

## Divers and Networks in the Sea Egg Fishery in Grenada

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### ABSTRACT

The white sea urchin (*Tripneustes ventricosus*), referred to as 'sea egg' in Grenada, is most commonly found in nearshore 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. This paper describes the sea egg fishery in Grenada prior to its closure. It also examines how the fishery may operate should it be re-opened. 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. Should the fishery be reopened without adequate provision for management, its sustainability may be threatened by harvesting and marketing networks that could facilitate rapid resource depletion.

KEY WORDS: Divers, sea urchins, networks

## Buzos y Redes Comerciales en la Pesca del Huevo Marino de Grenada

El erizo blanco de mar (*Tripneustes ventricosus*), conocido como "huevo marino" en Grenada, se encuentra comúnmente en hábitats costeros a lo largo de las costas orientales y surorientales de Grenada, desde el río Antoine hasta Calliste. La pesca comercial del huevo marino fue cerrada en 1995 después de colapsar debido a un periodo en el que su cosecha aumentó para suplir las demandas local y de exportación. Este artículo describe la pesca del huevo marino en Grenada antes de su clausura, como también examina cómo esta actividad podría operar en el caso de ser reabierto. Esta investigación fue llevada a cabo en Grenada durante el verano de 2008. Utilizamos una estrategia investigativa que comenzó con una reunión con los pescadores buzos, con los que llevamos a cabo observación participativa mientras acompañamos sus jornadas de pesca en el arrecife. Acto seguido, hicimos entrevistas semi-estructuradas con buzos, oficiales del servicio de pesca y comerciantes. Datos adicionales fueron conseguidos a través de la revisión de documentos asociados con la pesca y participando en muestreos en las áreas de pesca del huevo marino llevados a cabo por oficiales del servicio de pesca de Grenada y pescadores buzos de la zona. Antes de su clausura, la pesca comercial del huevo marino en Grenada era llevada a cabo por hombres jóvenes en edades entre los 15 y 35 años. Ellos se sumergían con esnorquel, aletas y máscara de buceo. Estos pescadores utilizaban botes de remo para alcanzar las áreas con mayor producción de huevo marino. Localmente, los huevos marinos eran vendidos a lo largo de las carreteras asados en su caparazón o crudos empacados en bolsas de plástico. Empacados crudos en contenedores o bolsas de plástico, estos erizos también eran exportados vía aérea a través de un reducido número de agentes comerciales situados al sur de Grenada y cuyo mercado principal era Barbados y Martinica. De reabrirse esta pesquera sin un manejo adecuado, su sostenibilidad se vería comprometida debido a estrategias de cosecha y redes de mercadeo que pueden acelerar el colapso de este recurso.

PALABRAS CLAVES: Buzos, Pescadores, redes de mercadeo, Erizos marinos

## Plongeurs et Réseaux dans les Pêcheries d'Oursins de Mer en Grenade

L'Oursin de mer Blanc (*Tripneustes ventricosus*), portant souvent, le nom "Œuf de l'Océan", peut être trouvé dans des habitats le long de la rive Est et Sud-est de « River Antoine » jusqu'à « Calliste ». L'objectif principal de ce travail est l'étude de la pêche, depuis sa fermeture en 1995 et de décrire leurs situations avant leurs fermetures et examinera comment elles devraient fonctionner advenant leur réouverture éventuelle. La rencontre ainsi que, l'observation participante de pêcheurs en apnée, l'accompagnement aux sites de pêches, ont été des outils de recherches utilisés. Ceci était suivi d'entrevues avec les pêcheurs, les vendeurs ainsi que les responsables de la pêche. L'observation de sites de pêches, la documentation ont aussi été d'importantes sources d'informations. Avant leurs fermetures les pêcheries étaient composées de jeunes hommes de 15 à 35 ans plongeant à l'aide de palmes, masks et tuba, utilisant de petit bateaux a rames pour se rendre aux endroits de pêches les plus productives. Les Oursins, étaient surtout vendus localement, Leur exportation ce faisaient surtout crue et mis dans de grands bacs, vendu, surtout à la Barbade par l'entremise d'agent situé dans le sud de la Grenade.

Finalement advenant la réouverture des pêcheries, une attention spéciale devrait être porté aux besoins des dirigeants, Le succès ou non des pêcheries pourraient être mis en danger par la récolte ainsi que par le développement de réseaux qui pourraient amener l'épuisement des ressources.

MOTS CLÉS: Plongeurs, Réseaux et Oursins de Mers

## INTRODUCTION

Fishing is a livelihood activity that is unpredictable and very complex (Acheson 1981). Commercial small-scale fisheries are significant contributors to employment, income, and food in less-developed tropical coastal communities (Berkes *et al.* 2001, Salas *et al.* 2007), even if they may not make a significant contribution to the overall gross domestic product of a nation based on official statistics.

Many coastal communities in the Caribbean feature the characteristics of small-scale fisheries and are known for being small operations that target multiple species using simple, multiple gear types that require only low levels of capital investment (Brown and Pomeroy 1999, Berkes *et al.* 2001, Salas *et al.* 2007). However, Caribbean fishing communities also exhibit a great deal of heterogeneity and complexity that stem from the use of multiple gear types, high mobility, and the likelihood that fishers will move around to other areas in pursuit of various fish stocks (Breton *et al.* 2006). Additionally, the wide dispersal, transboundary and small-scale nature of many fishing activities in the Caribbean make the more common command and control style of management too costly and beyond the capacity for many Caribbean government agencies to enforce this type of regulation (McConney *et al.* 2003). These are some of the challenges and features of small-scale fisheries that are well known but are not entirely understood and further complicate the management of marine resources in the Caribbean (Breton *et al.* 2006).

Marine resources in the Caribbean are threatened because they frequently do not fall under centrally managed coordinated plans; they are overexploited and/or have suffered from severe habitat degradation (McConney and Mahon 2006). This trend is illustrated by the decline of the white spined sea urchin (*Tripneustes ventricosus*) stocks in the Eastern Caribbean. White sea urchins, locally referred to in Grenada as the 'sea egg' are a popular local delicacy on some Caribbean islands (Macia and Robinson 2008). While the sea egg is an important grazer in sea grass and coral reef habitats, the factors affecting their recruitment and population dynamics are poorly understood (Macia and Robinson 2008).

The sea egg fisheries in St. Lucia, Barbados, and Grenada have experienced repeated collapses, especially since the 1980s; sea eggs, once settled, are vulnerable to overfishing because they are found close to shore, in shallow waters and are virtually immobile (McConney *et al.* 2003). Year-round collecting became more prevalent in St. Lucia, Barbados, and Grenada as market prices increased (Smith and Berkes 1991, McConney *et al.* 2003, C.I. Unpubl. data), and it is thought that this accelerated depletion of the stocks by destroying immature individuals that had yet to reproduce (Smith and Berkes 1991).

Social, economic and ecological factors have placed pressure on this fishery on all three islands. Grenada, the site of this case study, experienced increased capitalization

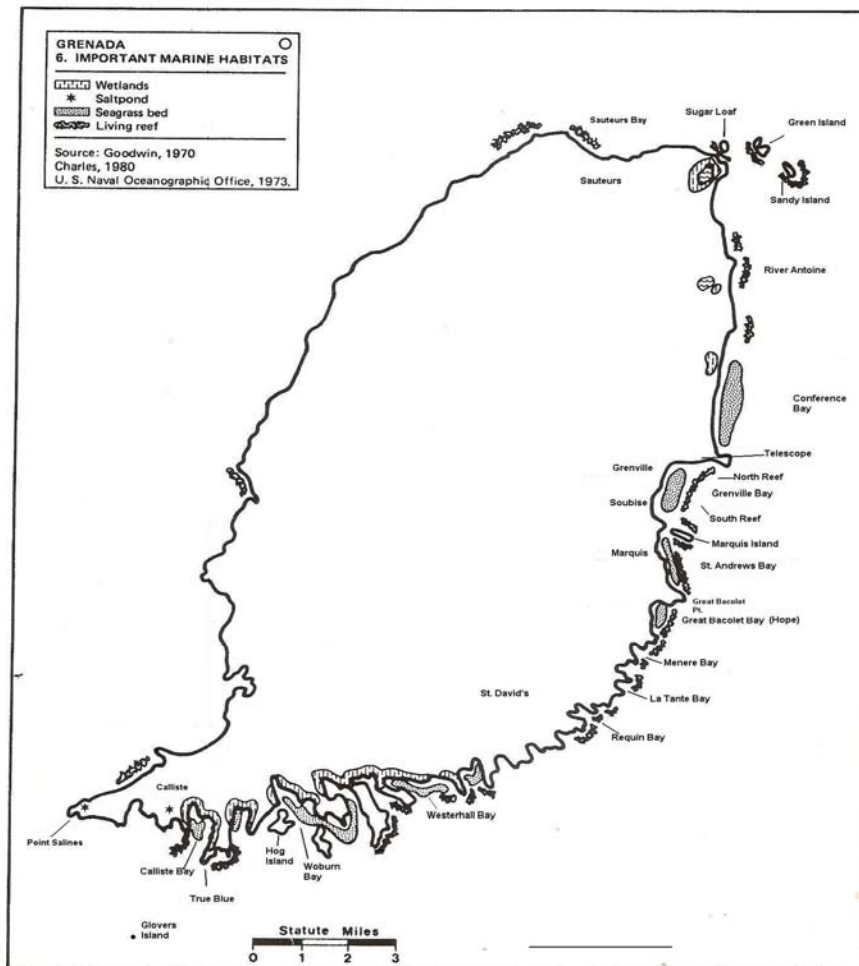
and investment in harvesting sea eggs in the late 1980s and early 1990s as demand gradually increased (Stephen Nimrod, St. George's University, Pers. comm.). This coincided with a decrease in recruitment and population density at certain key sea egg grounds in Grenville Bay, which experienced heavy harvesting between 1987- 1989 (A.J., unpublished data, C.I. Unpubl. data).

It was predicted that the increasing value of sea eggs could result in overharvesting and the subsequent decline of the fishery might mirror the rise and fall of the Barbados sea egg fishery (C.I. Unpubl. data). The Grenadian fishery eventually collapsed and was closed in 1995, similar to the St. Lucia fishery, when demand outmatched the recruitment capacity of the sea egg population in the late 1980s (Scheibling and Mladenov 1987, Warner 1997, Smith and Koester 2001). In Grenada "overdiving" and that "everyone went for it" (R.N. Unpubl. data) was encouraged by the high earning potential from the local and export markets and were reasons attributed, by many of those interviewed for this project, as important factors in the sea eggs becoming "scarce" in the early 1990s.

There has been relatively little scientific study of the sea egg population or harvesting in Grenada. Figure 1 illustrates the main sea harvest grounds along the coast of Grenada. The last study on recruitment levels was conducted in 1990, and an inconclusive population survey occurred in 2003. The sea egg harvest has not historically been managed, with the exception of a closed season which was declared in 1981 from May 1- September 30 (C.I. Unpubl. data). Regulations stipulating restrictions on size, areas and seasons were invoked in 1996 but this was after the fishery was permanently closed in 1995 (C.I. Unpubl. data).

There is little data on the quantity of sea eggs that were harvested and data gaps in the quantity of sea eggs being exported, however, it has been estimated by Fisheries Division officials that between 500,000 - 1,000,000 sea urchins were being harvested annually (C.I. Unpubl. data). Table 1 illustrates the limited data available from the Grenada Fisheries Division for the amount of sea eggs that were exported 1988 - 1994.

The Grenada sea egg fishery has remained closed since the initial ban in 1995. There were a minimum of 110 commercial sea egg divers harvesting sea eggs for local sale and for export between the late 1980s and 1994 (Isaac 1990). They were earning between \$5 - \$7 Eastern Caribbean currency (EC) per packed shell and \$5 - \$7EC per pound (450g) when sold wholesale. There is still illegal harvesting occurring, fulfilling the demands of local residents and returnees (Just Come Backs) who visit during the summer months and want to enjoy sea eggs on their holidays.



**Figure 1.** Sea egg grounds around mainland Grenada Source: Goodwin, 1970. Eastern Caribbean Natural Area Management Program. U.S. Naval Oceanographic Office.

Pressure from divers to find alternate management strategies for this fishery is increasing as they perceive that the sea urchins have recovered, and they would like the fishery reopened. It has been suggested that the structural properties of social networks are important factors that may determine whether successful resource management can generally be achieved (Abrahamson and Rosenkopf 1997; Bodin 2006). Structural properties of social networks impact upon how information is distributed and shared (Crona and Bodin 2006, Bodin 2006). These interactions occur at various sites of information exchange, where actors interact to exchange information, socialize, gain emotional support (Grant 2006) and to exchange stories (Bernard 2006).

Sites of information exchange provide insights into the formal and informal social institutions that the harvesters may belong to and this in turn will impact to what degree and how information is exchanged (Grant 2006). The structural properties of social networks will impact the ability of a community to take collective action and the

strength of their adaptive capabilities to govern and manage their fishery resources (Crona and Bodin 2006, Bodin 2007).

Varying features of social structure, such as the position of an individual within a network, have varying effects on other aspects of social structure and consequently, on potential resource co-management and governance (Bodin *et al.* 2006). The position of key actors in a network or community may promote or inhibit management efforts by influencing communication and the ability of the rest of the community to organize (Crona and Bodin 2006).

Another network feature, betweenness, measures the tendency of a network to form multiple groups (Bodin *et al.* 2006), and this becomes relevant to this discussion because the degree of modularity that can exist can link different groups or isolate them. This affects 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 betweenness 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 as they have access to a variety of information from each group, know 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).

Identifying key sites of information exchange, betweenness and identifying possible brokers that could have linked the different groups of sea egg divers is important for considering future management strategies for such a widely dispersed and ephemeral species as *Tripneustes ventricosus*.

**Table 1.** Sea egg export data for Grenada 1985-1994. Source: Grenada Fisheries Division, Grenada, W.I.

Year	Exports (number of eggs)
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

## METHODS

Identifying features of the sea egg fishery such as the participants, the equipment, the preparation of the gonads, the locations of important sea egg grounds and landing sites was essential to create a description of the fishery and to identify the network structures of interest. Participant selection was not limited to divers, and interviews with Fisheries Division officials and exporters were also conducted. Between the months of April - June 2008, participant observation, informal and semi-formal interviews were the main methods of data collection for this study. Participant observation and direct observation were also important, as the researcher spent a lot of time with the divers in their communities and on the sea while they were diving.

Twenty-three (23) participants gave semi-formal interviews, including divers, exporters and fisheries officials. Additionally, another 11 participants gave informal interviews including local academics, divers, breakers (people who remove the gonads from the shell), and a current seafood export/importer to give more perspectives and context to the background and the future of the fishery. The interviews were used to gain a description of how the sea egg fishery operated prior to the

closure, including identifying who were diving sea eggs, who was selling and who were the main consumers.

The majority of the sea egg divers came from the fishing villages of Calliste (n = 10), Grenville (n = 2) and Soubise (n = 8), and one from Westerhall. All the communities have a rich history of fishing livelihoods. Calliste fishers primarily use scuba to dive for conch (mainly the queen conch, *Strombus gigas*, locally referred to as “lambie”), spiny lobster (*Panulirus argus*), and various reef fish. Soubise has a concentration of pelagic and nearshore fishermen as well as divers and former divers who have moved on to fishing other species. Grenville, the second largest town in Grenada has the Grenville Fish Market and is the site for one branch of the Fisheries Division and the Soubise Fisherman’ Co-operative’s main business which operates a gas station, tackle shop and rum bar.

Receiving peer referrals from key informants and other participants was an important method for obtaining introductions to potential participants. From early informal conversations it became clear that many of the “sea egg experts” would have been referred for the study because they had been heavily involved in sea egg diving but they were no longer living in Grenada. The remaining participants were still contacted from introductions made by key informants and participants. Participants were selected if they had been involved in the fishery, through harvesting, marketing, preparation or administratively through the government. Sea egg divers that had sold sea eggs commercially were targeted as participants.

Despite being “commercial” sea egg divers, these divers were still small-scale fishermen that were also diving and fishing other species at the same time. Commercial sea egg harvesting was differentiated for this study because sea egg diving for personal subsistence was widespread and would have included a wide variety of people whose impact on the fishery would not have been as significant an impact from their occasional harvesting.

## Participants in the Fishery

Similar to Barbados, St. Lucia, and Martinique, sea eggs in Grenada are a popular local delicacy that are enjoyed most commonly roasted over fire, fried with onions, bell peppers and seasonings, in soup, as broth or simply eaten with bread. Being found in shallow waters all along the east coast, sea eggs used to be collected by grandparents, children and anyone who was able to wade out from the beach to gather sea eggs. They were easy to see with the naked eye and because specialized equipment was not needed for their harvest they were easily taken by people of all ages. Sea eggs provided food, employment and a source of income for Grenadians. Employment as a “breaker” usually kept women, youth and young men employed. A breaker would crack open and scoop out the gonads when big loads of sea eggs were brought in and needed to be prepared.

Subsistence sea egg harvesting was a common activity for many living in coastal communities in Grenada, and as market demands increased it became a source of income and employment. With market demands increasing, specialized commercial sea egg divers emerged and sea eggs became a regular part of their weekly catch and made up at least part of, or most of, their income. Commercial sea egg divers were typically young men between the ages of 16 - 35 years, and from those interviewed it appears that many gained their initial experience working in the sea from harvesting sea eggs as children or youth (Isaac 1990). Other participants had already been involved in fishing and incorporated sea eggs into their catch.

Catches from commercial harvesters were larger than the small-scale and subsistence harvesting being done by villagers and youth. It has been estimated that at least six trips per week, per crew (1 - 3 people), were being conducted by the commercial harvesters with anywhere between 400 - 700 sea eggs being taken in one trip (A.J. Unpubl. data, C.I., Unpubl. data). In spite of this effort, sea eggs did not provide full-time employment for the divers and many were targeting other demersal species at the same time (C.I. Unpubl. data). Approximately 4 - 5 people, who lived in southern Grenada, in or near the village of Calliste, were involved in the exporting of sea eggs.

### Equipment

Divers interviewed from the fishing villages of Calliste, Soubise, and Grenville recounted that typically they used non-motorized rowboats and dove 'bare wind' (free diving with a mask, snorkel, and fins) to gather sea eggs. Crews would usually consist of three people, and boats would often go out together, sometimes collectively hiring a boat with an engine to tow them to the grounds (C.I. Unpubl. data). The quantity of sea eggs that could be taken was influenced by the equipment that was used to dive. In Calliste, divers gradually transitioned from free diving to scuba diving (C.I. Unpubl. data). One diver said that before he switched to scuba, using a snorkel to harvest would "take a week to empty [patches so full of sea eggs]" (R.N. Unpubl. data). The transition from free-diving to scuba in Calliste allowed the divers to maximize the amount of time they could spend underwater to catch sea eggs, lambie, lobster, and fish.

### Location

The sea egg fishery was mainly concentrated on the eastern and south eastern coasts of Grenada and around the east and southwest coasts of Carriacou; however commercial harvesting in Carriacou was not as prevalent (C.I. Unpubl. data). There was a link between the seagrass bed habitats of the sea egg populations and the targeted harvesting sites (C.I. Unpubl. data). The Government of Grenada's Fisheries Division identified nearly a dozen primary sea egg harvesting grounds with another half

dozen secondary sites where sea eggs are known to inhabit and where harvesting was concentrated. Please see Figure 1 for a map of the primary harvesting sites that were identified in partnership with sea egg divers and from the Fisheries Officials' personal experience and knowledge. Sea eggs were mostly harvested in shallow seagrass beds and near rocky or coral reefs; habitat necessary to sustain large sea egg populations. This habitat is not as prevalent around the western and northern coasts, and this is thought to be one reason one sea egg harvesting is uncommon in these areas (C.I. Unpubl. data).

The eleven primary sites of sea egg grounds identified by the Grenada Fisheries Division include the following: True Blue Bay & Glovers Island; Woburn Bay; Petite Bacaye; La Tante Bay; Crochu Bay; Marquis; Conference Bay; Windward (Carriacou); Hillsborough (Carriacou); L'Estere Bay/ Harvey Vale Bay (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 Soubise and Grenville commonly listed the following sea egg grounds as the ones they dove: Conference Bay; Marquis Island; South and North reef (Grenville Bay); and, River Antoine. The divers would keep an eye out for sea egg grounds that may be ready for harvesting and as one diver said, they "would go out and check as moving [in the boat], we would see while out in de water" (R. N. Unpubl. data).

Meanwhile the divers from Calliste primarily dove around the southeast coast as sea eggs were abundant along the reef by their landing site at Calliste Beach and north around True Blue bay.

### Gonad Preparation for Local and Export Markets

The gonads of the sea eggs (referred to as 'roe') were processed and prepared by the divers before being sold to local customers or to the agents who exported them to other islands. There was a clear difference in how the gonads were prepared for local versus export sale.

When the sea eggs were being sold locally to villagers in the area, or to the local agents who were selling sea eggs in St. George's, Grenada, sea eggs were usually sold roasted in the shell unless otherwise specified. The divers, or their breakers, would spend the afternoon scooping the gonads out of each shell and pack one shell until it was full of cooked roe (C.I. Unpubl. data). The packed shells would then be placed in a pit under a piece of galvanized aluminum with a fire built on top. This was called "roasting" and the cooked roe were packed into shells and sold for \$4 - 5 EC depending upon the size of the shell (C. I. Unpubl. data).

If a diver was selling sea eggs to an exporter, they would sell and prepare the gonads for wholesale, sold per pound. In this case, fresh gonads would be packed into plastic bags or buckets and frozen or, instead of roasting

packed shells, the divers would “scald” the gonads (Crafton Isaac, Grenada Fisheries Division Pers. communication). In this method of processing, the gonads are scooped out of the shell and placed in boiling water for approximately 20 minutes to prevent “melting” (A.J. Unpubl. data). If the gonads are scooped out of the shell and not scalded, they lose their form and become too runny to eat. The scalded or boiled gonads are then packed into plastic bags, or large pails, that were picked up by the exporter or taken down to St. George’s by the diver. The exporters pack the bags and pails into cold storage containers and ship the sea eggs to the off-island buyers by airplane.

### Export and Local Sale

Exporting raw or semi-cooked sea egg gonads to Barbados and Martinique emerged as a significant market for divers during the early 1990s (C.I. Unpubl. data). The potential income that could be earned from selling to agents that exported sea eggs to these other islands significantly increased the quantity of sea eggs being collected and the process by which sea eggs were being prepared for sale (Crafton Isaac, Fisheries Division, Grenada Pers. communication, Stephen Nimrod, St. George’s University Pers. communication). Breaking and packing sea eggs was labour intensive and time consuming. When large quantities of sea eggs were brought in, breakers were frequently hired to help break, scoop, and scald the sea egg roe. For local sales the sites for breaking and selling prepared sea eggs in Soubise and in Grenville occurred on the beaches/ landing sites and roads along which the divers kept their boats. In Calliste, sales would happen at their landing site as well as from their homes. As mentioned previously, the method of processing the sea egg roe would differ depending whether it was for local sale, sale in St. George’s or export to other islands.

For example, in Soubise, which is a relatively small settlement, villagers would buy roasted sea eggs when they were passing by the main road. Customers would stop and buy sea eggs as they were being prepared and readied for sale. Much like today, people were aware of when fishermen were arriving with their catches and would stop to see if there was a particular fish available that day. The participants interviewed in Soubise pointed out a couple of empty lots that bordered the bay where they used to clean and prepare sea eggs for sale. People would be drawn to the lots if they saw the smoke of the fires from the roasting. Another way customers could get sea eggs was by placing an order directly with the divers that they knew. There were also agents with whom some of the Soubise divers would also sell to. These agents were part of the local informal marketing of sea eggs where it could be the fisher, the processor (breakers like mothers, sisters or friends) or a school-aged child who would sell sea eggs in the street (C. Isaac, Grenada Fisheries Division Pers. communication). Some of these agents would come from nearby villages

like Marquis and take the roasted sea eggs to the southern parish of St. George’s to sell. There were also four well known exporters who would regularly drive along the east coast, buying from divers from villages in between Calliste and Grenville (i.e. Woburn, St. David’s, etc.) who would sell raw sea eggs to Barbados and Martinique wholesale.

In Calliste, boats would also come in full to the brim with sea eggs, and breakers would stand in the water breaking the shells open while others would be scooping the gonads out with a spoon. Both barewind and tank divers went out at least a few days a week, but factors like weather and what other species were available, and whether they were more lucrative during that particular season, were also considerations for how many days and what was going to be fished each week.

The exporters who traveled from Calliste to Soubise, Grenville, and villages in between were nearly based in Calliste, and the Calliste divers who sold for export sold their catches to the same exporters as those in Soubise and Calliste. The exporters used word of mouth, letting the news spread between divers if they were looking to buy sea eggs for a shipment to another island.

### Diver Management Suggestions

While not all the divers ( $n = 5$ ) agreed that the fishery should be reopened, some saying that “they’re not enough for taking” the majority 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 the most frequently offered from the divers (R.N. Unpubl. data):

- i) Open the fishery for a few days and monitor what happens for x-amount of months or the year before allowing more harvesting,
- ii) Open the fishery for a month at a time, with intervals of closed months to give the fishery time to recover,
- iii) Issue licenses to limit how many divers are harvesting,
- iv) Prohibit or limit export sales and only allow sea eggs to be sold domestically,
- v) Limit the kind of equipment being used. i.e. do not allow scuba or motorboats to be used,
- vi) Carefully monitor the impacts of harvesting so that more is known about how harvesting is impacting the population, and
- vii) Better enforcement of harvesting restrictions.

### Network Implications

Using a networks perspective to look at managing Grenada’s sea egg fishery, the divers from Calliste and Grenville, Telescope, and Soubise were not as well-connected as one would have assumed, given the relatively small size of Grenada’s population. During the years of sea egg harvesting, sea egg divers could not easily travel

the coast while using rowboats and even today with motorized boats, the different groups of divers rarely interact. While some were known to each other, it did not appear that there were any close ties linking the groups. When comparing the sea egg grounds that were targeted by the divers, it is clear that the fishermen dove for sea eggs on sea egg grounds that were near their villages. None of the participants interviewed for this study listed sea egg grounds that were outside the immediate vicinity of their home villages, which helps explain the lack of interaction between the divers in the south and those on the east coast. It appears that prior to the fishery closure, the main actors or “brokers” linking the different coastal villages involved in sea egg diving were the sea egg exporters who were coming from southern Grenada and drove along the coast to pick up their orders of sea eggs (Bodin *et al.* 2006:17).

Presently, within each community, Calliste, Grenville, Telescope, and Soubise, the interaction between the divers and fishermen are frequent and relatively cohesive. The well-established routines the fishers have as they leave and return each day contributes to this cohesion and reinforces frequent interaction at the landing sites. This has implications for the management of the sea egg stocks if the Fisheries Division chooses to involve the divers in managing and/or enforcing harvesting regulations in the future. It is clear that there are established groups that do have routines and leadership that may facilitate managing the fishery and possibly assigning harvesting rights if they are included in management efforts, and if their ability to participate in governance is enabled.

### CONCLUSIONS

The Grenada sea egg fishery mirrored the rise and fall of the sea egg fisheries in St. Lucia and Barbados, except its fishery was never re-opened after its initial closure in 1995. Now that there is public pressure and increasing anecdotal evidence that the sea egg grounds are rebounding to levels that may be able to sustain a limited harvest, reopening the fishery is a possibility. However, with opening the season, management will be required to ensure that the current grounds are not depleted beyond their capacity for regeneration. Over twelve years have passed since the closure, and while many former sea egg divers have left the island, have moved onto fishing other species, or have left fishing altogether for other occupations, there are still many who eagerly anticipate the opening of the season. Since the closure, new technology and gear has increased accessibility as well as harvesting and diving efficiency. These changes will present new challenges for the sea egg fishery and need to be considered in designing new management strategies. For example, everyone who was interviewed, and whose livelihood is still based on fishing or diving, either own or have access to a motorized boat. Prior to the closure most were using rowboats. This alone will dramatically change the accessibility to sea egg grounds and reduce harvest effort. These factors suggest

that the intensity of harvesting on the productive sea egg grounds found offshore of Grenada and those located off nearby islands such as Carriacou will increase. Before the fishery closure, Carriacou was not a primary sea egg harvesting site, and the divers interviewed said they did not go there to harvest sea eggs, likely because the distance made it inaccessible by rowboat. But now, with widespread motorboat ownership, Carriacou is visited regularly for overnight fishing trips by many divers and fishermen from Grenville and Soubise.

If the sea egg fishery should be opened in the near future, there are some important considerations that need to be taken into account to prevent the fishery from collapse. Sea eggs remain a significant part of the Grenadian psyche, remembered fondly and with enthusiasm, and there would be a demand for them if the fishery reopened. It appears that many of those interviewed are aware that over-harvesting occurred. The divers recognize that they had a role in the depletion of the sea egg stocks. This may prove favourable for management because many already acknowledge that something needs to be done to prevent the fishery from collapsing again and that their actions play a part in the solution. Given that sea eggs are not mobile, and that there appears to be a linkage between a diver's residence location and the sea egg grounds fished with little overlap between the grounds, it should be possible to design a community-based solution for this fishery.

If the Grenadian sea egg fishery season is reopened, for any amount of time, with consideration of the responses given for this study, management will likely be received positively from those who have been following the ban, in exchange for simply being allowed to harvest sea eggs again.

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