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The sea urchin fishery in Grenada: A case study of social-ecological networks

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ABSTRACT

The sea urchin fishery in Grenada: A case study of social-ecological networks

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This paper examines 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 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 for the research f a Masters degree at the Natural Resources Institute at the University of Manitoba, Canada. Methodology included 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.

Keywords: white sea urchin fishery; social-ecological networks; Grenada

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1. INTRODUCTION

Small-scale fisheries provide important livelihoods for fishermen and for communities around the world, and especially in some parts of the Caribbean. Near shore species like the white sea urchin (*Tripneustes ventricosus*) or "sea egg" provide employment and income in several Caribbean countries including Grenada, Barbados, and St. Lucia (McConney et al. 2003).

This study contributes to the growing body of literature and research on sea urchin fisheries in the Caribbean. Grenada's experience had not been well documented and this research focuses attention on this small-scale fishery. Using a social networks perspective to understand the structural properties of the fishery provides new insight and contributes to improving fisher participation in the management of the fishery. Compared to a conventional management approach, 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. Hopefully this approach will contribute to the development and implementation of new governance arrangements that effectively addresses the challenges and uncertainty facing Grenada's sea urchin fishery.

1.1 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).

The features that create SSF the complexity 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).

1.2 Research objectives

The research objectives were:

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.

1.3 Overview of Grenada's sea egg fishery

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 severs habitat degradation (McConney and Mahon 2006). This trend has been illustrated by the decline of the white-spined sea urchin (*Tripneustes ventricosus*) in the Easter 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.

This research was conducted on the island nation of Grenada (Figure 1-1). Grenada is located in the Eastern Caribbean, 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 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.

Although this fishery emerged in Grenada 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.

The sea egg fishery in Grenada thrived in the 1980s and 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.

Figure 1-1 Map of Grenada

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 egg grounds for signs of recovery. By mid0August nine sea egg grounds off Grenville's coast and three sites off the coast of Carriacou had been surveyed. In October 2008, the Fisheries Division revealed that the government was considering opening the sea egg season for four weeks in 2009 (Isaac pers. comm. 2008).

In 2008 the ban was still in place but illegal harvesting was 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.

The remainder of this report contains the research methods, results, discussion and recommendations. However, this report is not the end of the sea egg story in Grenada (see brochure in Appendix 1). The Grenada Fisheries Division, under a small grant from the Marine Resource Governance in the Eastern Caribbean (MarGov) Project is in the process of developing a sea urchin fishery management plan, due to be completed late in 2009. Other sea urchin fishery research associated with MarGov continues in Barbados and St. Lucia, all connected to a wider sub-regional effort to better understand and manage this fishery in several locations.

2. METHODOLOGY

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).

Information about the sea egg fishery in Grenada was gathered using a variety of methods. Participant observation, direct observation, semi-formal and informal interviews, and document review were all techniques used to gather information and gain a better appreciation of how the fishery operated and who was involved.

Before arriving in Grenada, contacts and meetings were arranged so that an introduction to the current situation regarding the fishery as well as to potential participants.

2.1 Data collection

Interview schedules were used to guide the interviews with the participants during this study. 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.

2.2 Data Analysis

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

3. RESULTS

3.1 Context

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.

3.2 Social networks in 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.

3.3 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 3-1.

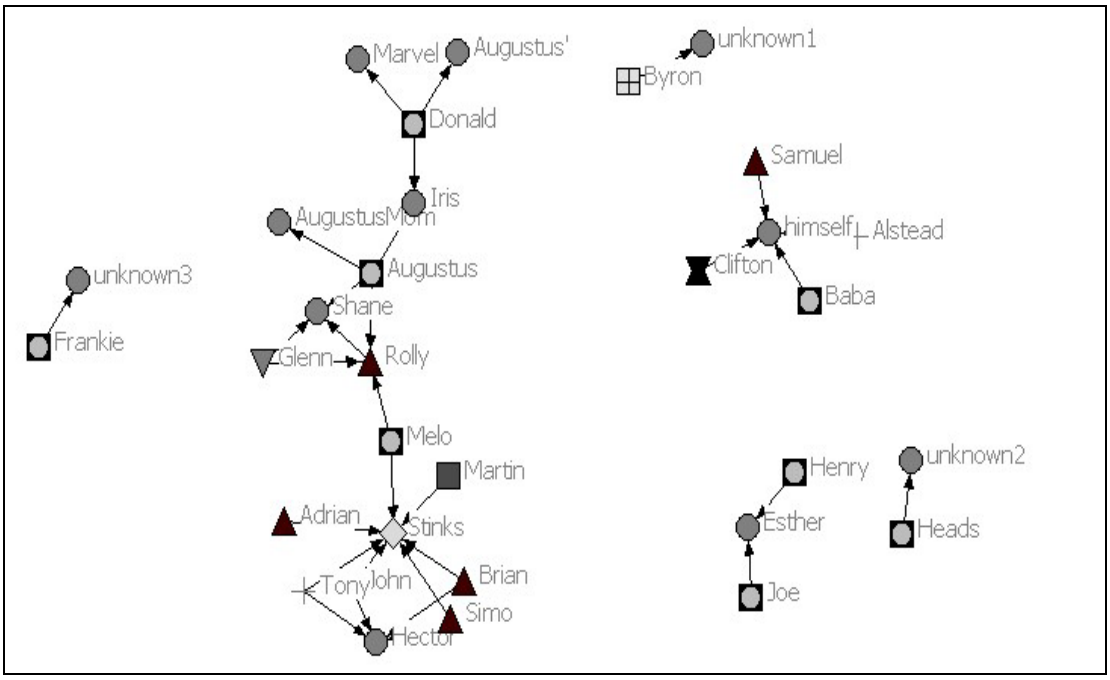

Figure 3-1 Representation of sea egg marketing networks using Netdraw in UCINET 4

3.4 The Fishery Participants

3.4.1 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). 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).

3.4.2 Calliste divers

Calliste is a small fishing village located on the far south eastern coast of Grenada. It is 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).

3.4.3 Participants in 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.

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

3.5 Organisation of 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.

3.6 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 increase, 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 six 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.

3.7 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."

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 3-1 provides a summary of the various reasons why the divers thought sea eggs went scarce in the 1990s.

Table 3-1 Reasons why the divers thought sea eggs went "scarce"

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

3.8 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.

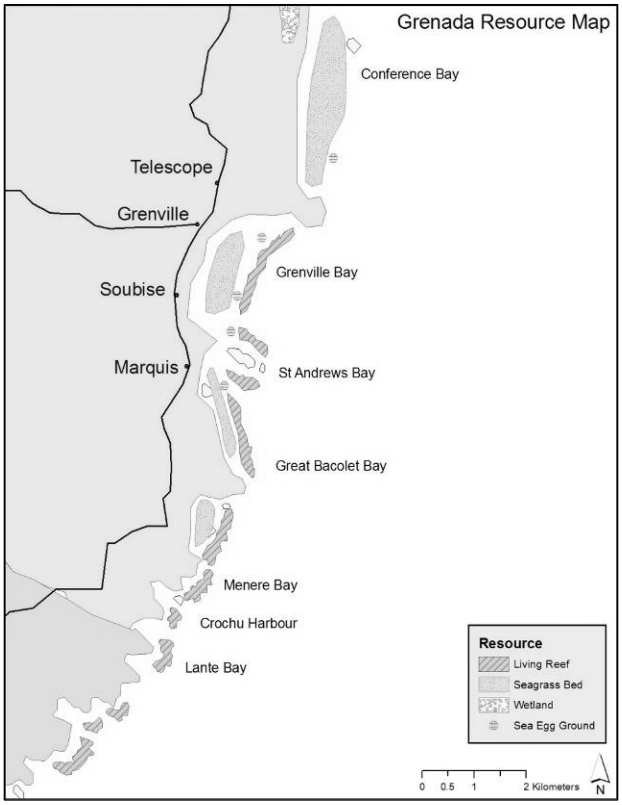

Figure 3-2 Grenada resource map of the eastern coast
(Produced by S. Keo for author, using information from the Grenada Fisheries Division)

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 3-2 and 3-3 are maps of the two coasts showing where some of the surveyed sea eggs grounds are located.

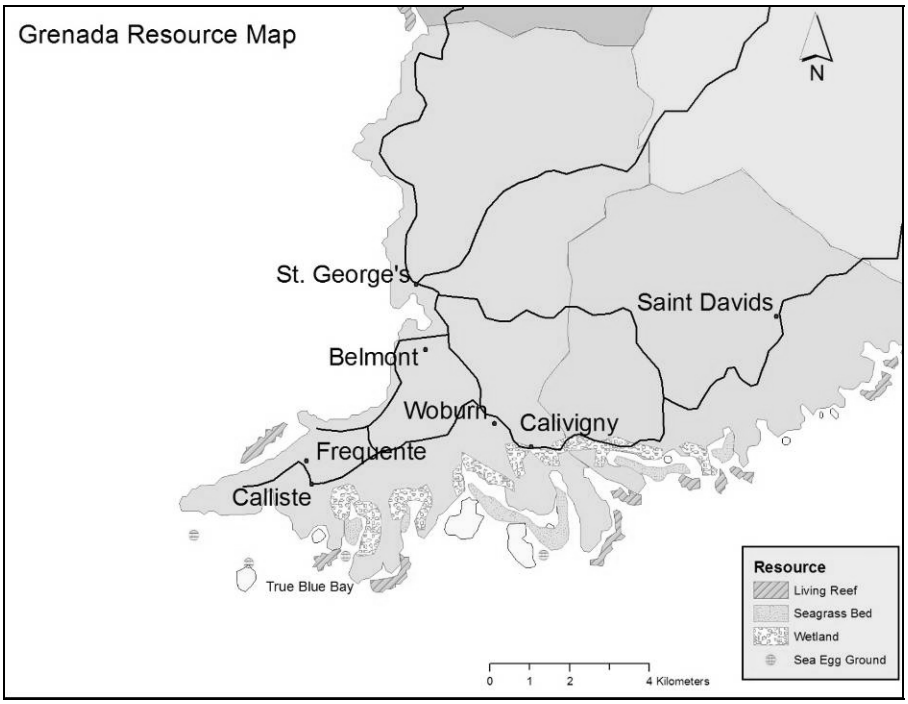

Figure 3-3 Grenada resource map of the south eastern coast
(Produced by S. Keo for author using information from the Grenada Fisheries Division)

3.9 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.

3.10 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 aluminum 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.

3.11 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). Table 3-2 lists the available sea egg export data available from 1985-1994.

Table 3-2 Grenada sea egg exports (lbs.)

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

Source: Grenada Fisheries Division

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 3-3).

Table 3-3 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

3.12 Diver suggestions for managing 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. 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 (in Table 3-4) were those offered from the divers:

Table 3-4 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

4. DISCUSSION AND RECOMMENDATIONS

4.1 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 and 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 2007). 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 2007).

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).

4.2 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.

4.3 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 (Table 3-4) 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.

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. 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.

4.4 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.

5. 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.

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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7. APPENDICES

Appendix 1. Sea egg research summary brochure

Introduction

Small-scale fisheries in the Caribbean are complex and face a variety of challenges for effective management of the array of species being fished in local and regional waters.

The sea egg fishery in Grenada experienced an increase in harvesting in the 1980s and early 1990s. Sea eggs were harvested for local use and export sale, with large quantities being bought wholesale by local agents from divers. They sold these orders to neighbouring islands like Barbados and Martinique.

Participants

Over 25 people including, divers, fishermen, fisheries officials and agents gave informal and semi-formal interviews for this project. Most participants were from Calliste, Soubise, Telescope, Westerhall and Grenville.

Research & Objectives

The sea egg fishery was closed in 1995 and has not been re-opened. Interest in examining the sea egg fishery began because Grenada's experience has not been well documented and this study came at a time when there is renewed interest in sea egg management in the Caribbean by a variety of organizations.

This study was conducted from April-August 2008. To organize the research, the following research objectives were developed:

1. Identify the actors that were part of the sea egg fishery network
2. Analyze the linkages between the actors
3. Describe the shared sites of interaction and exchange
4. Determine the implications of the social-ecological networks had for sea egg co-management

Diver Management Suggestions

- Ban exporting
- Have seasons (like lobster)
- Have licenses
- Open season and then close to see what happens
- No motor boats
- Have licenses and training to teach how to test see if the sea eggs are ready
- Open for a few weeks or months and then close
- Let people take for themselves
- Better enforcement of the laws

Findings & Recommendations

To make sure sea eggs do not get overfished, managing the fishery is necessary. But sea eggs are unpredictable and knowing how many will be available each year will be nearly impossible.

Using Adaptive Co-management may be a good approach to use. It will allow for divers to contribute their knowledge and participate in management. Additionally, it is flexible and can allow for changes to the management plan when sea egg populations fluctuate or if new management strategies are needed.

Working with divers and agents, establishing seasons and having gear restrictions are all considerations that would be worthwhile. Including the divers and agents will also give incentive for compliance and in the participation and management of Grenada's sea egg fishery.

Thank You!

I would like to give my deepest thanks to the fishermen, divers and the people of Grenada for welcoming me into their lives and their homes. Thank you to everyone who made my stay unforgettable and making it one of the best summers I have ever had. Thank you to the communities and fishermen in Calliste, Grenville, Soubise and Telescope as well as everyone at the Grenada Fisheries Division who helped me with my research.

The hospitality, open welcome and generosity that I received by so many people in Grenada will never be forgotten and always appreciated.

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

A Master's thesis for the Natural Resource Institute at the University of Manitoba, Canada

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