After reviewing the interviews and entering them into Excel Spreadsheets, some respondents were contacted by phone or in person with follow-up questions if there was information missing or if a point required further clarification.

There was also a great deal of overlap in the responses given in the interviews, regardless of where the participants resided. The consistency of the responses led me to believe that most of those responses were relatively accurate. If there were points that were unusual or had not been mentioned by previous participants, I would try to ask about them in subsequent interviews and/or check with my key informant in the Fisheries Division to see if the information could be confirmed.

The Fisheries Biology Unit Sea Egg Survey

Over four weeks in late July and early August of 2008, I volunteered with a sea egg survey being conducted by the Fisheries Biology Unit in Grenville. They designed and conducted a population survey that would count sea eggs at grounds that had been identified as primary sites by divers and the fisheries officials' from their personal knowledge of the area.

The survey was initially designed to take three random 10m transects within the grounds as chosen by the divers who loaned their boats and assisted in the water for the project. The transects were difficult to perform with the currents and eventually counting the number of sea eggs was abandoned and Fisheries Officials decided to assess the amount of clumping at each site

instead. I participated in the survey, free diving around the east coast where we went from Conference Bay to Hope and later at three sites around Carriacou. At the end of my stay, the Fisheries Division had not yet set a date to complete the surveys around south- eastern Grenada, around Woburn and Calliste, areas that were heavily targeted for harvesting. However, the Fisheries Division was able to complete the study in the fall and had some informal consultations with fishermen about opening the season (Crafton Isaac, pers. comm., 2008).

Research Challenges and Limitations

Study Area (scale)

Before I left for Grenada, I knew that harvesting had occurred along Grenada's east coast but I did not know much about where or who exactly used to harvest sea eggs. So when I visualized having to map out the social networks I assumed that I would have to find participants from all over the island. However I did not want too broad of a sample, and to maintain the elements of the case study (Yin 2003) that would retain context, I decided to interview two groups that were both involved in harvesting. I then compared the differences and similarities and whether these two groups had any connections or networks that linked them together.

For the divers, I decided to focus on those from Calliste and those in the Grenville area so that there was a sample from two parts of the island while also being able to spend time with both to develop rapport as well as a detailed description of how they operated and how their livelihoods have changed since the ban. I relied on peer referrals from participants in both groups as well as from fisheries officials.

Completing a detailed social network also proved to be difficult as I was not entirely prepared for the task of having to get the names of all of those who participated in the harvesting of sea eggs. Having started my interviews with the divers, it became clear I would not be able to

compose a comprehensive list of everyone who had harvested sea eggs as needed to do a social network analysis. One diver commented that "not everyone from different parishes know each other, sometimes false names [nicknames], not real names". My questioning shifted away from getting a comprehensive list of actors of who harvested sea eggs because many participants could not remember the names of everyone from their village who dove sea eggs, faltering after giving after listing some names and usually finishing with "there's more but I can't remember" and even fewer could consistently provide the names of divers they saw from other villages. One diver from Soubise said he did not know Calliste divers because "they too far and divers stuck to their own area." Many respondents could only remember either the false name or true name but it was not consistent and made identifying recurring actors even more difficult.

Another challenge to selecting participants that would provide information about an island-wide social network was that while many divers said they did know others around the island they did not necessarily know their real names and often only knew the nick names of other fishermen. Later, I realized that the divers were also interchanging some false names with real names some were using the real names for my benefit, possibly to make it more official for my study while others were using the nick names for the same people. This resulted in some overlap in the naming of other sea egg divers. There were some participants who had minor acquaintances with fishers from around the island but rarely were these relationships described as strong or noteworthy unless the diver had lived in another area and had strong ties to the community from having lived there.

Mobile and Unpredictable Groups

Fishermen are characterized for their high mobility and for moving to different areas in pursuit of different fish stocks. In the Caribbean, this is amplified because of the relatively small

landmass to sea ratio which facilitates the ease of moving across local and national waters as they please (Mahon and McConney 2004). Additionally, Grenadians are renowned for running on "Grenada time" making it difficult to predict if and when someone may appear regardless if a meeting time had been arranged. These two characteristics posed some interesting challenges for me, trying to meet up with participants or even being at the landing site at the right time. For me, knowing if they had gone out early or later to work with changing tides, weather or personal schedules was nearly impossible unless someone told me the day before so I frequently arrived much too early or too late, with the daily catches being taken away and the divers gone. If the opportunity arose to go overnight to another fishing ground, like up in Carriacou, people could leave at a moment's notice and I would arrive to find my informants or interviewee had left for a day or two.

I often ended up missing the group(s), or my participants, and on a number of occasions I had been stood up and left waiting for someone I had prearranged to meet with for an interview. Sometimes it would take 2-3 appointments before I was able to have an interview, if at all. Adapting to this required flexibility and patience and for the most part I was still able to conduct interviews with nearly of all of my enlisted participants.

Community and Researcher Perceptions

Having prior experience in Grenada I had already experienced many aspects of living and working with locals in a research setting on the island. I was aware that being a "white girl" hanging out with fishermen would impact how I was perceived and how I would be received by the communities and by the divers. I was not sure if it would work in my favour or not. As it turned out, I think that by liming and going out to sea, I proved that I was not a typical foreigner and that even though I was there conducting research, I had shown more interest in the

participants as people and not merely as research subjects that I needed to get information from. This helped me greatly and I was welcomed into both groups.

Having gained this acceptance, I gained credibility and respect in the wider communities and enjoyed a good rapport with fishermen and others not directly related to the study.

The readings I conducted for my literature review also impacted my perceptions on small-scale fishermen. I had come versed with the adjectives I used in my proposal such as poor, landless and people on the margins of society. I had painted an image of poor uneducated, labourers who had no other employment options. While in some respects this description is accurate, what I was surprised to learn was that while by our standards, most Grenadians are relatively poor and lacking the material wealth we take for granted, when I asked the fishermen how they liked their occupations, the response was surprisingly positive. The fishermen acknowledged that fishing is hard work and the cost of living in Grenada is putting additional stress on them to make ends meet, but many enjoy the freedom that comes from fishing. Being their own boss and working the hours that they chose. This flexibility and the potential for earning significantly more than construction workers held great appeal.

Data Analysis

I used Microsoft Excel to enter my data into spreadsheets in order to see the emergence of data trends from the interviews. I used the networks software UCINET with its Netdraw program (Borgatti et al. 2002) to compile my networks data and to produce the networks maps that have been included in Chapter 4 (results).

Lessons Learned

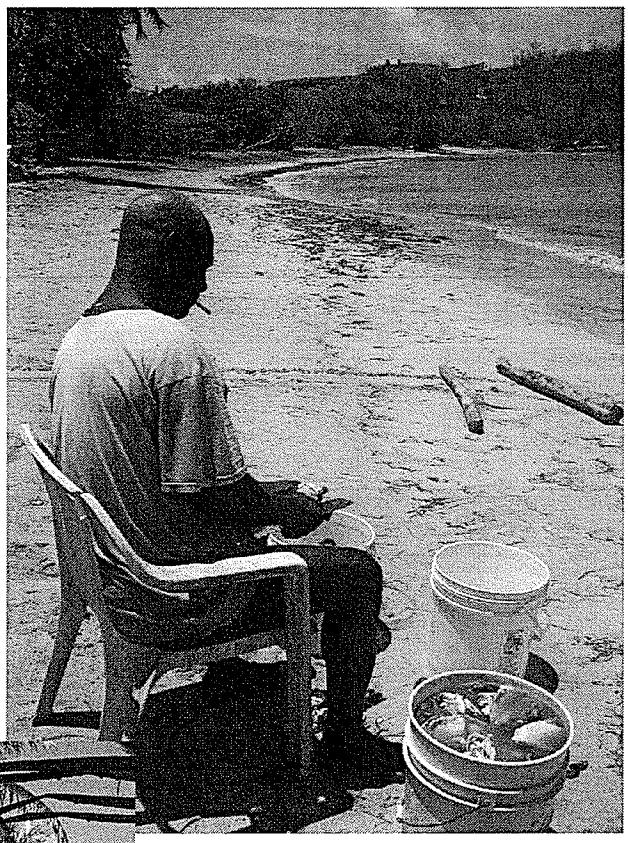
I went into the field expecting to find destitute fishermen who were desperate and dissatisfied with their lot in life and instead I met people who enjoyed their lives and their work

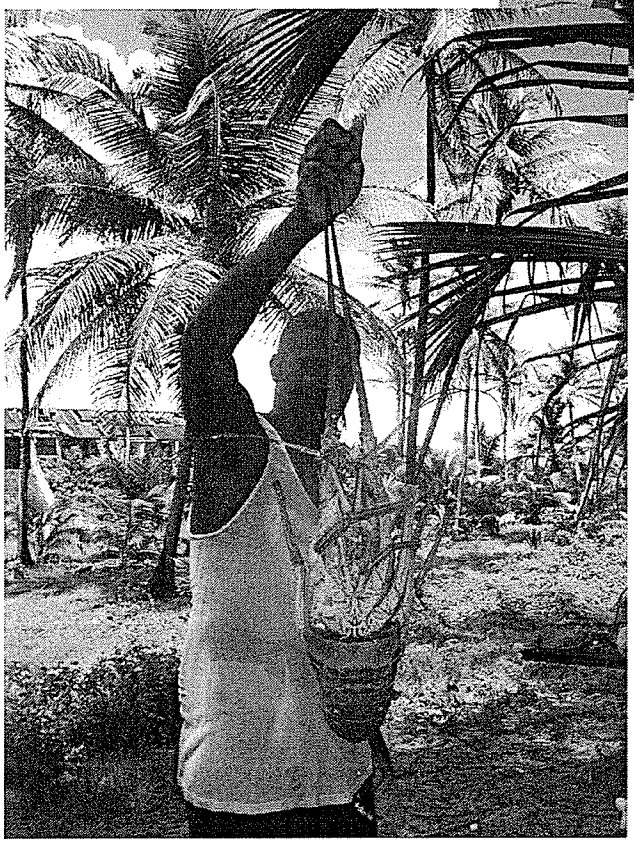
more than most people in Canada. This could have been one of the biggest lessons that I learned during my field visit. While fishing is undeniably labour intensive and dangerous it provided the means for many to enjoy "the good life" as one diver called it.

I also saw first hand many of the variables that complicate managing the sea egg fishery, including the continuing difficulty there is with effective enforcement of the current regulations and the challenges that will be present if new ones are imposed to limit harvesting during an open season.

I came away from this study learning more than I anticipated, learning so much about the lives and livelihoods of the participants as well as came away understanding how hard managing the sea egg fishery effectively will be, if it is even possible.

CHAPTER FOUR:
Results





Introduction

Grenada's sea egg fishery was an opportunistic fishery that fluctuated with availability from year to year. Initially, the fishery was very informal and eating sea eggs for personal use and social occasions were the main motivations for diving for sea eggs. When sea eggs were enjoyed in homes, shared with friends and neighbours or during weekend cook-ups on the beach the annual variability in sea egg abundance would not have been as noticeable then as it became in later years.

The subsistence fishery drew men, women and children, people of all ages to diving and cooking before market demands began to increase in the 1980s and early 1990s. This is when commercial sea egg diving became an activity that attracted young men and was then followed by the emergence of groups of specialized divers. They incorporated sea eggs into their weekly, daily or monthly catch and began selling sea eggs in earnest as a means of supplemental income. The divers were primarily men although other villagers were included in related activities. Women and youth were hired as "breakers" when large loads of sea eggs were brought in and helped with the breaking and cooking of the sea eggs before they were sold.

Fishing villages dot Grenada's eastern coast, from Calliste all the way to Grenville and many people from these communities took part in sea egg diving. The participants in this study were mostly from two fishing communities, the diver village of Calliste and the fishing villages near Grenville, in the parish of St. Andrews. All the participants were involved in the fishery, either as a diver, a breaker, exporter or fishery official and they participated in informal and semi-formal interviews to contribute to the descriptions written here. Tables 1 and 2 list the respondents, their age, current village and occupation.

Table 1.Informal interview participants.

Name	Gender	Age	Village	Current occupation
SuC1	M	20	Calliste	Diver
GdC1	M	24	Calliste	Diver
MP1	M	46	Calliste	Diver
NC1	F	DNR	Calliste	Retired
SiC1	M	31	Calliste	Diver
CYC1	M	34	Calliste	Captain
DVDC1	M	21	Calliste	Diver
SN1	M	DNR	n/a	Professor
JISG1	M	32	St. George's	Fish exporting company manager

Table 2. Semi- formal interview participants.

Name	Gender	Age	Village	Current occupation
DC1	M	45	Belmont	Diver/ boat owner
SiC1	M	DNR	Calliste	Captain
AC1	M	40	Calliste	Diver
GC1	M	52	Calliste	Diver
RC1	M	DNR	Calliste	Was an exporter/diver, now has the bends
SC1	M	DNR	Calliste	Was an exporter/diver, now has the bends & owns trawling boat
SmC1	M	DNR	Calliste	Diver
BBC1	M	45	Calliste	Has the bends
BGA	M	56	G.A. Valley	Diver
MC1	M	DNR	Proceral	Fishing
DS1	M	37	Soubise	Diver
JS1	M	DNR	Soubise	Diver, construction
HS1	M	42	Soubise	Fishing, masonry, building
MS1	M	DNR	Soubise	Fishing
AS1	M	DNR	Soubise	Fishing
RS1	M	DNR	Soubise	Street Cleaner in Grenville
BW1	M	DNR	Soubise	Unknown
TG1	M	34	Telescope	Diver, fishing
ALT1	M	DNR	Telescope	Fishing, diving, bus driver
CPW	M	DNR	Westerhall	Retired diver/ fisherman
CIG	M	DNR	Grenville	Fisheries official
JF1	M	DNR	n/a	Retired CFO

Social Networks of the Sea Egg Fishery

Grenada has a population of just over 110 000 people (Baldeo 2001) living on its three main islands. Relatively, mainland Grenada is small and does not take a lot of time to travel across. By bus, starting at the bus station in downtown St. George's and taking the longer "bottom road" that runs along the south-eastern coast it takes approximately an hour to travel to Grenville. By car or taking a bus over the mountains to Grenville, the journey will take a half hour to forty five minutes, in all a relatively short amount of time to travel across the island.

While overland travel between Calliste and Grenville may take a North American visitor the same amount of time as their daily commute to work, there was not a lot of travel or interaction between these two participants groups during the peak of sea egg diving or today. While the fishery had a loosely formed network whose main common feature was involvement in sea egg diving or marketing, the groups tended to stay near or around their immediate part of the island. As one diver explained, "divers stick to their own district." This may have contributed to the reason why most of the respondents did not know or only vaguely knew of divers in the other participant groups, another said that, "not everyone from different parishes know each other…sometimes false names but not full."

However, there were a few individuals who were named by respondents in both groups, the Fisheries Officials and informal interview respondents. These common actors were the exporters, former divers who had begun buying sea eggs from divers in villages around coastal Grenada. These exporters send the shipments of sea eggs by air to the neighbouring islands where demand for sea eggs was increasing.

Marketing Networks

"Brokers" (Bodin et al. 2006) are actors who link otherwise separate groups in a network. For Grenada's sea egg fishery, these brokers were the exporters who traveled along the coast to pick up orders of sea eggs that were sold by the pound at wholesale prices. Because the shipments had to be frozen and flown in shipping containers, the sea eggs were sent either raw or boiled and packed into plastic bags or buckets for the exporters.

There were four exporters who were named by a variety of participants and they traveled from southern Grenada to Grenville to buy sea eggs for export sale. At the time, three of the four exporters lived in Calliste and two were interviewed for this study. Both men described how they established a fairly regular routine for collecting orders. They would drive to different points

along the road or into the villages and landing sites where divers who wanted to sell could bring their catch. There were also times when the divers would bring the sea eggs down to town, meeting the exporters in St. George's with their delivery.

Not all the divers sold for export. One diver said that you could make more money selling locally because you did not have to sell at wholesale prices. Other divers did not know the names of who was buying the sea eggs because other members of their crew were taking the orders down to St. George's to meet the exporters. For those selling sea eggs for export and could name their buyers, a marketing network emerged and by using UCINET's Netdraw software a representation of the marketing network is illustrated in Figure 2.

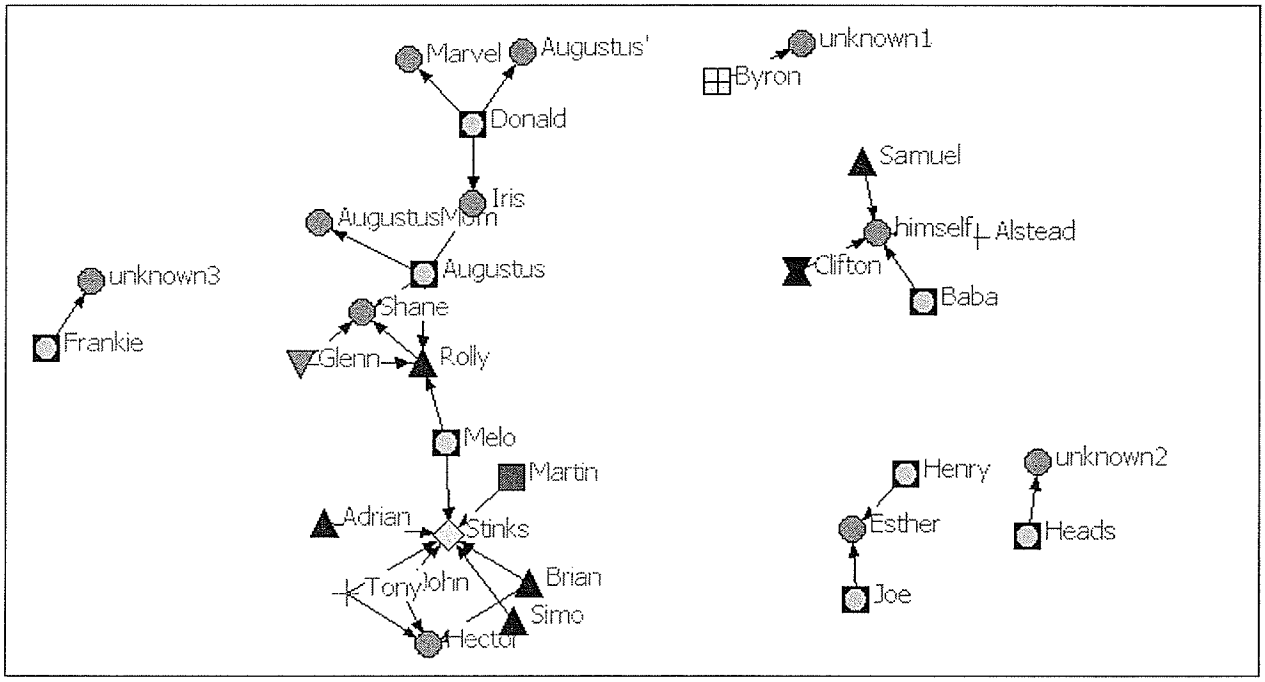


Figure 2: Netdraw representation of the sea egg marketing networks

The Fishery Participants

The Grenada Fisheries Division

The management of marine and freshwater resources in Grenada is assigned to the Fisheries Division. The Division falls under the jurisdiction of the Ministry of Agriculture, Lands, Forestry, Fisheries and Public Utilities and Energy (Grant 2006, FAO 2007). Under this title, the Ministry is responsible for ten departments including the Fisheries Division. The Division has representation around Grenada including at the seven government-run fish markets that are strategically placed to distribute the variety of services the government provides to fishing centres around the country (FAO 2007). Figure 3 shows the distribution of the main landing sites in Grenada and Carriacou. There are also 37 secondary landing sites that are located on beaches and bays and are distinguished because they have no infrastructure (FAO 2007).

The Division's authority is drawn from legislation enacted in 1986 and 1987 (FAO 2007). In 1984 the FAO assisted Grenada with drafting harmonized fisheries laws and regulations

(Finlay 1990 in Mohammed and Rennie 2003) and management has since been guided by the Grenada Fisheries Act #15 of 1986 and the Grenada Fisheries regulations SRO #9 of 1987 (Mohammed and Rennie 2003).

The Division has two main focuses: administrative; and, the development and management of the nation's fisheries (Phillip 2004 cited in Grant 2006). The administrative responsibilities of the Division include: issuing fishing licenses; enforcing regulations; data collection; and, quality control of the fish markets. In the development and management of fisheries, the Division manages onshore infrastructure for fish marketing, cold storage, the communication of marine safety information, ice making and general services to the fishing community (FAO 2007). As well, the Division identifies each fishery, evaluates their current conditions and determines management objectives management and measures (Phillip 2003 cited in Grant 2006).

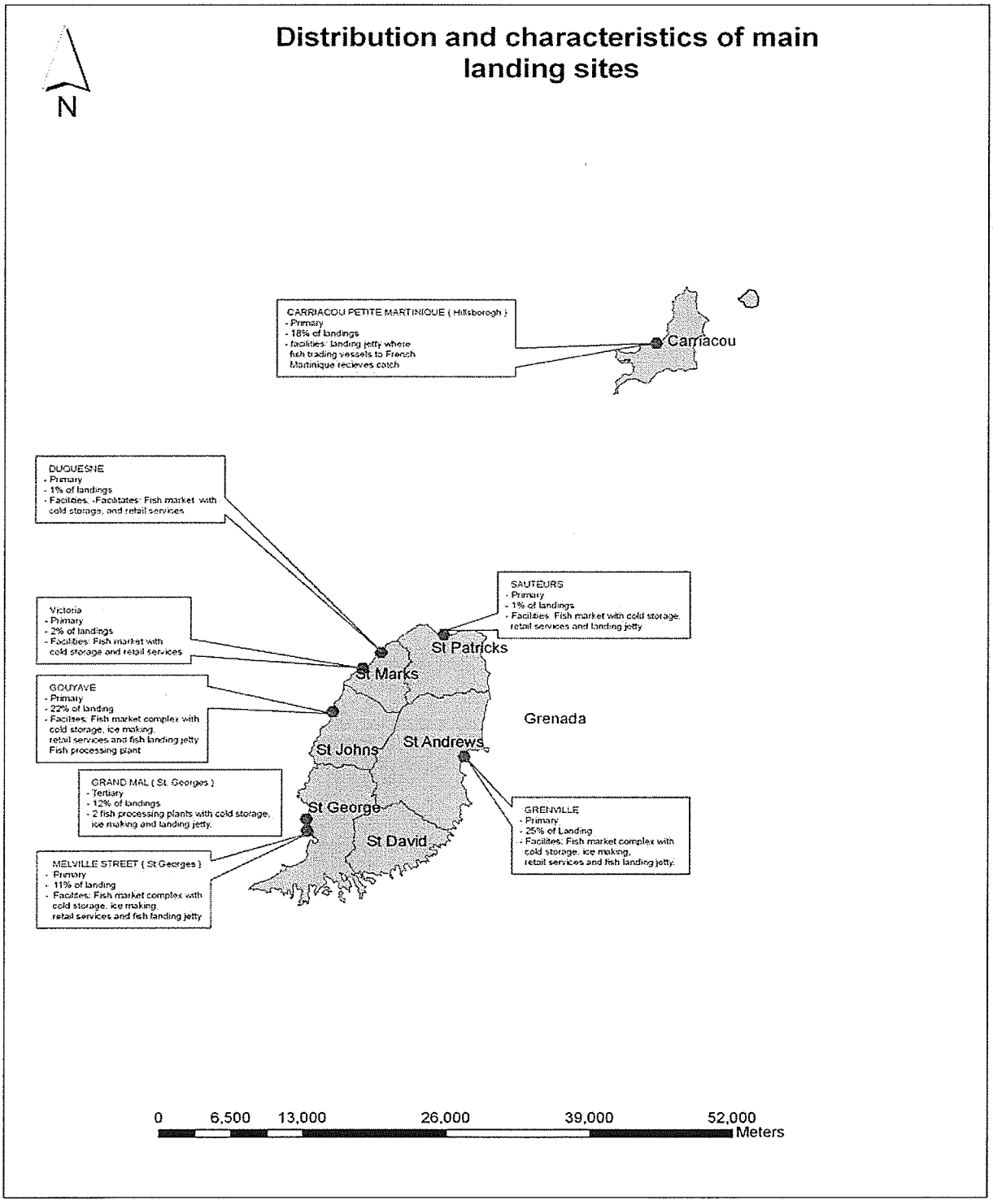


Figure 3: Map of the distribution and characteristics of the main landing sites in Grenada (source: FAO 2007b).

The Calliste Divers

The fishing village Calliste is tucked away on Calliste Hill, with a main road that diverges at the top towards the south and the west. Calliste was relocated when the airport was installed after the revolution in the 1980s. Calliste is a coastal community with a mixed livelihood activity history of dairy production and later fishing which emerged after the dairy closed (Finlay, unpublished). The villagers have a longstanding affiliation with the sea and many grew up along the bay before the village was moved. Fortunately, they still have access to several low-traffic, local beaches that provide plenty of opportunity and space for bathing, soccer and fishing, the usual Sunday pass time for many in the area.

Calliste is also home to a unique group of fishermen who specialize in full-time scuba diving along the coastal shelf, on the south-eastern coast. This coastal shelf has been described as one of the widest and most accessible of the shallow bottoms in Grenada and are prime fishing grounds for sea moss, sea eggs, "lambie" (conch), a variety of fish and the occasional turtle (Finlay unpublished).

These "multi-stock sedentary fishers" (Finlay, unpublished: 25) primarily target shellfish like lambie and lobster but they also pick sea moss off the sea floor which is later dried and sold to be blended with condensed milk and nutmeg to make a cold, milkshake-like drink. They are unique and are set apart from the average Caribbean small-scale fisherman because of differences in their organization and fishing activities. Unlike the St. Andrews participants, the spatial mobility of the divers is relatively low, they rarely travel overnight and they mainly fish on grounds that are within a few hours from their main landing site (Breton et al. 2006). The limited travel requirements are also partially due to the fact that when they alternate target species, it is based on seasonal changes rather than geographic reasons (Finlay unpublished, Breton et al.

2006). To reach their target species, the divers use a combination of visual landmarks on land and experiential knowledge to orient themselves on the sea and to find their preferred fishing grounds (Kishore et al. 2006). GPS is increasingly being used to mark "good grounds" and they have their own names for productive fishing grounds, like "The Boss" which was a former sea egg bed and "The Hole" for an area that was covered in sea moss. Figure **4** is a map that was developed by a former Chief Fisheries Officer who worked with the divers for another study and documented the local names assigned to the Calliste fishing grounds.

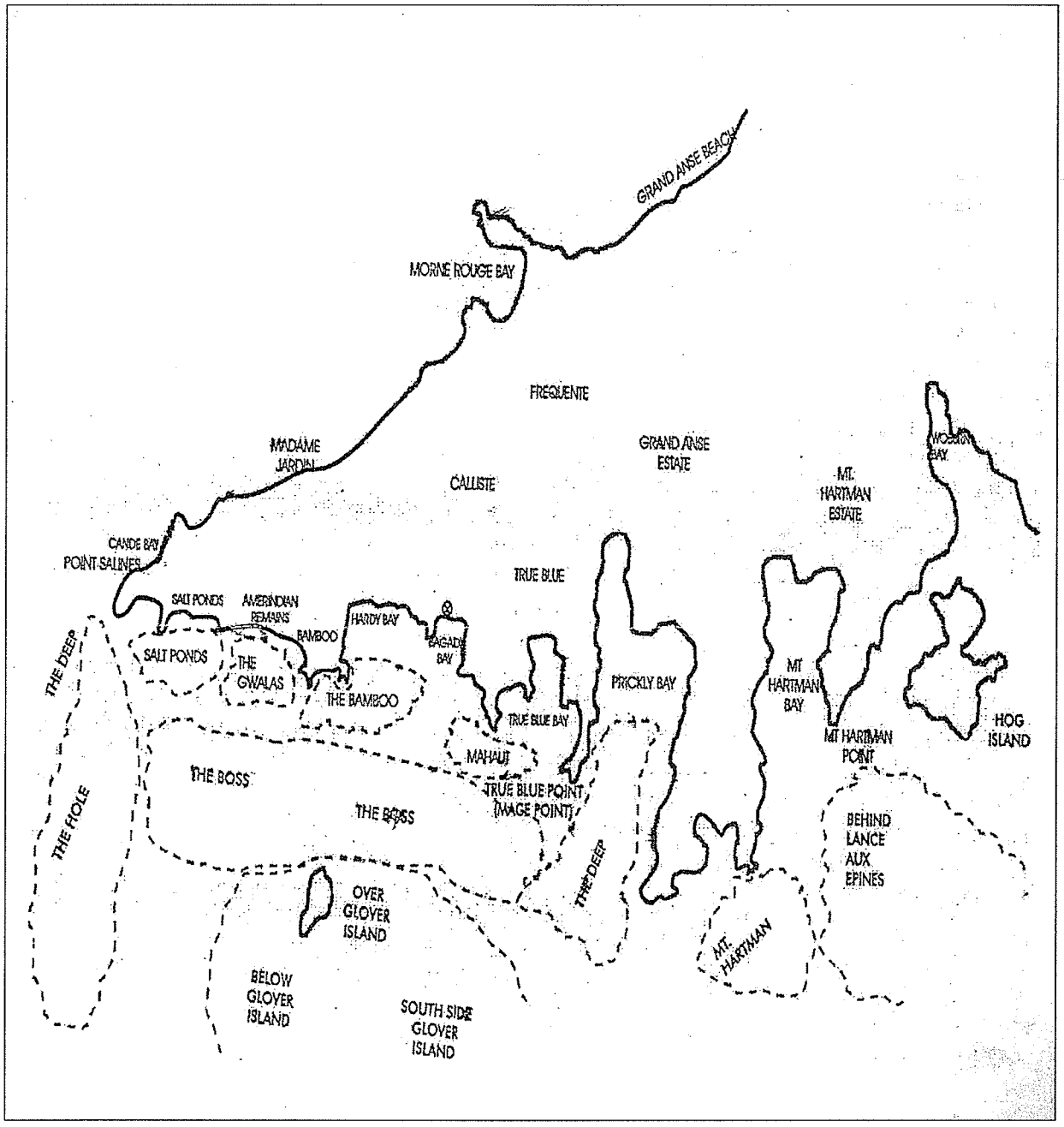


Figure 4: Map of the fishing grounds and local names of the Calliste fishermen (Source: produced by James Finlay, Grenada)

Another distinguishing feature is the organization of the group. They have an informal code of conduct, a regular routine and only use one landing site to launch their boats and where

they return to clean their catch (Finlay unpublished, Breton et al. 2006). These opportunities for interaction and socializing occur in the mornings and again in the early afternoons, while everyone is returning to the beach.

This regular routine brings the divers, who cover a broad age range of men who are anywhere from their early 20s to mid 50s, to the beach every morning and again in the afternoons. This routine is said to provide part of the cohesion and cooperation that is found amongst the divers (Breton et al. 2006). Every morning, everyone makes their way to Calliste beach, some men wait at the junction to catch a ride from the divers who have pickup trucks, riding in the back on the unpaved gravel road that runs between the airport and the university. Others walk, taking short cuts through Calliste, down the hill, cutting through the bushes on cow paths and down the same gravel road until they reach the beach. From there, everyone starts loading their boats with scuba tanks and the equipment they are going to need for that day and then everyone sets off to sea. There is an informal coordination of the fishing trips, crews loosely follow one another to the different grounds, and they fish within view of one another. They also return at about the same time, although departures will be somewhat staggered. Finlay (unpublished) found that this routine reinforces social cohesion and communication, while one diver commented that they planned their trips this way "for safety."

Since the divers only use one landing site, they have more time and opportunity to interact each day compared to other fishermen who typically use several landing sites and do not have a regular routine that brings them together each day. This cohesion and the closeness of the group was renewed after three divers were lost in 2004. The divers were all from Calliste and had strong ties to the community. But one day they did not tell anyone where they had gone fishing and rough weather stirred up the sea and they were never seen again. Calliste is a small, tight-knit community with strong kinship ties (Breton et al. 2006) and it seems everyone was affected

by this loss. It was after this the divers began conscientiously leaving in pairs or groups, diving with the boats within view of one another and returning to Calliste beach at nearly the same time. Some of the respondents said that they share their whereabouts so people know where they have gone and even go as far as sharing information about good fishing grounds, so that "everyone survives."

This system is not perfect and there were complaints that "some leave ahead and don't wait and go for themselves." One captain admitted that sometimes he will share the locations of good grounds but other times "I mark a spot with a GPS and go back on my own."

The divers return around 1pm after using anywhere between 2-4 tanks of air. They typically return with lambie, lobster, fish, sea moss and/or if a net was set, a turtle. Lobsters are caught with a handmade trap consisting of a thin pole with a wire noose attached to the end. Spear guns are used to catch fish and nets are dragged below the boat to hold lambie and sea moss.

On the beach, the captains are busy cleaning out their boats while the divers unload the catch and start cleaning the fish or lambie. The lambie is removed from the shells while the crew is out on the water, they turn off the engine and sit, removing the animal and tossing the shell overboard. Then they are then put in buckets and brought to shore where the unwanted pieces, the eyes, stomach, organs are all cut off with a few strokes of a knife and thrown back onto the beach and swept away by the water.

There is one diver who is claimed to be the only certified diver in the group and he is also the supplier of the oxygen tanks for the rest. He has a small shop with his own air compressor and charged $10EC (Eastern Caribbean Dollars) per tank. These divers are mostly self-taught or learned how to scuba dive from a friend or relative. They use very little and well-worn equipment, usually only the air tank, a regulator and then an old wetsuit or just a t-shirt and shorts

while they are in the water. BCDs, safety markers are not used and the only way the captain or "keep up man" can track the divers under water is by watching their bubbles released from their exhalations. So, if a captain loses track of the bubbles, a diver can be "lost" and left to tread water or to swim back to shore if they are not found.

Unfortunately, being lost is not the only danger facing the divers. Decompression sickness or the bends is another trouble and on-going problem for this group. Getting the bends happens when the divers stay below too long and do not leave enough air to reach the surface with the necessary safety stops along the way. Nitrogen bubbles can form in their muscles and tissues and can cause paralysis or severely reduce their mobility and range of motion. There are several divers in Calliste who are now permanently disabled and cannot leave their homes because they got the bends.

At the end of the workday, the crew divides their catch and they give an extra share to the boat owner for "the boat" to cover maintenance expenses, gasoline and engine oil. The rest take their share back home to sell, they frequently have already sold their share and drop the order off on the way home, or else they take it back to their house and people to come pick up their order. Some of the divers and businesses that buy from the divers have signs outside their homes that advertise lambie and sea moss for sale. These sign distinguish the divers' households and illustrate the entrepreneurial nature of this group.

Box 1: The Calliste Divers Cooperative

The Calliste divers have formed the Calliste Divers Co-operative to organize the divers and collect dues to support injured divers who are unable to work.

To join the Co-op there is an initial registration fee and then monthly dues that are expected to be paid by all members. This money is saved and used to help support divers who are injured or who need expensive medical treatment, like for the bends.

The Co-op also participates in the village and they often take it upon themselves to organize fundraisers and events like the annual Fisherman's Birthday Party. This is a fete that the fishermen host, to thank everyone for supporting them throughout the year. This party is different in every village but this year, the divers served food all afternoon and into the evening, had a cash bar and hired a DJ to play music.

The history of the Co-op is a little unclear, one diver said, "the association has been around for awhile but we got more organized after our boats were thieved". Meanwhile according to Kishore et al (2006) said the Co-op was organized after their socio-economic study had been conducted. According to the same diver, having all their boats stolen provided the motivation for them to organize, represent and support the divers.

How effective the Co-op is has been called into question by a couple of the members who were interviewed. Less than half of the divers and captains are members and there is a noticeable absence of the younger divers (under 30). Attendance at their bi-weekly meetings is also not strong, one diver complained about the poor attendance and how it was hard to get projects done when not everyone was coming to the meetings.

Despite this seeming lack of interest in being an official member, there is still widespread support for Co-op initiatives and events. Most of the non-members who were interviewed said that even though they do not belong to the group they try to attend whatever event the group is hosting.

Calliste Interaction & Information Exchange

The divers see each other nearly every day because Calliste beach is their only landing site. Accessible by a single road, they often drive to the beach or ride home together along the dusty road that winds between St. George's University and the back of the airport. The beach is the primary place where everyone has the opportunity to talk because outside of their workday not everyone "limes" or socializes together or at the same places.

The subgroups of friends frequently had age or similar interests in common, even if the interests were only "liming" or socializing. But not all the divers limed and a distinction was made during informal conversations between the churchmen and the others who did like to lime.

In Calliste, the popular liming spots centered around the shops that dotted the main road, there were two or three shops that attracted the most traffic by a variety of villagers. One had pool tables and monthly seafood buffets, another drew regulars who like playing cards and dominoes while other shop was across from the Friday night barbecue stand at the junction at the top of the hill. This barbecue stand drew a regular crowd on the Fridays. The stand was set up under the tree at the junction at the top of the hill, where everyone needs to pass on the way home after work and to go out back on Friday night. Starting in the late afternoon it is a husband and wife who began grilling chicken and pork, basted in a homemade barbecue sauce. Every Friday a few of the divers and friends from the village would sit under the tree late into the night usually sharing a bottle of red wine and talking.

The divers who did not lime, or lime with the other divers, gave reasons that included having too many family responsibilities to afford or have the time to lime, that they had other friends they preferred to hang out with or that they liked to go to other places instead. Meanwhile, there was one diver who did not lime in the village but provided a gym to anyone who wanted to use it. His goal was to provide a space that was an alternative to his perceived increase in the heavy drinking young men were becoming increasingly involved in. From his perspective, the drinking was unhealthy and unproductive and happening too regularly for Grenada's youth and providing the gym was one way to give them something else to do. He makes this gym free to use and a few of the younger and single divers use the gym regularly.

Calliste is a relatively small village with recurring kinship ties and plenty of opportunity for interaction and information and exchange on and off the beach. It is important to note that

interactions are never limited to the places described here and the villagers unabashedly heckle, shout out greetings, comments and jokes from their balconies to people passing up the road. Sitting under the tree, riding the bus to town and walking along the road are all opportunities to interact, Grenadians like to talk and visit and the villagers in Calliste are no exception.

The Parish of St. Andrews

Grenville is located on the eastern coast of Grenada and borders Grenville Bay. It is the second largest town on the island and is home to the Grenville Fish Market and a branch of the Fisheries Division. Grenville is also the capital of the parish of St. Andrews, a parish that has many fishing villages sprinkled along the coast including the villages of Soubise and Telescope. There was less written information about Grenville and the fishermen from these villages to confirm the observations made for this study Grenville and the fish market provide a central meeting place where a multitude of fishers from the surrounding area pass through nearly everyday.

The entrance to the fish market is found on the northern half of the main road that runs through Grenville. Navigating around store fronts, small stands selling fruit, waiting buses and the conductors who are trying to recruit passengers make getting to the market a trek in itself. If there is a surplus of fish young men will walk up and down the main road holding a few fish by the tail. Others will be sitting with more fish on ice, just inside the market entrance, continuously dropping the price as the day progresses. On quieter days, walking up to the market, one notices the shops clustered on the south side, creating a narrow jumble of small shacks selling drinks and food in the shade. The main buildings in the market include the Soubise Fisherman's Co-op's gas station which is a few meters away from the pier and then there is a fish vendor station. This government-sponsored facility is contained in a building on the northern end of the market.

The market is a main landing site for the area's fishers. There, fish can be sold to the fish vendors and ice and limited storage for surpluses are available. Meanwhile the Co-op's gas station supplies gas, engine oil, lures and drinks. In addition, there are two women, one European and one Canadian, who sell compressed air to divers and fishing lures respectively, from their own setups on the periphery of the market. The market provides a setting that is less "physically cohesive" (Kishore et al. 2006: 206) than the Calliste beach however it provides the facilities and all types of services that a wider variety of fishermen can utilize. There are fishermen who are targeting near shore and deep water species, using small fishing boats, larger trawlers, scuba or free diving, setting nets and shooting fish and who all congregate at this market.

The Grenville Fish Market is a place that allows one to fully appreciate the variety of fishing livelihoods that exist in Grenada. These fishers supply the market with everything from small reef fish to larger groupers, barracuda, snapper and then even larger pelagic species like dolphinfish and kingfish.

Typically the fishermen will refill their gas tanks at the end of the workday, before they head home, or they go to the market early in the morning to refuel. Most come to the market after a trip out to sea to sell their fish to the vendors and those from Soubise usually stop and "make a lime" at the Co-op gas station to play cards and have a drink.

Many of the study's participants came from the small fishing village of Soubise. Soubise is known as a village that retains the characteristics of a classic Grenadian fishing village (Isaac, pers. comm., 2008) with simple brightly painted homes that border the southern edge of Grenville Bay. These homes are separated from the water by a very thin strip of black sand beach and is so close to the water that the government is planning an eventual relocation further off the road, where the rest of the village extends into the hills.

Soubise has a large number of young fishermen (18-39 years) who catch a variety of pelagic and reef fish. Of the participants, 6 former sea egg divers have switched to fishing these species after the fishery closed. Appendix 7 provides a list of the species the participants have been fishing.

Compared to Calliste, the fishermen from Soubise are catching a greater variety of species and travel a further distance to catch them. They travel a wide area that extends to Carriacou and likely further beyond. It is not uncommon for overnight or multiple night trips to be taken to fish and dive in distant waters. This reduces the opportunity for predictable interaction and a regular routine similar to the Calliste divers since different crews that are targeting different species requires having different departure and return times. For example, the men who target the pelagic species like kingfish leave at 4am and return from their first run around 9-10am. Meanwhile, when the barewind divers go for lambie, they may leave after 7am and return in the afternoon around 2pm or later.

Even though there is not a single routine that brings all the fishers from Soubise together each day, they limed together noticeably more than the Calliste divers. This may be partially because the average age in this group being a lot younger than the Calliste divers. There was an undeniable social element to being a fisherman in this village. Fetes, cook ups, and liming at shops happened regularly and without cause. Comparatively, in Calliste, it would take a community event like Fisherman's Birthday an annual celebration hosted by fishing communities in Grenada, to draw most of the divers out for a night.

Soubise is a young fishing village that is part of the larger fishing community in St. Andrews. It has a lot of young men that are still involved in this livelihood and strong identity with fishing. This fishing village contributes to the bustling traffic of the fish market. A lot of fishers come from Soubise, there is the Co-op's businesses and then the fishers who attend

fisheries meetings. The fishing community has an active presence at the fish market and many of its residents are trying to improve fishing as a livelihood for everyone.

Box 2: The Soubise Fisherman's Co-operative

Soubise has its own co-operative as well, but its membership includes any eligible fisherman who applies to join so it's not limited to only divers.

A conversation with one of the board members provided the details of the Co-op and an appreciation for the work that has gotten the Co-op to where it is today, 30 years after its formation. Members must apply and they are only accepted if they are accepted. They are screened because, "not everybody are good members." They do not want disrespectful or uncooperative people who may complicate or hinder the work the Co-op does.

The Co-op owns and runs several businesses including the gas station, the lure counter and the drink shop in the Grenville Fish Market. They also own property in Grenville and have hired several women to work at their various businesses.

The Soubise Fisherman's Co-op has provided several busy and popular businesses to the fish market as well as a social place for fishermen to interact after work.

Grenada's Sea Egg Fishery

Grenada's sea egg fishery was a loosely formed fishery that drew a variety of people into the harvest, preparation and sale of sea eggs. Fishermen and young men would dive for sea eggs to supplement their income, taking them as they were available. Meanwhile families would send its members diving for sea eggs for cook ups on the beach and for cooking at home.

Preparing sea eggs for sale was labour-intensive and largely done by divers and people they hired as "breakers" to scoop out and cook the roe. After they were cooked and ready for sale they were sold outside of the marketplace, usually along the road or bought in bulk from local exporters.

The fishery was very small in scale but had far reaching impacts on the regional sea egg supply as it supplied to other islands who had already fished out their own stocks. The stability and abundance of Grenada's sea egg population was decimated and negatively impacted during

commercial harvesting of the 1980s and 1990s and is being still felt today. This is a description of the fishery prior to its closure in 1995.

Sea Egg Harvesting

Found in shallow waters all along the coast, sea eggs used to be collected by nearly anyone who was able to wade out from the beach and shallow dive. Sea eggs were easy to see with the naked eye and since specialized equipment was not needed for diving, sea eggs could easily be taken by nearly anyone.

Sea eggs provided food, income and a source of employment for Grenadians. In addition to those diving, others would be hired as breakers, part time work for women and young people who would help clean and cook the large boatfuls that would come in during the afternoon. Breaking sea eggs was time consuming and difficult. Taking a spoon or small piece of coral, sea eggs were broken face down on the palm of one's hand. After the husk was split open, the loose content of the stomach and mouth would be emptied and then the roe would be scraped out from the interior of the shell. A full boatload could take a whole afternoon to break with several people standing in the water, breaking and cooking the roe for sale.

When domestic and export market demands began to reach new heights, sea egg diving began to provide supplemental income, especially for young men. Specialized sea egg divers emerged and they began harvesting regularly. For some of these divers, in season, sea eggs were providing a significant amount of work and money (Isaac 1990). These commercial divers were typically young men between the ages of 16-35 and were described as, "young guys, opportunistic and looking to make money" (Isaac pers. comm., 2008).

The commercial divers were diving larger quantities of sea eggs than the average Grenadian who would dive for their own use. It was estimated that up to 6 trips per week, per crew of 1-3 men were being made by the commercial divers and that anywhere between 400-700

sea eggs were taken in one trip (Isaac 1990, Johnson 1990). But in spite of this effort, it never really provided full-time employment and many were targeting other demersal species at the same time(Isaac 1990).

Other than the divers, there were other people involved in the fishery. There were the aforementioned breakers, hired to help the divers with sea egg preparations and cooking, the exporters and the Fisheries Officials. All these actors contributed to the harvest sale and overall composition of this small opportunistic fishery that was still able to provide a livelihood and informal economic activity for the island.

Box 3: Barewind Diving in St. Andrews

Two key informants from Telescope and Soubise still dive using a snorkel, fins and a mask for lambie, lobster and to spearfish. They were the only two men I met that were diving "barewind" regularly and are possibly part of a very exclusive minority in the Grenville area.

Diving barewind is not particularly specialized but to be profitable, a diver has to be good and had to be able to dive at fairly deep depths. Other fishermen would go out diving with these two but it was well known that they could dive significantly deeper than the average person. Usually when other fishermen would go out to sea with them, it was to captain the boat and be keep-up while they dove because they could go the deepest.

These two divers were seen diving to approximately 60 feet but they said they could go down 80-110 feet when they wanted. Lambie was often at these depths around Sandy Island so they would use their sharp vision to spot the lambie on the seafloor, dive and then carry them to the surface. If there were too many to carry, they would flip them over onto their backs, making them visible from the surface with the pink lip exposed, eliminating its camouflage.

Diving for lobsters with the same pole and wire hook as the Calliste divers and spear fishing were also done barewind. When spear fishing, they targeted parrotfish, snapper, hind and anything else they found. They would swim underwater, shoot the fish and drag it on a clear plastic fishing line that was buoyed with a plastic soda bottle.

They went to different fishing grounds, depending on the day, the currents and which target species they wanted. There were lobster grounds, several lambie grounds and then other places where they would go to shoot fish. Like in Calliste, lambie was cleaned on the water just inside Grenville Bay, with one person chipping a hole in the shell's spire so the other person could knock the animal out. The third person would clean the lambie and they would go back with their catch to the market.

Barewind diving as a livelihood is physically demanding and the divers face many of the same risks that other fishermen experience. However, these two barewind divers preferred barewind diving to scuba because it was "natural" and they took pride on their skill as two of the deepest divers from Telescope and Soubise.

Equipment

Not a lot of equipment was needed to dive for sea eggs, especially at the beginning of the emergence of the commercial markets that fuelled this fishery. Only snorkel, fins and a mask were used for diving. Diving "barewind" and using non-motorized rowboats was the primary method for harvesting sea eggs, in all, very little investment was made, making sea eggs very profitable (Isaac 1990).

Crews would consist of approximately three people and the rowboats would often go out together, "sometimes, five boats would get towed out by an engine boat [to the sea egg grounds]" but one diver clarified that "we don't dive the same place...we got towed to the same grounds and then split up."

Naturally, the quantity of sea egg that could be taken at one time was influenced by the kind of equipment that was being used. In Calliste, as the divers gradually transitioned from free diving to scuba, harvesting efficiency increased noticeably. One diver commented that before he switched to scuba, using just a snorkel, fins and mark to dive, "patches were so full of sea eggs, they would take a week to empty but with scuba you could dive out in a whole day."

There was a general recognition that sea egg went "scarce" but the reasons and understanding varied between the participants and the participant groups. Table 3 provides a summary of the various reasons why the divers thought sea eggs went scarce in the 1990s.

Name	Village	Reason for going scarce
DC1	Belmont	Pollution from university
AC1	Calliste	Doesn't know
SuC1	Calliste	Diving too heavy
GoC1	Calliste	No data
GC1*	Calliste	Effects from revolution, chemcials, need more information
BGA	Grand Anse Valley	Pollution
RC1	Calliste	Over fishing
SS1	Calliste	Doesn't know
StC1	Calliste	Over fishing, not having a season
BC1	Calliste	Doesn't know
SiC1	Calliste	Over fishing
TG1	Telescope	Overfishing and another reason he doesn't know
HS1	Soubise	Doesn't know
MS1	Soubise	Doesn't know
DS1	Soubise	Doesn't know
AS1	Soubise	Doesn't know
RS1	Soubise	Dove too much
MC1	Porceral	Dove too much
JS1	Soubise	Over fishing, demand too great, did not give enough to regrow
BW1	Soubise	Pollution/chemcials in the water
ALT1	Telescope	Heavy fishing, too easy food and money
*originally from Grenville		

Table 3: Reasons why divers thought sea eggs declined

Location

Commercial sea egg diving was mainly concentrated along the eastern coast from River Sallee, to Woburn and along the south east coast around True Blue and Calliste. There was a small amount of sea egg diving in Carriacou, on its eastern and south-eastern coasts but there was not nearly as much as in Grenada (Isaac 1990).

The Grenada Fisheries Division identified nearly a dozen primary sea egg grounds where diving was concentrated, with another half dozen secondary sites that had sea urchin populations

but not as much diving. These sites were identified by divers and the fisheries officials' personal experience and knowledge of the area and of the fishery.

It was known that the preferred habitat of sea eggs that could sustain large populations, was in the shallow sea grass beds with loose, rocky bottoms or near coral reefs. This habitat is widespread on Grenada's eastern and south eastern coasts but not nearly as common on the northern tip of the island, near Sauteurs or along the western coast. This has been one suggestion as to why sea egg diving is uncommon on the other side of Grenada (Isaac 1990).

The eleven primary sites identified by the Fisheries Division include: True Blue Bay and Glovers Island; Woburn Bay; Petite Bacaye; La Tante Bay; Crochu Bay; Marquis; Conference Bay; Windward (Carriacou); Hillsborough (Carriacou); L'Esterre/Harvey Vale (Carriacou); and, Grenville Bay (the site of north and south reef). Secondary sites include: Petit Trou; Requin Bay; Marene Bay; River Antoine; Sandy and Green Island; Sauteurs Bay and Isle de Rhonde. The divers from Calliste primarily dove around the southeast coast as sea eggs were abundant along the reef by Calliste Beach and just north, around True Blue Bay.

The divers themselves listed the following sea egg grounds as the ones they dove, often using local names for the same sites identified by the Fisheries Division: Conference Bay; Marquis Island; South and North Reef; and River Antoine. The divers would keep an eye out for sea egg grounds and ones that might be ready for harvesting, they "would go out and check as we moving [in the boat] we would see them while out in the water."

Figures 5 and 6 are maps of the two coasts and where some of the surveyed sea eggs grounds are located.

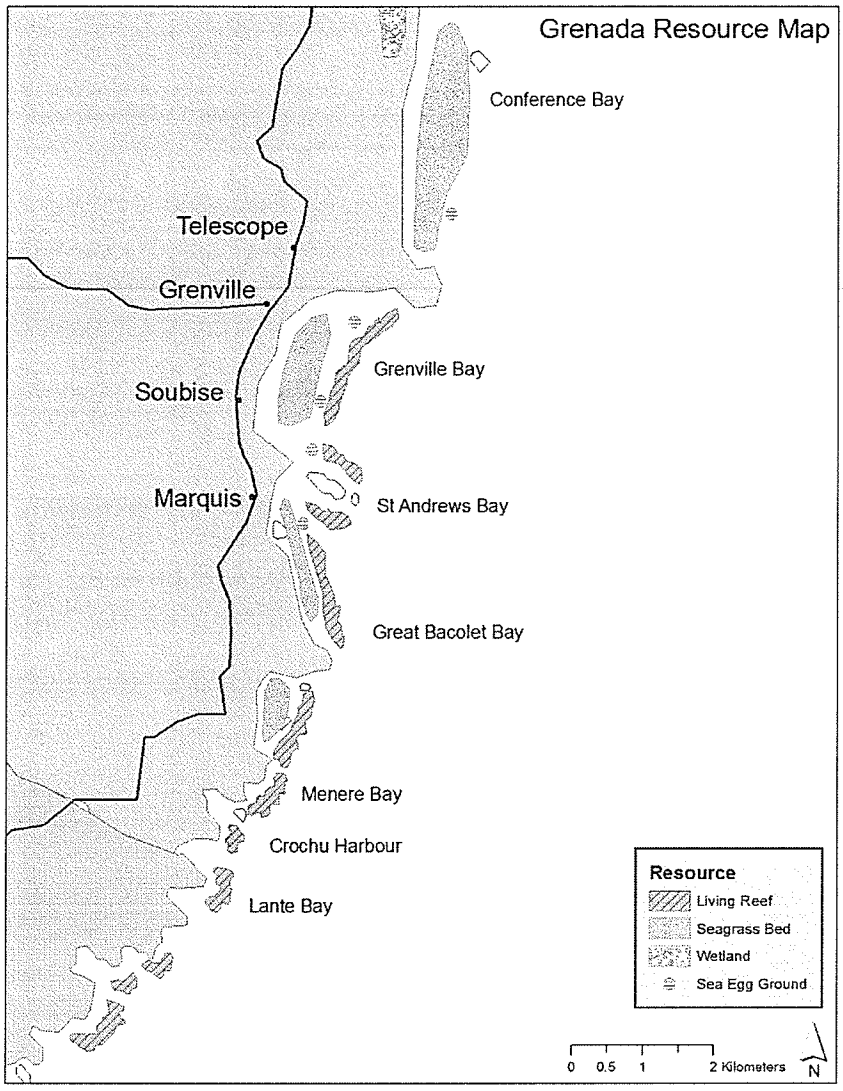


Figure 5. Grenada resource map of the eastern coast. Produced by S. Keo for author using information from the Grenada Fisheries Division.

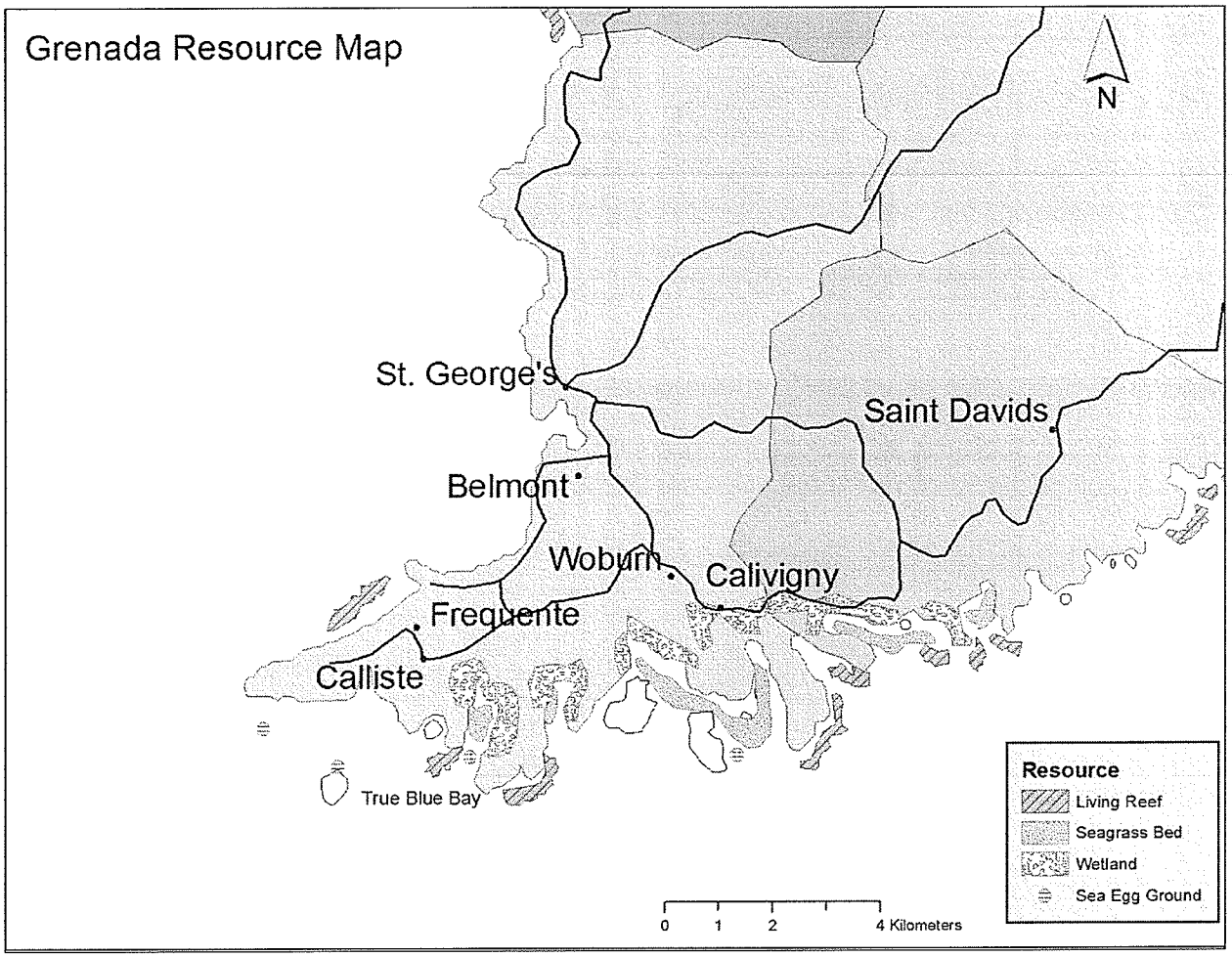


Figure 6. Grenada resource map of the south eastern coast. Produced by S. Keo for author using information from the Grenada Fisheries Division

Geospatial Relationship to Harvesting Locations

During the interviews it became clear that the divers did not venture far from their villages to go diving. The primary sea egg grounds identified by the Fisheries Division and those listed by the divers were almost always near the villages of the participants. After comparing the villages where the divers lived to where they dove for sea eggs, nobody went very far from their villages, this may have contributed to why there was such little interaction between the

participants groups. Additionally, after reviewing maps produced by the Fisheries Division, there appears to be a natural break in sea egg habitat along the coast near Requin and Westerhall Bay. This break along the coast would have likely discouraged divers, who were mostly traveling by rowboat, to venture beyond this point, given the amount of effort it would have required to reach sea egg grounds further past this point to reach other sea egg grounds.

Sea Egg Preparation

Boiled, roasted and served on toast were all popular ways to eat sea eggs. But cleaning and preparing sea eggs was a time consuming process and when the divers were selling sea eggs locally, they had the added task of having to cook the sea eggs too.

When the sea eggs were being sold locally, they were roasted and served in a half-shell. The divers and breakers would spend the afternoon scooping the roe out of each urchin and pack another half-shell until it was full. The packed shells would then be placed in a pit and covered with a piece of galvanized aluminium with a fire built on top, this was "roasting" the sea eggs and they would be sold for $4-5 EC depending on the size of the shell (Isaac 1990).

In contrast, if a diver was selling to an exporter, they were selling at wholesale prices per pound. In this case, the gonads would be "scalded" or placed in a pot of boiling water to keep them from "melting" or becoming too runny and losing their form. The sea eggs would then be packed into plastic bags or buckets and frozen and kept in cold storage by the exporter until they were flown to their destination.

Table 4 is the record of the quantity (lbs.) per year of sea egg exports that were shipped as made available by the Fisheries Division.

Table 4. Quantity (lbs.) of sea eggs exports (1985-1994).

Year	Exports (lbs.)
1985	No data
1986	No data
1988	1, 439
1989	No data
1990	No data
1991	7, 382
1992	816
1993	7, 519
1994	45, 031

Export and Local Sale

Exporting raw or semi-cooked sea eggs to Barbados and Martinique emerged as a significant market during the early 1990s (Isaac 1990). This new demand increased the quantities being harvested and changed how sea eggs were prepared for sale (Isaac pers. comm., 2008, Nimrod pers. comm., 2008).

The exporters and agents who were buying had routines established so the divers knew which days they would be driving up to buy or when the divers could bring sea egg down to St. George's. They also used word of mouth to spread news about new orders and shipments. When the divers were selling to local customers they cooked and sold sea eggs along the road. In Soubise, there were a couple of overgrown lots that were pointed out during interviews and it was where the divers would drag their boats ashore and would, break, cook and sell their sea eggs. As free and incidental advertising, the smoke from the fires built for roasting was a signal to the village that sea eggs had come in and were being readied for sale. Other divers had orders placed

in advanced and sold to their regular customers. Table 5 provides the responses of whom the divers were selling their sea eggs to:

Table 5. Who the divers sold their sea eggs to and where they thought they were being sold.

Diver (Respondent)	Buyer	Place thought being exported
DC1	SC1	Martinique
AC1	SC1	Barbados
GC1	RC1 & SC1	Barbados
BGA	Unknown	Barbados, TT, Martinique
BGA1	SC1 & HGA1	Barbados
SSC1	SC1 & HGA1	Barbados
RC1	RC1, SC1	Barbados, Miami
SC1	RC1	Grenada
TT1	SC1 & HGA1	Unknown
HS1	Unknown	Unknown
MS1	Unknown	Barbados
DS1	Iris, Marvel, AS1's Mom	Grenada
AS1	RC1, SC1, AS1's mom, Iris, BWS	Barbados, Grenada
MG1	SC1 & RC1	Barbados
RC2	Esther	Grenada
JS1	Esther	Grenada, Barbados
BWS	BWS	St. George's
CPW	CPW	Grenada
JS1	SC1 & HGA1	Grenada

Sites of Information Exchange

Identifying the sites of information exchange proved that there were several places that were still being used today much as they were before the ban was implemented. In Calliste, the beach was and currently is a primary meeting place.

In Grenville, the fish market is still a central meeting place but before, many transactions involving sea eggs occurred across a diffuse area, along roads and on what are now overgrown lots in villages like Soubise

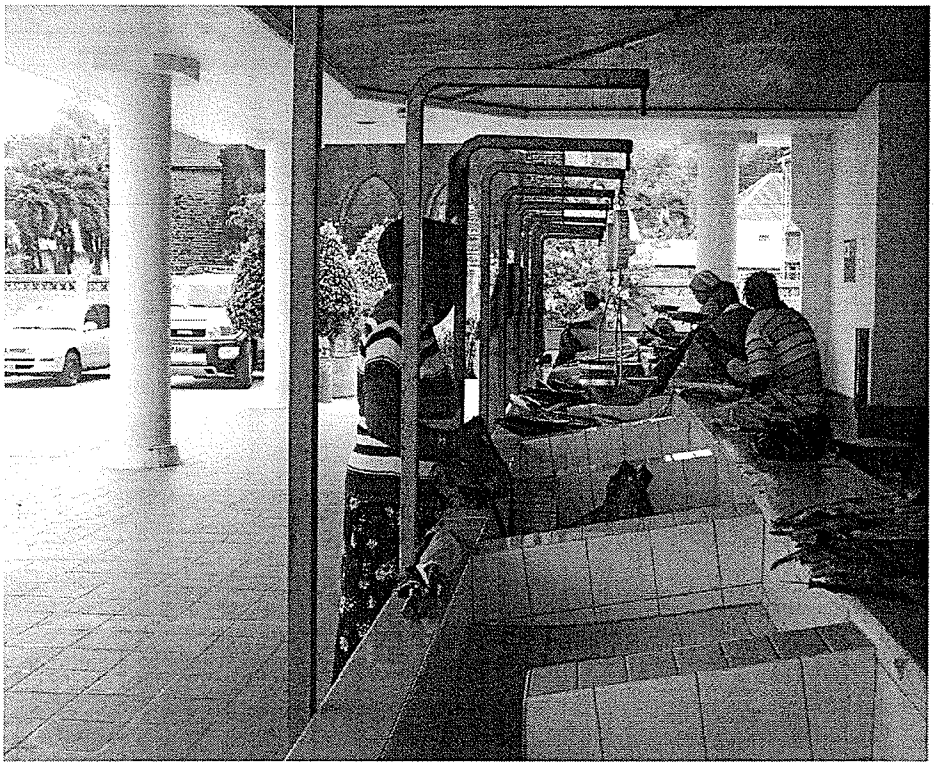
Diver Management Suggestions for Re- Opening the Sea Egg Fishery

Whether the fishery should be opened again was not unanimous among the divers. The reasoning for reopening the fishery varied, one diver from Telescope thought "the Beach Hunters [poachers] are already picking and it should be opened to give everyone who's been following the law a chance". Meanwhile three divers in Calliste complained that the fishery should be opened because the sea eggs were eating all the sea moss, a complaint acknowledged by two Fisheries Officials and a retired Chief Fisheries Officer. The four respondents that did not agree that the fishery should be reopened were all divers from Calliste. Two divers described the days when there were "so many sea eggs, it would take a week to empty" while another said "there used to be fields of sea eggs and there's not as much as before, there wouldn't be much of a fishery." However, the majority of the respondents felt that the fishery could withstand a certain level of harvesting. During the interviews the divers were asked for their ideas on how to manage the sea egg fishery if it were to re-open. The following suggestions were those offered from the divers:

Table 6. Diver management suggestions for re-opening the sea egg fishery.

Diver	Village	Management Suggestion	Open?
DC1	Belmont	Ban exporting	Y
SC1	Calliste	There should be a season, but shorter than lobster	Y
SS1	Calliste	A season like lobster, no fishing during reproduction	Y
MP1	Calliste	Licenses- but not enough to open	N
AC1	Calliste	Limit exports	N
GC1	Calliste	Not as much as before, can't have much of a fishery	N
RC1	Calliste	Not sure if there's enough to open	n/a
SSC1	Calliste	Season every other 6 months, take only small amounts	Y
SC1	Calliste	Reopen and have a season	Y
BGA	G.A. Valley	Limit boats going for sea eggs; can't manage b/c not enugh	N
MC1	Proceral	Have seasons and fines	Y
DS1	Soubise	Open fishery to see what happens and then close it	Y
JS1	Soubise	Should be able to take them home (personal use), have seasons	Y
HS1	Soubise	Open for a few weeks or month and then close and see how recovers	Y
MS1	Soubise	Open for a couple of months and close for the year, maybe reopen again	Y
DS1	Soubise	Open for short period of time, close and see what happens	Y
AS1	Soubise	No answer	Y
RS1	Soubise	No engine boats	Y
BW1	Soubise	Should reopen	Y
TG1	Telescope	Open fishery for 3 days as a test; allow taking for yourself, licenses	Y
ALT1	Telescope	Licenses that come with training to teach when to take sea eggs	Y
CPW	Westerhall	No answer	n/a

CHAPTER FIVE: Discussion, Recommendations & Conclusions





Discussion

The sea egg fishery is a small-scale fishery that exemplifies many of the complicating characteristics that make these fisheries difficult to manage (Breton et al. 2006). In this case, divers targeted multiple species, had relatively low capital investment, used small boats and traveled fairly short distances to reach the sea egg grounds.

Managing the sea egg fishery will be difficult given the obstacles and limitations surrounding the uncertainty of the population dynamics of the species. Historically, the absence of management and the proximity of the sea egg grounds to the shore created a situation where sea eggs were accessible to nearly anyone and there were very few social or ecological limitations to control harvesting. Additionally, the limited ability of the fisheries authorities and the fishing communities to fully engage and focus on managing this single species is another reality that needs to be addressed.

Managing the fishery will be difficult for these reasons and management authorities will be challenged on every front in finding an approach that might be effective. There are a complex set of limitations that stem from the uncertainty and the lack of understanding of the population dynamics of the species, their own limited ability to focus on managing solely this species and of the fishing communities, who will invariably be involved in the fishing and management of the species.

There is relatively little information on sea egg population dynamics and the factors influencing their abundance and distribution are not well understood. Having a blanket strategy that tries to manage without having a detailed assessment of the stocks each year prior to the start of the season would be futile. At the same time, however, conducting extensive research to collect data on the species, their reproduction, patterns, distribution and abundance would be time consuming and expensive. Such large costs would add to the obstacles facing the Fisheries

Division. There is a general understanding that quite often fisheries authorities in SIDS are ill-equipped to manage the diverse number of fisheries that fall under their jurisdictions which means that undertaking comprehensive management for the numerous fisheries that earn little revenue is often not practical nor feasible. This is because the fisheries authorities are often modeled after colonial-era systems that are suited to, and properly supported in, large, developed countries, but translate poorly to SIDS fisheries departments that are often insufficiently funded. (Mahon and McConney 2004). This creates a situation where a management plan that is meant for large, high value species administered by well funded department leaves many fisheries authorities in SIDS with insufficient staff, with resources that are spread too thinly and which leave no single fishery being effectively managed. (Mahon McConney 2004).

Fishing communities face their own obstacles that parallel those of fisheries authorities. They are frequently challenged by issues related to poverty and allied problems, limiting their ability to access information, to participate in management and incorporate sustainable fishing practices into their livelihoods (FAO 2007b). These circumstances reduce the ability of fishers to improve their quality of life and reduce the harmful impacts they may have on local fishery resources (FAO 2007b).

How to manage a fishery like sea eggs depends on several factors and alternatives to conventional management should be examined. There is potential to develop new systems of governance but this depends on existing legal, political, economic and cultural institutions and the ability for new ones to be created (Swan 2000). Converting the fishery from an unregulated livelihood activity to one that is managed could be costly, ineffective and subsequently may reduce the economic and social benefits the fishery provides (Floodman Becker 2004).

A new approach to management is necessary because what has been tried has not been very effective. Left unregulated, the sea egg populations collapsed while the current moratorium

has not stopped poaching from happening. But improving management and compliance is difficult, if not impossible, because of the high degree of uncertainty surrounding the population dynamics of the species. Additionally there are the limitations of the fishery participants and so considering new alternatives to fisheries governance may be a worthwhile consideration.

Adaptive co-management strategies can be designed to adjust and change as new information is learned while one approach is applied and the results are experienced (Smith and Berkes 1991). Using an ACM approach that can be modified based on the location of the sea egg grounds and site-specific conditions could circumvent the difficulty of managing with uncertainty and the risks of inefficient overregulation (Floodman Becker 2004) allowing fisheries authorities to take advantage of the informal fisher networks, the presence of influential fishermen to disseminate information, redistribute power and include the resource users in decision-making (McConney et al. 2007).

The Geospatial Relationship to Harvesting

There were several reasons which likely contributed to why divers primarily dove for sea eggs near their villages rather than traveling great distances along the coast. Including the use of non-motorized rowboats as the primary method of transportation to the harvesting areas, posing a significant limit to how far they could potentially travel, and the gap between sea egg grounds along the coast near St. David's. These factors may all have contributed to the infrequent interaction between the different diver groups while they were diving for sea eggs.

If sea egg diving still followed this pattern, it would suggest that managing the sea egg grounds with the adjacent fishing villages would be possible because there had been little overlapping use of the sea egg grounds by distant groups of divers like those in Calliste and Grenville. Even though the divers do travel a great deal further today, there is still minimal

interaction because they target different species and they do not use the same fishing equipment. However it is the widespread use of motorboats, cell phones and scuba equipment that has changed communication, increased harvesting efficiency and the possibility that divers will dive further from their villages to get sea eggs.

Today there is high spatial mobility that has come with the widespread use of motorized fishing boats, there is increased harvesting efficiency and limited personnel to manage this relatively low-value, poorly understood species. ACM is one approach that can be used to address this however comprehensively managing only this one species is unlikely and probably not worth the investment of the already stretched time and resources of the Fisheries Division. Instead, capitalizing on Section 19 of the 1986 Fisheries Act could provide the opportunity and legal basis for putting some or all management responsibility into the hands of the fisher groups, taking the pressure off the Fisheries Division. That section reads, ,

"The Minister may notice by Gazette:

a) designate a local area as a fisheries management area

b) designate any local authority fishermen's authority or fishermen's co-operative or fishermen's association or any other appropriate body representing fishermen in the area at the Local Fisheries Management Authority for that area" (Grenada Fisheries Act 1986).

The Fisheries Division could use this section as basis to make use of the geospatial relationship of past and current diving patterns, the presence of the diver communities and the underlying need to manage more than just this one sedentary species. Using an ACM approach that does manage for fishing territory would justify and increase the overall worth of investment in management.

Acknowledging the relationship between the fishers' residence, their target species and their gear types reflects the geospatial factors that are influencing the interaction between the two groups and also may provide the basis for assigning conditions that can manage areas and their targeted species that may have otherwise been overlooked. This may also provide the basis for assigning conditions and harvesting rights to the existing groups of divers while providing for them to participate in the assigned fishing territories that require monitoring to ensure regulations are being followed for multiple species.

Networks and Social Network Analysis (SNA)

The questions about the social network connections were framed in the interview schedule by asking the divers with whom they went diving and whether they knew the names or of any divers from the other participant group. It turned out that trying to create lists of specific individuals who were diving for sea eggs in the 1980s and 1990s was difficult. Divers had trouble remembering specific names of other divers, especially if they were not from the same parish or village.

Despite this it became clear that the divers from St. Andrews and Calliste interacted very little when the fishery was open and this persists to this day. The geospatial connection the divers had with their chosen sea egg grounds reduced the possibility that these two groups would interact on the same sea egg grounds. As well, there was the reduced mobility that has to be attributed to the use of non-motorized boats. The time and exertion it would have taken to row to the various grounds would certainly have influenced how far the divers were willing to travel to go diving.

Examining the social networks of the fishery revealed that while there was little interaction between the two groups of divers, there were other notable social network features.

"Betweeness" or the high level of modularity with a distinct separation was apparent between the Calliste and St. Andrews divers. High degrees of modularity or betweeness can affect the development of knowledge, access to information and the ability to perceive changes in an ecosystem (Bodin et al. 2006). These effects emerged when the divers gave their suggestions for re-opening the fishery (please see table 6) and suggested reasons why sea eggs went scarce. Only in Calliste were there respondents who felt that the fishery should not be re-opened, while everyone in the St. Andrews group felt that at least some level of harvesting could be sustained. This may reflect differences in local sea egg populations but it also could be the influence of a prevailing consensus that has gradually become accepted over time. This modularity may also help increase understanding as to why there were regional differences in the suggestions of why the divers thought the sea eggs had declined. It was in Calliste where a few divers had thought that pollution and discharge from underwater pipes at St. George's University and at the airport caused the sea eggs to go scarce and has prevented them from returning. In contrast, over fishing was said to be at least one of the causes of decline by nearly all of the participants.

Differing perceptions and knowledge about sea egg abundance and distribution and what should be done to manage the fishery is understandable. That there are differences between both groups and within the groups reflects perceived differences and general knowledge, possibly reflecting population and environmental differences along the coast. This is another reason why designing a more flexible, adaptive management strategy is required. If the Fisheries Division collaborates with the different diver groups or villages, it will be able to adjust for the different rates of recovery between the different sea egg populations as well as empower the divers by acknowledging and valuing their knowledge. Using their understanding of the fishing grounds is necessary and it would also include the divers, giving them more incentive to cooperate and participate in management.

Divers are not the only fishery participants who need to be included in governance. Incorporating the future sea egg marketers is also needed because historically, these were the actors who were supplying the demand created by the export markets. These actors had an advantage as the only people who were connecting the separate group of divers, giving them the advantageous position as a "broker" who had access to information and had the option of disseminating what they had learned or keeping any new information to themselves (Bodin et al. 2006). As a major player in the marketing and sale of sea eggs, the role that the exporters have in the future sea egg fishery and its management must be taken into consideration. Hopefully only management can positively take advantage of the position they will occupy in the fishery's network.

Another social network feature that was identified was the existence of cohesive resource user groups. This was useful for determining whether there were communities of resources users that could be included in improving fisher governance of the fishery as well as identifying a group to whom harvesting rights could be assigned(Acheson 1981). Using the networks approach contributed to the overall understanding of the different features of interaction (Carlsson and Berkes 2005) and the basis for how the resource groups are presently formed in Grenada.

Using participant and direct observation, it was clear that cohesive groups and subgroups existed in both communities. Within both, there were clearly some divers who had the attention and respect of their peers and occupied positions of leadership and influence. They did not necessarily lead the group or dominate it as such but their influence was unmistakable. A diver in Calliste said "divers are the leaders, they are the ones that bring in the money". While one Calliste captain described the leadership dynamics in Calliste as, "every boat captain is a leader but no one rules the beach. Meetings start with anyone who has something to say". It was true, if

someone had a concern or something they wanted to discuss, it would be mentioned. The presence of leadership was certainly acknowledged though it seemed depending on one's role in a crew affected their perceptions of who had more influence.

In St. Andrews, having the Fisheries Division office at the fish market was convenient for relaying information from the office directly to those working in the market. Organized meetings and the open-door atmosphere of the office created a relationship where the fishermen had nearly direct access to the Fisheries Officials (FO) and in return, the FOs were well aware of the activities and routines many of the fishermen had, making it easy to find individuals when they were needed.

Another feature that may make an ACM approach to management possible with the participant communities is that they both were two small fishing villages that bordered a bay. Being in Grenada, one could not say that the villages were isolated; however, the neighbouring village was not in the immediate area. This may improve the chance that each group may be willing to take part in the management of their respective sea egg grounds, if they are part of a recognized fishing territory they can claim some level of responsibility.

Fishery Management Recommendations

The sea egg fishery faces a variety of challenges if it is to be managed and a lot of variables need to be taken into consideration. Unfortunately, a lot of information that would be required to make decisive management decisions is not available because of the uncertainty surrounding the population dynamics of the species. However, the re-opening of the fishery is possible with the growing opinion that the sea eggs are back and "going to waste." Despite the uncertainty management will likely come down to whether the Fishery Division uses a

conventional management approach, an ACM approach or a combination of the two. Incorporating some management regulations that reflect the contribution overharvesting had in the collapse of the fishery would be prudent to help curb potential violations and overfishing.

Prohibiting exports, gear restrictions and having short, defined seasons may the most sensible management policies to help prevent overharvesting. Eliminating the possibility of export sales would also remove one of the major stressors on the fishery and reduce the overexpansion of the fishery.

Gear restrictions, prohibiting the use of diving with scuba or using motorized boats would also reduce the harvesting efficiency of the divers as well as limit the distance and area a diver could exploit in a given day.

Having short defined seasons and possibly managing fishing grounds or territories would be another way to manage and control the quantity of sea eggs being taken. To facilitate enforcement and monitoring, staggering the opening of various grounds, depending on their readiness may be another option to consider.

These are all suggestions based on the premise that they would be followed and that there would be adequate enforcement. But the reality is that current restrictions for other species are violated and also very difficult to enforce because there are not enough Fisheries Officials to monitor every area. Seasonal closures are circumvented by stockpiling out of season. Certain species are frozen in home freezers until the season is reopened and then they are sold. This is why limiting export sales might be one restriction over which the Fisheries Division may be able to retain relative control over. Exporting seafood requires a license and sea eggs had to be flown off-island as they would have spoiled before they reached their destination had they been sent by sea (J. Finlay pers. comm., 2008). Given that the government continues to have a lot more

control over shipments being sent through the airport rather than by sea it remains likely to be able to continue to control export sales of sea eggs.

Managing with so much uncertainty will be difficult and using an adaptive approach would be the best way to compensate for the lack of information, limited research and resources available for management. Adaptive co-management would merge the best of both management approaches by not being heavily reliant on data, engaging resource users and, if territorial management rather than species-specific management was used, it could maximize the investment being made to manage the fishery.

Conclusions

Uncertainty was a recurring theme and underlies many of the key concepts that were examined in this study. Uncertainty was seen as an important component to sea egg population dynamics, livelihood diversification and provided at least one reason why adaptive co-management (ACM) would be a fitting management approach for this fishery.

Meanwhile, the research objectives for the research were investigated and answered. The objectives drew out more of the implications uncertainty will have in management but also contributed to the overall description of the fishery and its networks. The objectives and the results are as follows:

Objective 1: Identify the actors in the sea urchin harvester network:

The actors in the sea fishery were not solely divers; there were exporters, breakers, buyers and Fisheries Officials and all participated in the fishery network. The divers were the majority

and pivotal to the activity but the exporters and the others all contributed to the marketing and distribution of sea eggs in the area.

Objective 2: Analyze the linkages between the actors:

Contrary to expectations, the divers in the participant communities did not have direct linkages among them. Within both groups, linkages were strong, however there was very little interaction between the actors in both groups when the fishery was still open. This may have been in part due to the use of non motorized boats and the distribution of the sea egg grounds which had a natural divide between the east and south-eastern coast. This created a geospatial relationship between the sea egg grounds and the villages of the divers.

It also became clear that the key actors that connected the two participant groups were the exporters who traveled along the coast, buying sea eggs from the divers from several coastal villages including Calliste, Woburn, and villages around Grenville. Divers and Fisheries Officials named these exporters as the buyers who were buying sea eggs for export sale to other islands.

Objective 3: Describe the shared sites of interaction and exchange amongst the actors:

The divers in Calliste used Calliste beach as their main landing site and this continues today. The crews set out each morning and return in the afternoons, maintaining a routine that allows them to interact on a daily basis. More informal exchanges occur at liming spots in Calliste, at various shops and during community events. More formally organized is the Calliste Divers Co-Operative which meets twice a month to discuss ideas and projects related to the group and its members.

The divers in St. Andrews gathered at the Grenville Fish Market, a place where their catches were sold or stored, and a place where most necessities for a day at sea could be bought. When the divers sold sea eggs, they broke and sold them at various beaches and vacant lots along Grenville bay, wherever they landed their boats. Sea eggs were sold along the side of the road and drew nearby villagers, who would follow the cooking fire's smoke, to the divers. Interactions and exchanges were a bit more diffused across the Grenville area with interactions occurring at the market, along the roadside, and at the various landing sites at the villages.

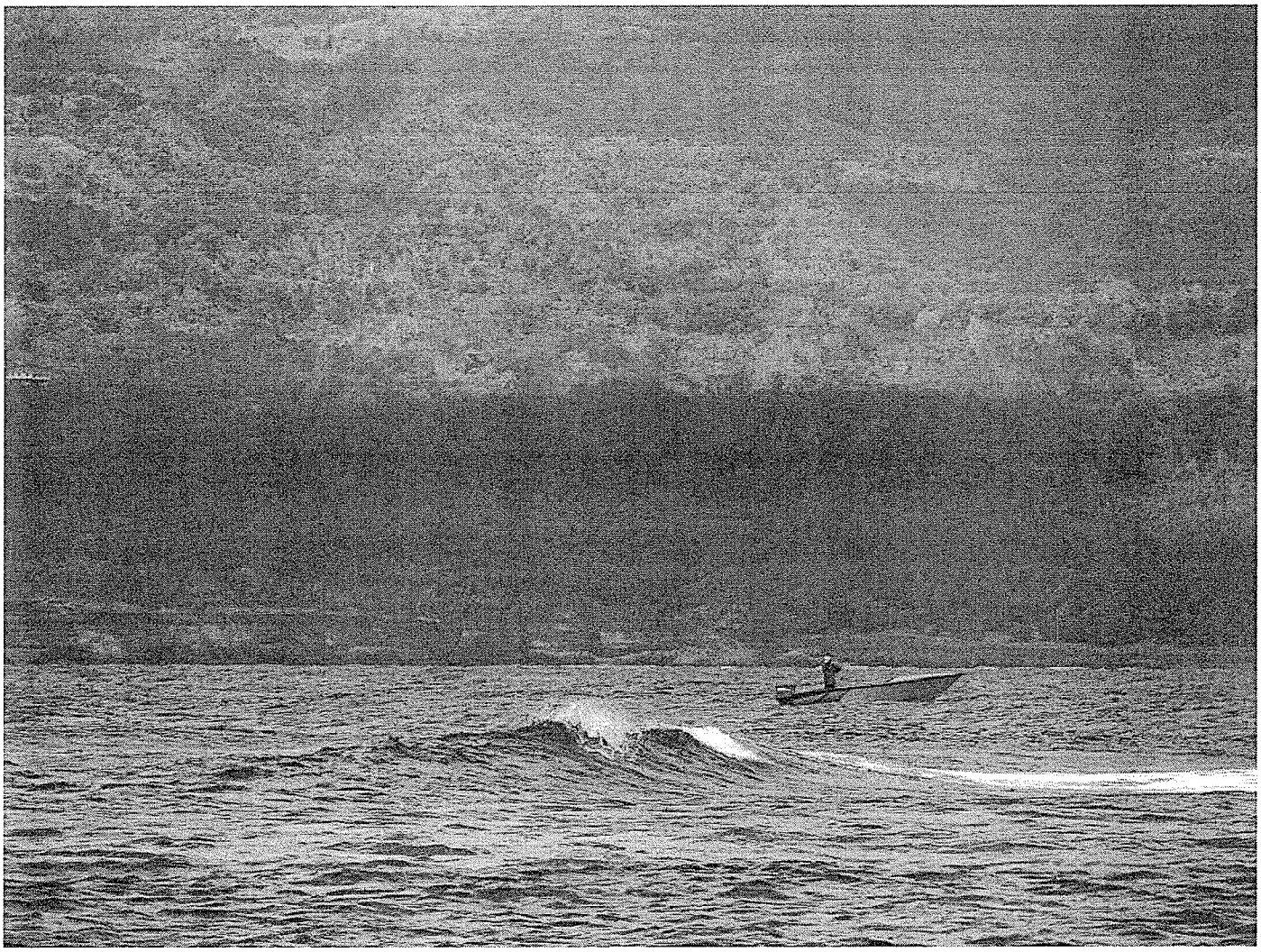
Objective 4: Determine the implications that the social-ecological networks have for sea egg co-management:

There have been changes to components and actors in the fishery's network since the fishery were closed over 14 years ago. Some divers have left fishing or have moved away altogether in the years following the moratorium. The present widespread use of motorized boats, scuba and cell phones would contrast sharply with fishing in the days of sea egg harvesting when rowboats that needed to be towed to sea egg grounds were the main means of transportation. Now harvesting efficiency and communication have changed and resulted in sea egg grounds being more accessible and harvesting was more efficient. It became clear that the specific historical social network linkages of the fishery may not be relevant for management today however the information about the role of actors like the exporters played is useful and can help shape the roles all the actors will play in future management.

These results showed that the organization of the fishery's network was informal and that uncertainty was an underpinning of the social and ecological components of the network. This indicates that any effective management plan has to take into consideration the high level of uncertainty. The opportunity to use an ACM approach to designate fishing territories and to delegate management responsibilities to the fishermen is possible because of Section 19 of the

Fisheries Act and should be examined further. This arrangement could be equipped to deal with local variability while extending the associated management costs across an entire area rather than a single species that generates a limited amount of revenue. This would justify the cost of management and allow the social and economic benefits the fishery.

Grenada is at a crossroads, it has witnessed the gains and failures of the management attempts of neighbouring sea egg fisheries in the region. It has now entered this discussion and begun to contemplate about what will be needed for its own fishery at a time when there is renewed local interest in sea urchin fisheries in the Caribbean and beyond by regional and international organizations. In Grenada's favour, the previous experiences of its neighbours and the growing body of ACM research available at its disposal, something, which was not available at the initial onset during the start of the period when sea eggs were overharvested. This marks a new chapter in the governance of Grenada's fisheries management and the new governance. It will be an interesting case to follow potentially drawing local and regional attention as governance options are explored and tested.



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Appendix 1: Methodology Table: Objectives

Objectives	Sub-objectives/ other questions	Methods	Data Sources
Identification of sea urchin harvesters and networks (how harvesters are connected to others)	What are the other occupations/ livelihoods?	Informal interviews, participant observation	Informants
	Where do harvesters fish/harvest?	Interviews, mapping, Participant observation	Informants
		Semi-structured interviews	Fisheries officials
Identification of sites of information exchange	Where do harvesters interact?	Informal interviewing, participant and direct observation	Informants,
		Semi-structured interviews	Fisheries officials
	What is the role of middlemen/ traders in information dissemination?	Informal interviewing, Participant and direct observation	Informants
	Does the govt try to communicate with harvesters? How?	Semi-structured interviews	Fisheries Officials
Implications for mar. res. gov. and ACM	How will network org affect governance? Possibilities for ACM?	Interviews, literature review, results from network analysis	

Appendix 2: Methodology Table: Sites of Information Exchange

Objectives	Sub-questions	Methods	Sources
Identification of informal sites of information exchange	Where are these informal meetings places?	Conversations, informal interviews, participant and direct observation	Informants
Identification of markets and selling points of sea urchin	Where were the selling points for s.u.? (ie. Roadside, markets, beach)	Conversations, informal interviews, participant and direct observation, mapping, document review	Informants
	Who were the vendors and traders?	Semi-structured interviews	Fisheries Officials
	How was the s.u. sold (barter, cash, etc)		
	Who did the harvester sell to? (vendor, trader, hotels, beach)		

Appendix 3: Interview guidelines with exporters:

The questions listed below are related to the characteristics to be identified as described by Martin (1995). Sea eggs were not sold at markets and when divers were not selling sea eggs directly, it was a small group of exporters that bought sea eggs for sale to other islands (C. Isaac, Grenada Fisheries Division, personal communication).

Exporters:

1. Where did you live before the ban? Current village?
2. How did you contact the divers?
3. Did you travel to other areas to buy sea urchin?
4. Who/ where did you sell to?
5. How often did you buy sea urchin?
6. How did you transport orders to other islands?
7. Did you sell other fish?
8. Who were other exporters?
9. How was it prepared?
10. How did the divers know how to prepare the orders?
11. Did you pick up orders? Where did you go?
12. Where did the divers come from?

Appendix 4: Interview guidelines for semi-structured interviews with Grenada Fisheries Officials

A. Information about the moratorium

1. When was the moratorium on harvesting sea urchin put in place?
2. Are there any conditions with the moratorium?
3. Have there been other bans on harvesting sea urchin before? When?
4. How did the department communicate the harvest ban to the harvesters?
5. Does the ban every get temporarily lifted? When? Why?
6. How does the department enforce and monitor the moratorium?
7. How successful is the compliance with the ban?

B. Identification of sea urchin harvester networks:

1. Who are the sea urchin harvesters? *(ie. names)*
2. Where did the sea urchin harvesters live?
3. Where did harvesting occur?
4. When did harvesting occur?
5. Was sea urchin a primary or secondary source of income for harvesters?
- Did this change with availability?
6. Was sea urchin harvesting done full-time, part-time, occasionally?
7. Do you know if these harvesters were employed in other jobs or participated in other fishing activities?

C. Identification of sea urchin networks:

1. Where sea urchin was harvested?
2. What kind of gear was used to harvest sea urchin?
3. How did harvesters reach the urchin? *(ie. diving, walking out from the beach or boats, etc)*
4. Were other species harvested at the same time? What kind?
5. Were other species harvested during other parts of the season by the harvesters? What kind?
6. Did harvesters increase pressure on any species after the ban was put in place? Which ones?

D. Assessing how harvesters link to other networks:

1. Do you know if any of the harvesters had other jobs?
2. Where was sea urchin sold? (ie. beaches, roadside, markets)
3. Who bought the sea urchin from the harvesters? (ie. traders, families)

E. Question about information dissemination

1. Were brokers or traders part of the sea urchin fishery? Who were they? Where were they from?
2. Were they mobile or stationary? What areas did they operate in? Did they move between islands? Which ones?
3. Who did they sell to?
4. Did they buy more than one product?
5. Did the Fisheries Division share information with harvesters? How were the harvesters contacted?
6. Did any harvesters or traders actively participate in fisheries meetings or on boards?

Appendix 5: Interview guideline for informal interviews with harvesters

A. Harvester Profile

1. Name
2. Where do you live?
3. How long had you harvested sea urchin?
4. Did you fish anything else?
5. Do you fish now? Which species?
6. Do you have any other jobs?

B. Harvesting Activity Questions

1. What are the good spots for harvesting sea urchins?
2. How often do you harvest? At what time of year?
3. Do you free dive or use anything else to pick sea urchins?
4. Do you harvest alone or with anyone else? Who?
5. Did anyone else help prepare sea urchin?
6. Was sea urchin ever a primary source of income? Secondary or less?

C. Informational Network Questions

Ecological Information:

1. Where did you learn about sea urchin biology? (i.e. apprenticeship with dad)
2. How do you know where to find sea urchin?

Marketing Information:

1. Where did you get market price information?
2. How did you find out who was buying sea urchin?
3. How did you know who was buying sea urchin?
4. How did you know how the sea urchin had to be prepared before being sold?

Harvesting Information:

1. From who did you learn how to harvest?
2. Were there other harvesters with whom you exchanged information about sea urchins from season to season? Why them?
3. How did you learn about the harvesting ban?

Information about Fishery Organization:

1. Do you know any other sea urchin harvesters?
2. How do you know the other harvesters? (i.e. family)
3. Do you ever meet with other harvesters? Where?
4. Do the harvesters ever meet in groups?
5. Were there any specific places where you would be most likely to see and talk to other harvesters? Where?

6. How was the fishery organized before the moratorium?
7. Do you belong to any organizations or groups?
8. Do you ever attend fisheries meetings? For which fisheries?
9. Are you friends with other harvesters? Where do you hang out? Do they have other jobs?

D. Marketing Network Questions:

1. Did you sell sea urchin or did you keep it for yourself/ family?
2. Where did you sell the sea urchin?
3. Who did you sell sea urchin to?
4. How did you know the buyer(s)?
5. How did you contact him when you had sea urchin to sell?
6. Do you know who the buyer sold to?

Other questions:

1. Do you have suggestions for managing the fishery?
2. Did divers know sea egg harvesters from other villages?
3. Why do you think sea eggs went scarce?
4. What local terms are used for sea eggs/sea egg-related things?

Appendix 6: Interview schedule for Calliste participants

A. Harvester Profile

1. Name
2. Where do you live?
3. How long had you harvested sea urchin?
4. Did you fish anything else?
5. Do you fish now? Which species?
6. Do you have any other jobs?

B. Harvesting Activity Questions

1. What are the good spots for harvesting sea urchins?
2. How often do you harvest? At what time of year?
3. Do you free dive or use anything else to pick sea urchins?
4. Do you harvest alone or with anyone else? Who?
5. Did anyone else help prepare sea urchin?
6. Was sea urchin ever a primary source of income? Secondary or less?

C. Informational Network Questions

Ecological Information:

1. Where did you learn about sea urchin biology? (i.e. apprenticeship with dad)
2. How do you know where to find sea urchin?

Marketing Information:

1. Where did you get market price information?
2. How did you find out who was buying sea urchin?
3. How did you know who was buying sea urchin?
4. How did you know how the sea urchin had to be prepared before being sold?

Harvesting Information:

1. From who did you learn how to harvest?
2. Were there other harvesters with whom you exchanged information about sea urchins from season to season? Why them?
3. How did you learn about the harvesting ban?

Information about Fishery Organization:

1. Do you know any other sea urchin harvesters?
2. How do you know the other harvesters? (i.e. family)
3. Do you ever meet with other harvesters? Where?
4. Do the harvesters ever meet in groups?
5. Were there any specific places where you would be most likely to see and talk to other harvesters? Where?
6. How was the fishery organized before the moratorium?
7. Do you belong to any organizations or groups?

8. Do you ever attend fisheries meetings? For which fisheries?
9. Are you friends with other harvesters? Where do you hang out? Do they have other jobs?

D. Marketing Network Questions:

1. Did you sell sea urchin or did you keep it for yourself/ family?
2. Where did you sell the sea urchin?
3. Who did you sell sea urchin to?
4. How did you know the buyer(s)?
5. How did you contact him when you had sea urchin to sell?
6. Do you know who the buyer sold to?

Other questions:

1. Do the boats go out together on purpose?
2. Do you mark the fishing grounds? How do you know where to go?
3. Do you have any ideas on why sea uchin went scarce?
4. Do you have suggestions for management?
5. Do you belong to the Divers Association?
6. Do you lime with the other divers?
7. Is information shared about good fishing grounds?
8. Why do you think sea eggs went scarce?
9. Are there local terms for sea eggs/ sea egg-related things?

Appendix 7: Current species being targeted by the divers

Diver	Target Species
DC1	Lambie, lobster, reef fish, sea moss
AC1	Lambie, lobster, reef fish, sea moss
GC1	Lambie, lobster, reef fish, sea moss
BGA	Lambie, lobster, reef fish, sea moss
SiC1	Lambie, lobster, reef fish, sea moss
SuC1	Lambie, lobster, reef fish, sea moss
GoC1	Lambie, lobster, reef fish, sea moss
BC1	Sea moss, lambie, lobster, spearfishing
SSC1	n/a
RC1	n/a
StC1	Owns trawling boat
TT1	Lambie, lobster, reef fish, pelgics
HS1	Yellowfin, Bluefin marlin, dolphinfish, kingfish
DS1	Lambie, lobster, reef fish, pelagics
MS1	Dolphinfish, kingfish, bonita
AS1	"Fish"- (he trawls)
MS1	Dolphinfish, kingfish, bonita
RS1	n/a
ALT1	Lobster, lambie, fish
CPW	Seamoss, lambie, lobster, longline, dolphinfish, barracuda

Appendix 8: Glossary of Local Terms

Barewind diving- free diving with a mask, snorkel and fins

Wawet- a type of seamoss that sea eggs eat and cover themselves

Tache- a patch of sea eggs

Sea egg brine- boiled sea egg stock

Scarce- when sea eggs were not abundant

Melting- used to describe when sea egg gonads were runny

Kaibot- a cluster of sea eggs

Ginger- pieces of broken coral that is shaped similar to ginger, sea eggs use to cover themselves

Keep-Up Man- the boat captain that looks for the rising bubbles from the scuba tanks. This how scuba divers are followed from the surface.



NOTICE

Fisheries (Amendment) Regulations 1996

CLOSED SEASON

The Minister Responsible for Fisheries, pursuant to the Fisheries Regulation 1996, hereby gives notice that he has declared the periods hereinafter mentioned as **CLOSED SEASON** for Lobsters and Turtles and a **CLOSED FISHERY** with regards to **SEA URCHINS (Sea Eggs).**

LOBSTERS -- 1st May to 31st August

TURTLES -- 1st May to 31st August

SEA URCHINS -- 1st January to 31st December
(SEA EGGS) (CLOSED FISHERY)

Permanent Secretary