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The Fisheries of St Vincent and the Grenadines: An Analysis of Catch Composition and Stock Assessment of Key Species

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A thesis submitted in partial fulfilment of the requirements for the Master of Marine Science,
The University of Auckland, 2016.
Abstract

The fisheries of St Vincent and the Grenadines (SVG) encompass a number of commercially important marine species, and underpin the livelihoods and food security of 2500 traditional fishers living throughout the 344 km² island chain. Fishing plays a significant role in the cultural, social and economic lifestyle of the people of St Vincent and the Grenadines (SVG). Five of the most prized species harvested in the waters of SVG are Jack, Mahi Mahi, Spiny Lobster, Queen Conch and Red Hind. The aim of this research is to examine the patterns in catch composition for these five species and to conduct a preliminary stock assessment generating equilibrium catches and maximum sustainable yields. Unfortunately, no stock assessment would be conducted for the Mahi Mahi species due to the fact that it is a highly migratory species and is not localised to the waters of SVG as do the other species. The research uses the Schaffer logistic curve to estimate the relationship between CPUE and total effort. After which it uses the parameters generated by the regression to estimate the equilibrium catch and maximum sustainable catches for the fish species. The data set for this research was collected during the period 1994 to 2014. There are ten primary fishing gears used by the fishers and an analysis of similarity demonstrated that there is a difference in the catch composition of these gears. Beach seine contributed the most to the overall fish catches while drop line contributed the least. Seasonal catches have been dominated by Mahi Mahi during winter and spring, Jacks in the summer and autumn, Red Hind, Queen Conch and Spiny Lobster dominated the autumn and winter months. Most Red Hind is harvested from fishing grounds in the Grenadines, Mahi Mahi from grounds on the Windward coast, Jack from the Leeward coast and Lobsters and Conchs from the Grenadines. Overall, the CPUE for all species decreases as fishing effort increases.
Acknowledgements

Firstly, I would like to say a heart-felt thanks and express my sincere appreciation to the Government and Commonwealth of New Zealand for giving me this opportunity to pursue a Master of Science in Marine Science. I would also like to say thanks to the University of Auckland for hosting me. I would like to give special thanks to my supervisor Dr. Ian Tuck for his understanding, patience, support and guidance throughout the year. I have learned so much from you and I am grateful for all your time and effort. To Dr. Meredith Lowe, thanks for sharing your expertise. Many thanks to the staff at NIWA, you’ve accepted me and made me feel like one of your own. I would also like to thank the Chief Fisheries Officer Mrs. Jennifer Cruickshank-Howard, I appreciate your guidance, support and encouragement over the years. Cheryl Jardine-Jackson of the Fisheries Division, thanks for making available all of the data that I needed.

Last but definitely not least I must thank my parents for raising an absolute gentleman. You raised me with love and you’ve imparted in me the belief that I can achieve anything I set my mind to. Mom Dad please know I could not have done this without your continual encouragement over the years. I am extremely grateful for all of your love and support.
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Chapter 1. Introduction

Saint Vincent and the Grenadines (SVG) is comprised of 32 islands and cays, the largest being St. Vincent, other main islands being Bequia, Mustique, Canouan, Union Island (Figure 1). The population of SVG is approximately 104,000 people. St. Vincent, is approximately 29 km long north-south and 17.7 km wide east-west and covers some 344 km². Bequia, the second largest island, covers some 18 km², while the remaining islands each covering 8 km² or less. All the major islands are of volcanic origin and the topography is characteristically deeply dissected with steep slopes and ridges tending toward the centre of the island (Jardine-Jackson & Straker, 2003).

Fishing is vital to the very fabric that fashioned the cultural, social and economic lifestyle of the people of St Vincent and the Grenadines (SVG). The fishing industry in St. Vincent and the Grenadines is predominantly artisanal with over 70% of the 2500 persons employed in the industry being exclusively dependent on fishing and related activities for their livelihood. There are 778 fishing vessels functioning in the waters of St. Vincent and the Grenadines and 34 on the high seas (Fisheries Division, 2014). The domestic fishing fleet is made up of mainly small open boats constructed from either wood or fibreglass or a combination of both. These vessels include flat transom boats (bow and stern boats or dories) pirogues, double-enders and canoes that are usually propelled by outboard engines ranging from 6 –115 HP (Jardine-Jackson & Straker, 2003). Vessels range from 3 –10m in length and fishing operations occur daily and incur medium to high input cost which are made worse by rising fuel prices. There is a small but increasing number of long liners included in the fishing fleet. These vessels are powered by inboard marine diesel engines ranging from 90 - 475 hp, and are outfitted with modern navigational and fishing equipment (Jardine-Jackson & Straker, 2003).

The fishing industry contributes approximately 1 - 1.5 % to the gross domestic product. With an estimated population of 110,000 persons in St. Vincent and the Grenadines, the per capita consumption of seafood is about 23lbs (10.4kg). Fish landings are an estimated 1.8 million lbs with a corresponding value of EC$9.7 million; fish imports stand at approximately 1.1 million lbs, at a value of EC$5.7 million; while fish exports are 0.2 million lbs, at a value of EC$1.4 million (Average data 2007 -2011). Consequently, St. Vincent and the Grenadines is a net importer of fish and fishery products (Fisheries Division, 2014).
Figure 1. Map of St Vincent and the Grenadines
Source: http://images.nationmaster.com/images/motw/islands_oceans_poles/st_vincent_rei96.jpg
1.1. Description of Area and Habitat

St Vincent and the Grenadines (SVG) lies between Grenada to the south (137km), Barbados to the east (179km) and St Lucia to the north (77km). The island and its neighbours constitute the Windward chain of islands (Windward Islands) of the Eastern Caribbean. Of the Grenadine islands comprising St Vincent and the Grenadines, only six are inhabited. St Vincent lies at the northern end of the chain, it is made up of remnants of several eroded volcanoes of which one called La Soufriere still remains active (Mills, 2001). There is a defined Exclusive Economic Zone (EEZ) of 183km to the west and an equidistance delimitation of 50 to 100km between SVG and Barbados to the east, Grenada to the south and St Lucia to the north (Mills, 2001) (Figure 2).

![Figure 2. Map of Maritime Boundaries and Coral Reef Location in the Caribbean.](http://www.wri.org/sites/default/files/map_rrcaribe_01_region_300dpi.jpg)

The islands lie on a vast shelf which is narrow around main land St Vincent whereas, it extends to approximately three times the size in the Grenadines with the majority extending to the east of the chain of islands. The Grenadine islands and St Vincent are separated by a deep water channel commonly known as the “Bequia Channel” (Figure 3). Correspondingly, there exist other less extensive and shallower channels between the other Grenadine islands, these channels rarely measure more than 40 m in depth. The Grenadines lie on a shallow reef; this gives support to the growth and development of coral reef. St Vincent on the other hand has
poor reef development owing to continuous volcanic activities in the past (Fisheries Division, 2014).

Figure 3. 3D Map of the Grenadines Bank

The beaches of mainland St Vincent are covered with black volcanic sand whereas those in the Grenadines are primarily coralline. Surface sand can be found in some reef areas however, and increases to the south of the chain (Mills, 2001). Equally important, large areas of sea-grass can be found off most reef protected shorelines in the Grenadines; these give support to a thriving marine biodiversity (Mills, 2001). The presence of mangrove is very uncommon, with only a small amount on mainland St Vincent and a much larger area on one of the Grenadine islands. There are extensive areas of macro algae throughout St Vincent and the Grenadines. Macro algae cover both reef and sandy areas and are thought to becoming invasive in key reef resource areas. There is a lack of significant upwelling and reef and other inshore systems are the most dependant and significant source for primary productivity (Fisheries Division, 2014). Globally coral reef ecosystems have suffered significant decline and degradation owed to a combination of anthropogenic and natural disturbances. Also contributing to this decline and degradation are increases in water temperatures (resulting in coral bleaching), hurricanes,
disease and direct impacts of fishing and industrialization on reef, mangrove, and sea-grass habitats (Gardner, Cote, Gill, Grant, & Watkinson, 2008). St Vincent and the Grenadines is no stranger to such impacts, in particular tropical storms. Over the years the island has been hit by several of these storms; Allen 1980, Danielle 1986, Emily 1987, Arthur 1990, Isaac 1998, Lenny 1999, Emily 2005 and Tomas 2010. Fortunately, due to the island’s low latitude, the majority of tropical storms originating off the west coast of Africa have drifted further north by the time they reached the Caribbean Sea (Global Facility for Disaster Reduction and Recovery, 2010).

Coral reef ecosystems stretch from beaches and mangroves across sea-grass and algal beds of fringing reefs, above the reef flats and down the slope to the shelf. Countless reef fish species are dependent on mangroves, sea-grass beds and shallow reefs as food supply, nursery and habitats; as the size of these species increase they would progressively move into deeper water (Munro, 2007). Quite often, the shelf area of a coral reef can be surrounded by a barrier reef or a sill reef at depths of 20-40 m, typically past this depth is a sudden drop-off at depths of 250 m. All these habitats where reef fish are found can be described as a coralline shelf (Munro, 1983). Coral reefs can only thrive in areas of sufficient light thus limiting their depth (Munro, 1973). Similarly, there are other influences apart from light which limits the growth of coral reefs; one such influence is the variations in wave energy. The east coast of St. Vincent is exposed to the Atlantic Ocean, with high energy waves and giving little reef development (Morris, 1983). Conversely, the west coast which extends from Kingstown to Chateaubelair receives lower wave energy as it is exposed to the Caribbean Sea. Further to that, it has a narrow shelf with coral layers that are well developed on rocky substrates around headlands. In like manner, the south and south east coast of St. Vincent gets low energy waves and have broad, shallow, well developed reef structures (Morris, 1983).

Unfortunately, literature regarding the fishing grounds for reef fishes in St. Vincent is limited to a study done on the red hind. Red hind is caught at depths of up to 50 m (Straker & Singh-Renton, 2000) on the southeast shelf of mainland St. Vincent and on the east shelf of the Grenadines bank.

1.2. Institutional Arrangement of the SVG Fisheries Division

The Fisheries Division operates under the Ministry of Agriculture, Rural Transformation, Forestry, Fisheries and Industry. It is responsible for the overall management and development of the fisheries sector. Following the enactment of the Fisheries Act (1986), the mandate of the
Division has increased in magnitude and diversity. The Fisheries Division is currently governed by six legal instruments, namely; The Fisheries Act (1986) and Regulation (1987), The Maritime Areas Act (1982), Fish Processing Regulations (2000), High Seas fishing Act (2001) and the Illegal Unreported Unregulated Fishing Regulations (2013).

A goal has been set by the political directorate to increase the productivity of the Fishing Industry. The Fisheries Division is expected to discharge a range of functions in the management and development of the fisheries sector, meanwhile promoting the commercialization of the fishing industry as a key objective. The Division’s limited resources, however, has impacted negatively on the implementation of some critical elements of its work programmes (Government of SVG, 2014). A part of the process facilitating the implementation of the Caribbean Community (CARICOM) Single Market and Economy (CSME) and the Common Fisheries Policy and Regime (CFPR) highlighted the need for the fishing industry in the Caribbean Community (CARICOM) to be competitive in all areas. The SVG Fisheries Sector must meet standards which are comparable regionally, at least for the harvesting sector, and internationally for the post-harvest sector. In like manner, the Fisheries Division has established important linkages with a number of institutions in the execution of its fisheries management and development mandate. These institutions whether they are local, regional or international, also places substantial burdens on the resources of the Fisheries Division (Government of SVG, 2014).

Currently, there are thirty-two (32) persons employed with the Fisheries Division, this includes the Chief Fisheries Officer who oversees the day to day administration of the Division. The Division is organised in seven units with responsibility for Administration, Extension, Data, Conservation, Biology Research, Quality Assurance and Product Development and Public Education (Figure 4).
1.2.1 Activity Structure of the Fisheries Division

The current activities of the Fisheries Division are disseminated among seven areas; these include: Management and development, fisheries extension, data gathering and analysis, fisheries promotional and public awareness programmes, administration, fisheries biology research, conservation and quality assurance and product development.

Administration

The Administrative Unit makes recommendations on all issues relative to the appointments, transfers and promotion of officers, conduct of officers, leave, training, travelling advances and
other allowances. The responsibility of the Unit is to ensure that procedures for procurement of goods and services, accounting, payments and revenue collection are followed as it relates to the Fisheries Division. The maintenance of an inventory of all assets assigned to the Fisheries Division and the production and maintenance of records of all formal communications are important functions of the Administration Unit. The coordination of all units and the development of overall budgetary proposals, projects and programmes complemented by appropriate reports are also critical functions of the Administrative Unit. A primary responsibility of the Unit is the development and maintenance of linkages with various national, regional and international organisations. The Unit is expected to make recommendations on the development of appropriate legislation and policy for management and development of the Fisheries Sector.

**Public Education**

The purpose of the Public Education Unit is to educate the public about fisheries and the fishing industry through the use of appropriate channels. The Unit seeks to make fisheries issues relevant to the different segments of society and to tailor education materials and programmes to meet specific needs. The content of the information disseminated is designed to educate and motivate target audiences to assume the essential roles they play in the proper management of fisheries resources and the development of the fishing industry. The Public Education Unit works with other units within the Division to implement Fisheries operational plans and to achieve the overall mission of the Division. It also works with the Fisherman’s Day Committee, fisher-folk organizations and other stakeholders in the fishing industry to disseminate relevant information.

**Conservation**

This Unit manages all matters of marine conservation and develops plans and programmes related to the conservation of marine resources. In particular, this is achieved by the monitoring of important fish stocks, conducting assessments of the health of crucial marine habitats, and assisting in the formation and amendment of fisheries legislation which relate to marine conservation. The protection of endangered or heavily exploited marine resources such as the Sea turtles, Spiny lobster, and Queen Conch are of primary interest to the conservation unit. The Unit also liaises with the relevant law enforcement agencies concerning the enforcement of fisheries conservation legislation.
**Biology/Research**

This Unit carries out research to provide assessment information and management advice to facilitate the sustainable utilisation of marine resources. The Unit also designs and executes projects that aim to gather data and information on fisheries interests that have not yet been studied. Additionally, the Unit liaises with relevant regional and international organisations to facilitate collaboration on the assessment of fisheries resources and the provision of management advice. One of the Unit’s largest programs is the continual biological and ecological assessment of all utilised marine species to help determine sustainable levels of exploitation. The unit also supports all other units with research aspects of their work.

**Quality Assurance and Product Development**

The Quality and Product Development Unit assumes responsibility for tasks relating to the assurance of quality of fish and fish products. The establishment and implementation of mechanisms to ensure compliance with appropriate fish quality standards and the monitoring of fish and fish products for local consumption and export are primary functions of the Unit. In terms of product development, the Unit engages in the research and promotes the development of new and value-added products. Additionally, the anthropological and natural disasters, which may adversely affect the health and safety of fish falls under the ambit of this Unit.

**Extension**

The Extension Unit is responsible for the transfer of technology and information to and among the fishers and other stakeholders. It is the Unit entrusted with the responsibility of breaking the barriers between the fishers and the Fisheries Division, facilitating greater fisher participation in the decision making processes of the sector. The unit also collaborates with other units in implementing the Fisheries Operational Plan. Additionally, by working with national, regional and international organisations the unit highlights the concerns of stakeholders and facilitates development and implementation of programmes that will allow for greater organisation among themselves.

**Data**

The Data Unit is responsible for the collection, analyses and management of all relevant fisheries data. The Unit is also responsible for the management and development of the licensing and registration of fishers and their vessels. The reporting of fisheries data to
national, regional and international bodies to which St. Vincent and the Grenadines is obligated also falls under the mandate of the Data Unit. Additionally, assistance is given to other units in developing surveys for gathering information with respect to various fisheries interests. The Unit provides statistical reports on which both the short and long term development strategies of the sector are based.

1.3. Management of the Various Fisheries

The fisheries and species harvested in St Vincent and the Grenadines have been grouped into seven main categories including Sharks, Whales and Turtles. Of these categories of fisheries, four are commercially significant to the country and are the pillar upon which the fishing industry is based, they are; Off-Shore Pelagic, In-Shore Pelagic, Demersal and Shell-Fish (Table 1). These categories were developed by the CARICOM Regional Fisheries Mechanism to facilitate adequate management of the fish resources (Fisheries Division, 2014).

<table>
<thead>
<tr>
<th>GROUP</th>
<th>DESCRIPTION</th>
<th>AVERAGE LANDING</th>
<th>MANAGEMENT TOOLS</th>
</tr>
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<tbody>
<tr>
<td>In-Shore Pelagic</td>
<td>Near shore fish found in mid water or surface water in beach areas, often smaller than offshore pelagic, e.g., Ballyhoo, Dodger, Jacks, Robin, Herring, Anchovy</td>
<td>Account for approximately 45% of total estimated landings. Average of 327 tons are landed annually.</td>
<td>Schooling species are caught by seines. There is a size restriction on gear mesh. The use of trammel (tangle) nets prohibited.</td>
</tr>
<tr>
<td>Off-Shore Pelagic</td>
<td>Fast swimming migratory fish that inhabit the deep sea; e.g., Mahi Mahi, Wahoo, Swordfish, Tuna.</td>
<td>Comprise approx. 20% of the estimated landings. Average annual landings 145 tons</td>
<td>Mainly caught by trolling east of the Grenadines bank. There are no regulations controlling the harvest of large pelagic in the Eastern Caribbean.</td>
</tr>
<tr>
<td>Demersal</td>
<td>Marine organisms dwelling at the sea bottom; e.g., butterfish,</td>
<td>Fished most heavily in the off-season for large pelagic. Comprise approx. 18% of the</td>
<td>Regulations stipulate that the use of dynamite, poisons and other noxious substances are</td>
</tr>
</tbody>
</table>

21
groupers, parrot fish, snappers. 

estimated landings. Average annual landings 100 - 150 tons.

prohibited. The use of spear guns is restricted.

Shell-Fish 

Marine species living at the sea bottom and are protected by a shell, e.g., conch, lobster, whelk. 

Comprise approx. 5.5% of the estimated landings. Lobsters: Approximate yield is 40 tons annually. Conch: An estimated 10.5 tons of conch is landed annually

Current regulations stipulate a closed season for lobster (1 May – 31 August) as well as minimum size limits, restrictions on fishing gear, and restrictions on taking berried females or moulting individuals. Current regulations stipulate a size restriction on (minimum shell length and meat weight) the harvesting of conch with a flared lip.

Table 1. Classification of the different categories of Fisheries in SVG

Source: (Fisheries Division, 2014)

The fishing industry in SVG consists mainly of small scale and artisanal elements, employing traditional gear, methods and vessels (Headley & Singh-Renton, 2009). The policy framework for the fisheries sector is based on expanding fish productivity in a sustainable manner to provide a key source of protein for the national populace at a competitive price. In order to support increased fish production, it is necessary that the marine environment is adequately conserved (Government of SVG, 2014). St Vincent and the Grenadines share banks and shelf areas with Grenada, hence joint management is recommended for the exploitation of demersal and shellfish species.

1.4. National Fisheries Policy and Management Objectives

The overall policy for the fisheries sector is the sustainable use of all fisheries resources to maximize benefits to all Vincentians in the present and future. The strategies and policies concerning fisheries management and development will be under continuous review with the
involvement of all stakeholders (Fisheries Division, 2014). Management regimes will serve to enhance the opportunities for fisheries to play a greater role in national food supply, thereby helping to alleviate under-nutrition and contribute to national food security. Emphasis will continue to be placed on the protection of the marine environment, in an effort to maintain and enhance its carrying capacity. Fisheries development goals and strategies will ensure the improvement of the socio-economic conditions of all stakeholders/beneficiaries within the Vincentian population. Fisheries development and management will take full account of the present and potential contributions from marine fisheries. Essential factors of production such as fishing boats, gear and technology, skilled personnel and research capability will be considered (Fisheries Division, 2014).

Fisheries Management Objectives

a. Develop and increase the potential of living marine resources to meet human nutritional needs, as well as social, economic and development goals of the sector.

b. Ensure that the fishing industry is integrated into the policy and decision-making process concerning fisheries and coastal zone management.

c. Take into account traditional knowledge and interests of local communities, small-scale artisanal fisheries and indigenous people in development and management programmes.

d. Maintain or restore populations of marine species at levels that can produce the maximum sustainable yield as qualified by relevant environmental and economic factors, taking into consideration relationships among species.

e. Promote the development and use of selective fishing gear and practices that minimize waste in the catch of target species and minimize by-catch of non-target species.

f. Ensure effective monitoring and enforcement with respect to fishing activities.

g. Protect and restore endangered marine species.

h. Preserve rare or fragile ecosystems, as well as habitats and other ecologically sensitive areas, especially coral reef ecosystems, estuaries, mangroves, sea grass beds and other spawning and nursery areas.

i. Promote scientific research with respect to fisheries resources.
j. Co-operate with other nations or organisations in the management of shared or highly migratory stocks.

1.5. Research Aim and Objectives

This research is aimed at examining the patterns in catch composition for the main fisheries, and focussing in more detail on five of the most commercially viable fish species found in the waters of St Vincent and the Grenadines, conducting preliminary stock assessments where possible. These species are Jacks/ Big Eye Scad (*Selar crumenophthalmus*), Mahi Mahi (*Coryphaena hippurus*), Red Hind (*Epinephelus guttatus*), Spiny Lobster (*Panulirus argus*) and Queen Conch (*Strombus gigas*). It uses catch and effort data and fish landings data collected by the Fisheries Division to depict any trends or discrepancies in the fish harvested and landed at the various landing sites across the island. Given that the dataset is limited, the research will use the Schaffer logistic curve to estimate the relationship between CPUE and total effort, and then use the parameters from the regression to estimate the equilibrium catch and maximum sustainable catches for the fish species. Also emerging will be the assessment of similarity and difference in catch composition between fishing gear and fishing grounds.

These species were chosen because of their high commercial value, susceptibility exhaustion and their significance as social and economic markers in fishing communities around SVG. It is expected that the results obtained would be used as examining tools for the purpose of investigating catch discrepancies, the development of stock assessment programs, establishment of maximum sustainable yields (MSY), development and implementation of quota and licensing system and other alternative and less traditional management strategies.

Chapter 1 of this thesis describes the SVG region, and the fisheries institutional structures of the region. Chapter 2 describes the legislative framework, Chapter 3 the structure of the fishing industry and fleets, and Chapter 4 the fisheries data collection processes. Data preparation and statistical analysis of the catch composition of the main fisheries is described in Chapter 5, along with more detailed along with more detailed analysis of the main fisheries targeting the five species of interest. Preliminary stock assessments are provided in Chapter 6, and overall conclusions are drawn together in Chapter 7.
Chapter 2. Legislative Framework

The most valuable fishing grounds predominantly lie in coastal waters and consequently the Exclusive Economic Zone (EEZ). This is primarily due to the complex dynamics of the biological production of the world’s oceans (Kullenberg, 1999). Evidence of the benefits of establishing EEZ is quite noticeable, almost 90% of global fish catches occur under national jurisdiction (Kullenberg, 1999).

The EEZ concept is a fairly new phenomenon, it came about during the latter half of the Twentieth Century. Around that time many countries began to re-examine the freedom of the seas principle which presented limitations to state’s jurisdiction over waters by which they were surrounded. There were growing concerns about oil and gas exploration, transportation of toxic wastes and overfishing by foreign fleets (Hannesson, 2013).

Establishing EEZ was and still is of ground-breaking significance to the management of fish resources. In a number of circumstances, the zone surrounds the entire habitat of fish stocks, thus, making them in fact the exclusive property of the coastal state involved. The Law of the Sea Convention (LOSC) supports optimum use of fish stocks without chancing depletion through over-exploitation (Kullenberg, 1999).

Each coastal State is encouraged to determine the total allowable catch for the fish species found in its EEZ, and additionally estimates its ability to harvest along with what it can and cannot secure as its own catch. Every coastal State is allowed jurisdiction for the protection and preservation of the marine environment and fish found in its EEZ (Kullenberg, 1999). To this end, states have the responsibility and are obligated to regulate their fisheries as they see fit (Hannesson, 2013). States can (but are not limited to) set catch quotas and license people or firms to engage in the fishery for limited time periods and with specified fishing equipment. These regulations can be supported by the state’s enforcement and judiciary system, taking offenders to court and imposing penalties as seen fit (Hannesson, 2013).

The establishment of Exclusive Economic Zones (EEZs) provided countries with a legal framework for the management of their marine resources. In St. Vincent and the Grenadines, primary fisheries legislation approved by parliament is broad in scope and lays down the principles and policies for fisheries management and development. It also defines the institutional structures for fisheries management and empowers these structures with the corresponding authority in a manner which avoids overlapping jurisdiction. The mandate for
fisheries management and development in St. Vincent and the Grenadines is embodied in the following primary legislation:

2.1. Fisheries Act of 1986

This Act makes provisions for the promotion, management and development of fisheries within the Exclusive Economic Zone (EEZ) of St Vincent and the Grenadines. It specifically makes provisions for the preparation, monitoring and implementation of fisheries management plans, which includes the powers necessary to formulate management measures. It further makes provision for the institution of licensing regimes, registration of local fishing vessels (Fisheries Act, 1986, sec. 4), establishment of marine reserves and conservation processes, the enforcement of management and conservation measures and penalties (Fisheries Act, 1986, Sec. 22). Provisions are also made for regional cooperation in Fisheries and fisheries access agreements. This Act is administered by the Minister with responsibility for Fisheries and provides a mandate for the Fisheries Division.

Enshrined in the FAO Code of Conduct for Responsible Fisheries is the framework for states to establish data analysis and collection system. “In order to ensure sustainable management of fisheries and to enable social and economic objectives to be achieved, sufficient knowledge of social, economic and institutional factors should be developed through data gathering, analysis and research” (FAO, 2011, Art 7.4.5). The Fisheries Act encourages the harmonisation of systems for fishery statistics collection, fishery surveys and procedures for assessing the states fisheries resources (Fisheries Act, 1986, Sec. 6). This also constitutes part of promoting regional cooperation between St Vincent and the Grenadines and other States in the Caribbean region.

2.2. Fisheries Regulation 1987

There are some legislations adopted by the Government through the Cabinet, and they generally set out the substantive and procedural details of implementing the provisions of the primary legislation. These are referred to as regulations and includes the Fisheries Regulations of 1987.

The Fisheries Regulations deal with the establishment of Fishery Advisory Committee (Fisheries Regulations, 1987, Sec. 2), and details the requirements for the implementation of local and foreign fishing licensing and registration systems (Fisheries Regulations, 1987, Sec. 6). It stipulates fisheries conservation measures, including gear restrictions, closed seasons and
areas, species minimum size and restrictions on the harvest and export of some species (Fisheries Regulations, 1987, Sec. 16). Further stipulations are made for the placing of fish aggregation devices and fisheries research (Fisheries Regulations, 1987, Sec. 26).

This research focusses on some species for which there are specific legislations regulating harvesting (Spiny Lobsters and Queen Conch) and others for which restrictions on the type of gear to be used in the harvesting are enforced (Jacks, Bigeye Scad). The following describes briefly the proceedings as set out in the Fisheries Regulations 1987.

2.2.1 Spiny Lobster

It will be demonstrated in this research that lobsters contribute significantly to the economy of St. Vincent and the Grenadines. While this is so, many people often violate the law by harvesting, selling and buying illegal lobsters, quite often the perpetrators include lobster divers, tourists, exporters, hotels/restaurants, and sometimes even the average consumer. Moreover, some of these people knowingly break the law, meanwhile, others may not even be aware of these regulations. Some of the most dominant offences committed are:

• Catching, purchasing and selling lobsters carrying eggs.

• Removal of eggs from female lobsters.

• Purchasing and selling lobsters from which eggs were removed.

• Catching, buying and selling undersized lobsters.

• Ignoring the closed season by catching, buying and selling during that time.

• The use of restricted gear to harvest lobsters.
2.2.2 Queen Conch

The Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES) controls trade in endangered species. This is done through the establishment of three appendices: Appendix 1- species threatened with extinction and prohibited from commercial trade, Appendix 2 - species which may
become extinct unless trade is strictly regulated, and Appendix 3 - species protected in their country of origin in cooperation with other nations.

The Queen Conch is considered an endangered species and therefore its exports are regulated. Appendix 2 regulates the exportation of the Queen Conch. Persons wishing to trade Conch, are required to land them in their shell to facilitate inspections by the Fisheries Division. This inspection assists in ensuring that only legal Conch are exported. Under CITES, traders must obtain permission from the exporting and importing countries before any exportation can occur. This permission is sought through application forms.

St Vincent and the Grenadines is doing its part to ensure the protection of this species. As such the country has laid out in its legislation condition governing the harvesting and exportation of Conch.

<table>
<thead>
<tr>
<th>Part VI Fishery Conservation Measures</th>
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<tbody>
<tr>
<td>CONCH</td>
</tr>
<tr>
<td>1. No person shall take, sell or purchase or have in his possession any immature conch.</td>
</tr>
<tr>
<td>2. The Minister may by Notice published in the Gazette declare any period as closed season for conch.</td>
</tr>
<tr>
<td>3. No person shall fish for conch during the period of a closed season for conch.</td>
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<tr>
<td>4. In this Regulation immature conch means:</td>
</tr>
<tr>
<td>(a) A conch the shell of which is smaller than 7 inches (18 centimetres) in length; or</td>
</tr>
<tr>
<td>(b) A conch the shell of which does not have a flared lip; or</td>
</tr>
<tr>
<td>(c) A conch with a total meat weight of less than 8oz (225 grams) after removal of the digestive gland.</td>
</tr>
</tbody>
</table>

(Fisheries Regulations, 1987)

### 2.2.3 Minimum Size for Nets

Minimum mesh sizes for nets is a means of ensuring the protection of juvenile fish. Smaller fish which pass through the mesh stands a chance of maturing and reproducing, hence replenishing the fish resources. Tangle nets are illegal as they prevent the escape of small fish. The Beach Seine fishery is another fishery which requires its mesh sizes to be regulated. Fisheries such tuna long line, bottom long line, trolling, fish pots, etc., have huge dependence on the beach seines for supplying fish to be used as bait. The consequences can be quite negative without a regular supply of bait fish as the other fisheries will suffer and the industry
may not show its true value. The Jacks (Bigeye Scad) are the most important bait species. Apart from its use as bait, Jacks also plays the vital role of being used for food among the Vincentian population and also as an export commodity for Vincentians abroad.

Efforts to Legislate Traditional Beach Seine Fishery:

Beach seine fishers uphold a recognized set of traditional rules for allocating fishing opportunities among themselves. Even so, as a result of a high level of intra and inter-fishery competition, conflicts usually arise. Quite often the beach seine fishers would agree that these traditional rules are sufficient to address the needs of the fishery. However, many have expressed the desire to have these traditions enacted as part of the fisheries legislation. The enactment of these traditions will also allow for greater protection of the Jacks and other susceptible species.

<table>
<thead>
<tr>
<th>Part VI Fishery Conservation Measures</th>
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<tbody>
<tr>
<td>PROHIBITION ON USE OF TANGLE NETS</td>
</tr>
<tr>
<td>22. No person shall use a tangle net for fishing in the fishery waters of Saint Vincent and the Grenadines.</td>
</tr>
<tr>
<td>MINIMUM SIZE FOR NETS</td>
</tr>
<tr>
<td>23. (1) The mesh size of a seine shall be not less than one inch square.</td>
</tr>
<tr>
<td>24. (2) The mesh size of a “Ballyhoo net” shall be not less than one half of an inch square.</td>
</tr>
<tr>
<td>BALLYHOO NET NOT TO BE DRAWN UP ON LAND</td>
</tr>
<tr>
<td>24. No person shall draw or haul any Ballyhoo net from the water up onto the land, or up onto any wharf or jetty, or up into or on any boat, canoe, vessel, raft or other floating construction, lying at the time within fifty feet of the land.</td>
</tr>
</tbody>
</table>

(Fisheries Regulations, 1987)
2.3. Description of Other Legislation

The following is a brief description of the other pieces of legislation governing the fishing industry of St Vincent and the Grenadines:

2.3.1 Maritime Act 1983

This Act declares and establishes the maritime areas of St. Vincent and the Grenadines and provides for the protection and use of these areas. The Act enabled the state to define the following areas: (1) Internal waters, (2) Archipelagic waters, (3) Territorial sea, (4) Contiguous Zone, (5) Exclusive Economic Zone, (EEZ), (6) Continental Shelf, (7) Territorial Extent and (8) Safety zones. These maritime areas are generally accepted by even though the boundaries have not been demarcated. This Act is administered by the Minister with responsibility for Foreign Affairs.

2.3.2 High-Seas Fishing Act 2001

In this act the legal basis for instituting a system for the regulation of vessels registered to St. Vincent and the Grenadines which fish on the High Seas is outlined. The Act provides for continuous monitoring, control and surveillance (MSC) of all registered vessels flying the flag of St. Vincent and the Grenadines which harvest high seas fisheries resource. MSC is achieved through appropriate data collection systems, licensing systems and international cooperation. The Act facilitates compliance with internationally agreed fisheries management measures established by the country’s Regional Fisheries Management Organization (RFMO) the International Convention for the Conservation of Atlantic Tunas (ICCAT). This Act is administered by the Minister with responsibility for Fisheries and provides the mandate for the Fisheries Division.

2.3.3 High-Seas Fish Regulations 2006

These Regulations compliment the High Seas Fishing Act 2001 and provides for the monitoring, control and surveillance of Vincentian registered vessels fishing on the high seas. It stipulates: the licensing process; safety and assistance to authorised officers; specific prohibitions relating to international conventions and agreement to which St. Vincent and the Grenadines is a signatory; reporting; limitations or actions in civil proceedings; fees infringements and penalties.
2.3.4 Fisheries (Fish and Fish Product) Regulations 2006

These Regulations were drafted in response to the increasingly stringent standards of the international community for the monitoring and control of the quality of fish and fish products. These regulations make provisions for the control of marketing, handling, transporting and storage of fish as well as the operations of fish processing establishments. Specific provisions include standards for handling and processing of fish and fish products on fishing vessels and fish processing establishments as well as requirements during and after landing of fish. The regulations also stipulate the checks required for health control and the monitoring of production conditions including minimum facilities, standards for hygiene, packaging and identification marks. The regulations further stipulate mandatory storage and transport conditions including the required temperatures. In addition, the procedures for approval and withdrawal of licences of fish processing establishments are clearly detailed with these regulations.

2.3.5 Aboriginal Subsistence Whaling Regulations 2003

These provides for the management of the Aboriginal Subsistence Whaling in Bequia. Specific provisions are made for a whaling licence, the declaration of whaling priority areas and whaling seasons, restrictions on the sale of whale products, the collection of data and information and procedures for accessing whales by persons fishing under an Aboriginal Subsistence Whaling Licence.
Chapter 3. Description of the Fishing Industry

Numerous attempts have been made to describe small scale fisheries worldwide; for example, FAO, (2000); Russel and Poopetech, (1990); Stapels et al., (2004) and many more. Although there is no universal definition, often words such as traditional or artisanal are used synonymously (Salas, Chuenpagdee, Seijo, & Charles, 2007). Some authors have generally taken into account several characteristics which are different depending on context and location; but nonetheless, common in all small scale fisheries. These features include: vessel size, movement of the fleet, method of production, organizational structure, and distribution of the products (Panayotou, 1982). Salas, et al. (2007) stated that even though the dissimilarities in small scale fisheries around the globe are acknowledged, some common features recognised are as follows:

(a) The use of multiple fishing vessel types and fishing gears to target a mix of species, thereby making it difficult to evaluate the state of the resources and the fishing pressure exerted.

(b) Low levels of capital input by fishers, and the employment of laborious methods of harvesting, processing and distribution of exploited fishery resources.

(c) A wide array of landing sites located along the coast utilised by fishers. These are often in small communities, thus presenting challenges in effectively recording catches and fishing effort data.

(d) The use of fishing resources on a seasonal basis, with supplemented income from other economic activities such as farming and construction (masonry or carpentry). This presents the dilemma of part-time fishers in the fishery.

(e) Substantial provision through fishing as food and employment for people in coastal communities.

(f) Luring of immigrants and encouragement of urbanisation to the coast for people in search of income from fishing. This typically requires less investment to enter the fishery, with regards to capital and skills. Additionally, migrants have the option of becoming “workers” in private companies.

(g) Lack of control or influence on the fish market by the fishers; this given their small-scale capital requirement; and as a result, greater dependence on middlemen for marketing and loans.
(h) Lack of socioeconomic structures for insurance, health and employment benefits to the fishers.

The concept of small scale fishing operations versus large scale fishing operations appears as though emphasis is placed more on the size of the fisher’s operation (Charles, 1991). Notwithstanding, a number of the same stocks that are being exploited by large scale fisheries are also being exploited by small scale fisheries along with a number of other smaller stocks. Small scale fisheries may be highly modernized and possess sophisticated technology (Berkes, 2001). According to (Berkes, 2001); most small scale fisheries tend to target the following groups of species:

1) Demersal fishes found in the deep off tropical slopes and shelves; and a typically harvested through the use of lines, nets and traps/ pots.

2) Large coastal pelagic fishes, caught normally by trolling and small scale longlines.

3) Coastal demersal species of bays and shelves harvested through the use of seine nets, traps and longlines. Often the same stocks are being exploited off-shore by large scale trawl fishery which targets the species at a different stage in its life history.

Whereas developing states predominantly have small scale fisheries; a few can also be found in developed states (Chuenpagdee, Liguori, Palomares, & Pauly, 2006). However, small scale fisheries in developed nations tend to employ more sophisticated vessels, gear and methods; nonetheless, they are considered small scale due to the fairly limited capital input and the labour intensive participation that exists (Charles, 1991).

The social science notion of “marginalization” can also be worthwhile when classifying small-scale fisheries. There is also the concept that small scale fisheries in any society are more suited to the “socially awkward” members of the community. Marginalized and socially awkward components of society include those people who are in a specific lesser grouping, such as indigenous people; those of a particular socioeconomic bracket such as the uneducated; and those through their geographic setting, such as rural or remote areas (Charles, 1991). Within this context small scale fisheries are disregarded and taken for granted. Charles (1991) further stated that some small scale fisheries are even considered as communities under threat from economic forces outside of their purview.

Data made available by the FAO has indicated that the global number of people involved in fishing has more than doubled in the last few decades (FAO, 2014). Employment in the fishing sector as of 2012 grew faster than the world’s population. There are approximately 60 million
people engaged in the primary fisheries sector production, of this figure 90% are small-scale fishers (FAO, 2014).

Small-scale fisheries have made significant contributions to poverty alleviation and food and nutrition security. These contributions are increasingly gaining recognition, for instance; in the Rio+20 outcome document “The Future We Want” (Rio, 2012) and in the development of the Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication (Kurien, 2015). It is the intention of these initiatives to ensure that fishers and the societies to which they belong have tenure security and market access while preserving their human rights (FAO, 2014). Small-scale fisheries are receiving international recognition as being fundamental to growth, but also as an element susceptible to the impacts linked to challenges ranging from climate change to maritime disputes (FAO, 2014).

One point that should be noted before detailing the fisheries in St Vincent and the Grenadines. Terminologies such as artisanal, subsistence and near/ in-shore are used interchangeably with small scale fisheries.

3.1. The History of Fisheries in SVG

The small scale fisheries nurtured by St Vincent and the Grenadines are part of a trans-boundary oceanographic and ecological linkage within the Caribbean (B. Chakalall, Mahon, McConney, Nurse, & Oderson, 2007). Due to the close proximity of the islands in the Caribbean, many marine resources are shared (Figure 5). These shared living marine resources require cooperation for governance and include both exploited and non-exploited resources and their habitats (B. Chakalall, Mahon, & McConney, 1998).
Most of the islands in the Caribbean region have relatively narrow shelf areas. Conversely, substantial shelf areas can be found around the Virgin Islands, Anguilla, St. Martin/St. Maarten/St. Barthelemy, Saba, Antigua/Barbuda and between St. Vincent and the Grenadines and Grenada (the Grenadines Bank) (B. Chakalall, 1995).

The fisheries in the Caribbean, the fishing communities and fisher-folks have attracted the attention of remarkably few academic geographers and anthropologists. There is a significant gap in our knowledge regarding Caribbean fishing technology, fishing methods and fishing gear. There is also a gap in our knowledge of the nature and distribution of marine industries in the islands and mainland coasts (Adams, 1978a). Possibly even more than agriculture, fishing and other sea-faring activities have remained and have been a constant with the way-of-life and diversity of fishing and maritime societies. Further to that, the fishing vessels and fishing techniques, the attitude and social structure, the dissemination of settlements, the range and character of operations, and the intimacy of interactions with the weather and the sea, provide a unique range of topics for scholarly research.\footnote{The view that the geography of fishing offers a wide array of research possibilities was articulated by James J. Parsons in his review of a book entitled: Die Grossen Fischereiraume der Welt by Fritz Bartz, which appeared in Geographical Review (volume 58), 1968. To date these sentiments, remain the same as very few scholarly research has been conducted into Caribbean fisheries and in particular the Lesser Antilles.}

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Figure 5. The countries of the Wider Caribbean and the mosaic of their EEZs.
Several centuries before Christopher Columbus visited the West Indies, a group of Amerindians known as the Caribs started settling in the Lesser Antilles (small southward islands of the Caribbean). By the turn of the fifteenth century the Caribs had occupied all of the islands of the Lesser Antilles (Adams, 1978b). Historical and archaeological evidence indicated that fishing played a significant role in the daily lives and the survival of these Caribs. During the seventeenth and eighteenth century, visiting French historians to the Lesser Antilles took time to observe on many occasions the livelihood patterns of the Caribs. The accounts documented clearly indicated that the Caribs were very skilled fishers, excellent divers and possessed great seamanship skills (Adams, 1978b).

Evidence demonstrates that the Caribs utilized weighted lines with baited hooks to harvest a range of finfish found over near-shore reefs. They also harvested the local spiny lobsters, various crab species and the Caribbean queen conch (Adams, 1978b). The diverse fishing techniques utilized by the Caribs were probably employed with huge success in the Grenadine islands as those island possess the largest concentration on reef fish, spiny lobsters and queen conch.

Whaling was historically the first fishery of importance in St. Vincent and the Grenadines. Even though there was a decline in the fishery in the 1920s evidence of its contribution can still be seen today on a small scale. In the west coast community of Barrouallie (on the main land) and on the small island of Bequia, the knowledge and technology of boat building and sailing persists (Mohammed, Straker, & Jardine, 2003). At the end of World War II there was mass entry into the fishing industry; then in 1946 a fisheries administration was formed under the Ministry of Agriculture. This administration consisted of one individual at the time (Jardine-Jackson & Straker, 2003). To this day the Fisheries Division remains under the umbrella of Ministry of Agriculture, but now has a fully functional staff of approximately thirty-six persons (Government of SVG, 2014).

During the period 1950 to the 1980s the majority of the fishing activities in St Vincent and the Grenadines took place on the west and south coast of the island. At that time a mere 6.13% of the fishing fleet in St. Vincent was motorised. On the west and south coast of the island where the bulk of the fishing activities took place, there were 10 ‘fishing centres also known as landing beaches’ (Morris, 1983) (Figure 6). Facilities at these fishing centres were significantly limited and only included a shed which was used as a fish market and taps providing potable running water (Mohammed & Lindop, 2015; Morris, 1983). Also at the time fishing on the windward end of the island (east coast) was inconsequential, hence there were no fishing
centres there (Mohammed & Lindop, 2015). The coastlines of St Vincent and the Grenadines vary to a large extent, and it is this variation that determines the distribution of fishing centres or landing beaches. This is especially so for the windward (east coast) of the main island St Vincent. The east coast of St Vincent is washed by the Atlantic Ocean; it is comprised of a number of long stretched high energy beaches, which are unsuitable to be used as landing beaches (Morris, 1983).

Figure 6. Typical fish landing facilities during the 1950s through to the 1980s

Beginning in the 1980s the government of St. Vincent and the Grenadines started the provision concession on fishing gears and vessels after the passage of hurricane Allen, which caused approximately US$26,000 in damages (Mohammed et al., 2003). Consequently, this resulted in the wide spread mechanisation of fishing vessels, thus increasing fishing effort in the country.

Although the fishing industry in St. Vincent and the Grenadines was still primarily small scale, by the turn of the 1990s most vessels have been motorised (Mohammed et al., 2003). In the early 1990s a project jointly funded by the Canadian International Development Agency and the government of St. Vincent and the Grenadines was implemented (Mohammed & Lindop, 2015). The main goals of the project were to support and enhance fisheries institutional capacity, foster community cooperation activities and institutions, and to allow sustainable growth of the fishing industry in St. Vincent and the Grenadines.

Through the Japan International Cooperation Agency (JICA) noteworthy development was also achieved through its Grant Aid Program. This comprised the upgrading of fish landing and processing facilities at the primary landing centre in Kingstown (Figure 7). In addition, the JICA aid program facilitated construction of fisheries centres in the Grenadines and on the main land, namely; Union Island, Canouan, Bequia and Calliaqua (Mohammed et al., 2003).
Other donation made by the Japan International Cooperation Agency to St Vincent and the Grenadines were 1 new pirogue fishing vessel and 5 new $12.5 m Yanmar multi-gear vessels fitted out with longline and trolling gear (R. Mahon & Singh-Renton, 1993). The arrival of these 5 multi-gear vessels revolutionized the fishing industry of St Vincent and the Grenadines and set the pace for the establishment of the tuna longline fleet. With a tuna longline fleet established there was an escalation in the importance of large pelagic resources such as tuna, billfish and shark in the 1990s (Morris, 1992).

Although the fishing industry was revolutionized by the arrival of the 5 longline vessels the fisheries were still predominantly small-scale and artisanal. Most of the boats were still open and powered by outboard engines. Nonetheless, towards the end of the 1990s substantial infrastructural development had occurred in the Grenadines (Bequia and Union) and Calliaqua in St. Vincent. Similar facilities were subsequently constructed in Barrouallie and Chateau Belair (Mohammed & Lindop, 2015). As recent as 2008 another facility was constructed in Owia on the east coast of St Vincent.
3.2. Fisheries Infrastructure Development

The last two decades have seen an improvement in the standard of infra-structural development at the various landing sites throughout St Vincent and the Grenadines. In the early 1990s the New Kingstown Fish Market (NKFM) was the only landing site with ample fish landing and storage facilities such as, vending stalls, ice machines, chillers among other basic necessities (Jardine-Jackson, Isaacs, & Jack, 2013). Presently, there are similar facilities which exist in Paget Farm, Bequia; Britannia Bay, Mustique; Friendship, Canouan; Clifton, Union Island; Canouan, Calliaqua, Barrouallie, Chateaubelair and Owia (Jardine-Jackson et al., 2013). Examples of these facilities are shown in Figure 8 - Figure 15

![Figure 8. Bequia fishing complex](image_url)
Figure 9. Calliaqua fishing complex

Figure 10. Canouan fishing complex
Figure 11. Union Island fishing complex

Figure 12. Mustique fishing complex
Figure 13. Chateaubelair fishing complex

Figure 14. Barrouallie fishing complex
St. Vincent and the Grenadines continues to explore all available sources of revenue in order to ensure food security for its people while meeting the challenges of sustainable utilization and a changing global environment. However, such efforts must be in compliance with acceptable international practices and standards. The country continues to develop, refine and implement the relevant legislative, management, monitoring and enforcement mechanisms with regards to its high seas fishing fleet. These measures are geared toward ensuring the activities of these vessels are fully compliant with the conservation and management initiatives taken by the International Commission for the Conservation of Atlantic Tunas (ICCAT) and other relevant organizations (Fisheries Division, 2014a).

3.3. High-seas Fishing

SVG’s fleet (Figure 16) operating in the ICCAT conservation area comprises mostly of long-line fishing vessels which target tuna and tuna like species. These vessels are foreign owned and registered with the St. Vincent and the Grenadines Maritime Department. The total number of tuna longline vessels operating in the ICCAT convention show slight decreases over the past five years with 2012 and 2013 having only 28 vessels operating (Fisheries Division, 2014a).
These vessels generally land and trans-ship their catches at two major trans-shipment ports in Trinidad and Tobago. While there is ongoing collaboration and good communication with ship owners for obtaining fishery statistics, St. Vincent and the Grenadines sees the need to establish an independent port sampling programme to verify landings and trans-shipping activities at these ports (Fisheries Division, 2014b).

For the 2014-2015 fishing season the following Quotas were allocated to St Vincent and the Grenadines by ICCAT: 75 metric tons (mt) of Swordfish, 350mt of Northern Albacore Tuna, 100mt of Southern Albacore Tuna and 2,100mt of Big Eye Tuna. Funding has been obtained from ICCAT to fund a port sampling programme which will be implemented during 2015 (Government of SVG, 2014).

![Figure 16. St Vincent and the Grenadines Flagged High-seas Fishing Vessel](image)
3.4. Fishing Fleet, Gear and Method

Fisheries in St. Vincent and the Grenadines are multi-gear and multi-species (Morris, 1983) and (Labban, Isaacs, & Oxenford, 2013). The distinction of the various fisheries of importance to the island is quite visible. The most prominent fisheries in St Vincent and the Grenadines are trolling, longline, handling, beach seine and pot fishing (B. Chakalall, 1982). These fisheries, the fishing gear utilized and the species caught will be further described later in this chapter. St. Vincent has a coastal shelf area of 7,800 km² which facilitates its fishing activities (Jardine-Jackson & Straker, 2003). The vast majority of artisanal fishers throughout St Vincent and the Grenadines use simple coastal fishing vessels ranging in size between 4-10 m. These vessels are open types or partially decked wooden or fiberglass boats, equipped with either oars, sails or outboard engines and would normally fish in inshore coastal areas, shallow coral reef areas and on deep fore-reef slopes (Y. Chakalall S., 1992). The fleet is composed of double-ender, pirogue, canoe, sloop, launch, and bow and stern type vessels (Morris, Cruickshank, & Mahon, 1988). Although some boat types specialize in a particular fishery, many boats are used for all types of fishing (Morris, 1991).

**Fishing Vessel Types**

**Pirogue:** These are open boats with a pointed bow and flat transom/ stern, however, the bow is much higher than that of the flat transom boats and they tend to be slightly larger, ranging from 7 – 10 m (19 – 30 ft) in length (Figure 17). They are constructed from fibreglass and powered by one or two outboard gasoline engines ranging from 40 -85 horsepower. These vessels are predominantly used in the trolling and demersal fisheries. Currently there are 560 pirogue vessels registered (Fisheries Division, 2014b).
Flat Transom (Bow & Stern): These are commonly called bow and stern or dories. They are open boats of 3 – 6 m (11-27ft) in length (Figure 18). They are constructed from wood or marine plywood which in many cases are covered by epoxy or fibreglass, which provides a waterproof covering. They are often powered by one or two outboard gasoline engines ranging from 14 – 115 horsepower. Oars maybe the only form of propulsion on rare occasions. These vessels are used mainly in the lobster and conch fishery in the Grenadines and there are currently 230 registered (Fisheries Division, 2014b).
Double Ender (two bows): There are 69 of these type of vessels registered; they are open wooden boats ranging from 3 – 9 m (10 – 29 ft) in length (Figure 19). Both ends of the boat are shaped like the bow of a boat. In most cases the only means of propulsion are oars, but occasionally, they may be powered by a small outboard gasoline engine specially rigged at one end of the boat. These engines range from 6 – 48 horsepower. These vessels are used mainly in the beach seine fishery (Fisheries Division, 2014b).

Multipurpose: In SVG these vessels range from 34.7 ft – 48.5 ft in length (Figure 20). The main type of long-liner is a Yanmar type made of glass reinforced plastic (GRP) powered by inboard diesel engines ranging from 90 – 190 hp. They are multi-purpose in nature and designed to operate up to 150 nautical miles from the islands with a 3 to 5 day stay at sea. These vessels are used primarily for tuna longline fishing, but may be utilized for trolling, bottom longline fishing, pot fishing and angling. There are 30 of these vessels registered (Fisheries Division, 2014b).
**Fishing Gear Types and Methods**

The fisheries of St Vincent and the Grenadines employ fishing gear which are generally simple, small scale and of low efficiency. As demonstrated previously, these fisheries are accessed by open wooden or fibre glass vessels (Y. Chakalall S., 1992). The materials for gear construction are mostly purchased locally and sometimes directly from trading vessels of neighbouring islands.

**Handline**

Handlining is one of the most widely practice fishing techniques throughout St Vincent and the Grenadines (Chakallal, Mahon, Ryan, & Oxenford, 1994). Bow and stern or Pirogue vessels are utilized within this fishery and target parrotfish, hinds and groupers on the shallow shelf and groupers and snappers on the deep slope area (FAO, 2002b). Handlining typically involves the use of a long weighted mono-filament line with one or more baited hooks attached (Figure 21). The average landings are between 60 – 125 lbs and are usually fished 5-6 days per week for 3-4 hours with a crew of 2-6 fishers (Jardine-Jackson & Straker, 2003).

![Figure 21. Handline Fishing](image-url)
Beach Seine

The primary gear used for the harvesting of coastal pelagic is seine net. Usually, seines are used in two ways: close inshore, by pulling the net onto a beach, or in a purse seine fashion by just encircling the fish offshore and hauling the net up into a boat (Figure 22) (Chakallal et al., 1994). Beach seine fishing is conducted in sheltered bays that have smooth and gently sloping seafloor (S. Mahon & Mahon, 1990). One end of the beach seine is secured on shore while the remaining portion is dragged in a semi-circular fashion from a double ender or row boat. Once the school is encircled the seine is slowly pulled in towards the shore carrying trapped fish with it. The catch mainly comprises Jacks (Bigeye Scad), Robin, Dodger and other inshore pelagic (Figure 23). The minimum legal mesh size in seine nets is 1 inch (2.5cm).

Figure 22. Beach Seine

Figure 23. Jacks harvested with beach seine
Trolling

Trolling or “towing” is an active type of line fishing used in catching offshore pelagic (Figure 24). It involves the use of one or a few long monofilament lines with several types of baited hooks and lures attached (Straker, 1997). Small multi-purpose vessels are driven with the line trailing behind and targets large offshore pelagic species such as tuna, wahoo, mahi mahi, barracuda and bill fish (Figure 25). Fast outboard boats are the preferred choice of vessels for trolling. Trolling is also a common fishing technique for recreational fishers and small inshore pelagic are the bait of choice for the fishery. Trolling can be performed solitarily or with a small crew (Gill, McConney, & Mahon, 2007).
Gillnet

Gill netting uses a net to catch schools of pelagic fish by trapping them by their gill covers (operculum) (Chakallal et al., 1994). Typically gillnets are made from monofilament nylon, not easily detected visually by fish. The net can be set fixed or left to drift (Figure 26) while the fish get trapped (S. Mahon & Mahon, 1990). These nets are equipped with a float and lead line which keeps it on the bottom. Once set the net is soaked for approximately 18-24 hours (McConney, 2003). Gillnets are generally set either circular, or semi-circular and are open to the beach while schools of fish are driven towards the mesh where they are trapped. These nets are used to catch pelagic fishes. The catch composition is usually determined by the size of the mesh. These nets are also utilised in the lobster fishery as nets left for an extended period of time contain decaying fish which attracts lobsters (McConney, 2003). This entanglement net is very unselective and catches many unwanted species leading to large quantities of by-catch which is detrimental to the marine ecosystem (Gill et al., 2007).

![Figure 26. Gillnet](image-url)
Traps/ Fish Pot

Trapping is a passive form of fishing (Straker, 1997). It consists of placing baited traps, constructed with hexagonal mesh wire stretched over a wooden or steel frame into the water and allowing the fish to be trapped (Matthes, 1984). The traps are traditional in nature (Figure 27 - Figure 28), some are set in shallow water for subsistence catches while most are set deeper at depths of 8-27m; at such depths they catch a large variety of reef fish including snappers, groupers, and parrotfish (Matthes, 1984). In addition, trap is the primary gear used in the harvesting of the spiny lobster (Straker, 1997). Upon setting the traps they are usually checked every 5-7 days. Traps are utilized throughout the year, but the focus on fish increases in May–August due to the closure of the lobster season. Many fishers replace their traps annually, this is due to corrosion, damage, misplacement or theft. During the lobster closed season many fishers switch to another fishery then upon re-opening they revert back to catching lobsters (Gill et al., 2007).

![Figure 27. Trap/ Fish Pot](image)

![Figure 28. Special trap for holding lobsters](image)
**Bottom-line**

Bottom-set longlines are largely used throughout St Vincent and the Grenadines. They consist of lines which are usually vertically hung down the shelf slope or bank edge (Figure 30). Sometimes the lines are also laid along the bottom of the reef (Figure 29) (S. Mahon & Mahon, 1990). The set up normally consists of no more than about 20 hooks and is left to soak only for several minutes at a time. It is used for catching reef and deep slope demersal such as snappers, groupers, hind and parrotfish throughout the waters of St. Vincent and the Grenadines (Straker, 1997).

![Figure 29. Bottom Longline set along the sea floor](image)

**Dropline**

Droplines are used mostly in deep-slope and bank areas. The method consist of a weighted line with an easily detachable sinker to which 3-6 hooks are attached by short branch lines (Figure 31). Hooks are typically baited with small pelagic fish such as jacks, and target species include carnivorous reef fish such snappers and groupers. Boats fishing with droplines either drift over the shelf area being fished or go "banking" where the boat tries to remain over a particular area and depth by rowing constantly (Matthes, 1984).
Palangue varies from the home made “set up” on smaller vessels to mechanised longlining with hydraulic pulley systems, found on the larger and more modernized longline fishing vessels (Chakallal et al., 1994). Palangue involves setting numerous baited branch lines suspended from a mainline and made buoyant by attaching buoys at various selected intervals (Figure 32). The gear could be more than 250 meters long and often consists of 150 or more baited hooks (Straker, 1997). Typically, lines are allowed to fish for several hours before being retrieved. Palangue is set high in the water column and this gear targets offshore pelagic species such as yellowfin tuna, bigeye tuna and swordfish (Figure 33). Bottom or “sinking “palangue targets demersals and are sometimes placed vertically along shelf slopes or along the edge of banks (Chakallal et al., 1994). This type of fishing is mainly carried out from the south western to
north western portion of the waters of St. Vincent and the Grenadines within the Exclusive Economic Zone (EEZ) (Straker, 1997).

Figure 32. Palangue Fishing Gear

Figure 33. Marlin is one of the off shore pelagic species targeted by this type of fishing gear
Spearfishing

Spear guns are used extensively and mainly by younger fishers in the Grenadines who either free dive or snorkel (Figure 34). The average crew size for spear fishers is 5-6 fishers and they can dive to depths of 60-80 feet (Chakallal et al., 1994). The spear gun is used by divers to harvest reef (Figure 35) and some pelagic fish. It is a requirement of the Fisheries Division that a spear gun permit be obtained from its office before these gun can be used in the fishery waters of St. Vincent and the Grenadines (Straker, 1997).

Figure 34. Spear fishing

Figure 35. Mix of species harvested with spear gun
Chapter 4. Fisheries Statistics and Data Gathering System

The importance of a proper data collection program for any harvested fishery resource can never be overemphasized. It is one of the fundamentals for successful future development in any fishery. Gone are the days when the sea was considered as having an endless and cheap source of protein. Today we now understand, by the gathering and analysis of fisheries information that this fallacy is far from true.

There are limitations to what and how much we can catch. With the increase in demand for protein the value of fish has also increased. With these recent trends come added pressures on the World’s fish stocks. Sustainable management becomes necessary, but it requires the available data to facilitate the implementation of appropriate management measures.

The main purpose of data is to facilitate the appropriate analyses that would aid in providing the necessary support to assist managers in making the correct management decisions. More specifically, these analyses would provide knowledge of the population dynamics of various fishery resources; knowledge of the catch and catch per unit effort of the various fisheries; information on fishing capacity, processing capacity, and other social and economic details of the fishing industry (Jardine-Jackson & Straker, 2003).

Since its revision in 1992; the data collection program in St. Vincent and the Grenadines has made tremendous strides and continues to do so. More than 20 years of data under this revised program have been collected thus far (Fisheries Division, 2014c).

Information collected from the Licensing and Registration Program (LRS) has also been accumulated, and provide some information on the sociological and economical aspects of the industry. With this achieved, it is most propitious that this resource be used in formalizing useful and up to date scientific analyses that can replace old hypotheses and obsolete anecdotal statistics (Fisheries Division, 2014c).

4.1. Data Collection

There are currently 5 data collectors, collecting biological and catch and effort data throughout St Vincent and the Grenadines. These data collectors have been trained to take accurate and unbiased data from the fishermen. They are each responsible for a given landing zone (Fisheries Division, 2014c). Presently, there are 36 landing sites across St Vincent and the Grenadines.
These landing sites are grouped into 6 zones with a data collector operating in each zone (Figure 36 - Figure 37).

Categorically, a landing site is considered as being either primary, secondary or tertiary. There are three main criteria which must be considered before a landing site can be placed into any of three categories. Namely, the number of fishing boats that regularly land fish at the site; the amount of fish landed; and the level of infra-structural development (Jardine-Jackson & Straker, 2003). There are two (2) primary sites (Kingstown and Barrouallie); fourteen (14) secondary and twenty (20) tertiary sites (FAO, 2002a). Besides these on-shore landing sites, a number of trading vessels take fish directly from the fishermen and they too are classified as landing sites (Jardine-Jackson & Straker, 2003).

The system of simple random sampling is used to identify the days of the month each landing site is sampled. No sampling takes place on Saturdays, Sundays and major holidays; all the same, every day is thought of as a potential fishing day. This makes the data analysis easier and does not seem to pose much error as fishermen fish whenever they can irrespective of what day it is. By combining the totals of all the estimates for the individual landing sites, an approximation of the quantity of fish landed in the country can be obtained.

Estimate for any site = sampled weight x (# of days in month / # of days sampled)

Total landings = Estimates (site1 + site2 + site3) etc.
Figure 36. Zones and Landing Sites around mainland St Vincent

KEY
B = Bow and Stern
D = Double Enders
C = Canoes
P = Pirogues
A = Launch
W = Whale/Blackfish
R = Dory
L = Langlin
Figure 37. Zones and Landing Sites around the Grenadine Islands
4.2. Licensing and Registration

The Licensing and Registration Programme (LRS) of fishers and fishing vessels in SVG began in 1995 and is now completed. The information collected from this programme forms an integral part of the entire data collection effort. This process is now a mandatory one and is expected to be further enforced. The Fisheries Division is also making moves to incorporate proper boat building and safety standards into this process by the implementation of the appropriate regulations. The process involves the completion of appropriate forms for both vessels and fishers. The vessels also must be inspected before they are officially registered. The issuance of fisher identification forms will also form an important element to this process, and will be implemented soon. Presently there are 651 vessels registered as fishing vessels, but not all of these are active at any one time. The estimated number of fishers that operate these vessels is 2,248. The distribution of these fishers and vessels by fishing zones are shown in Table 2. Zone 1 has the highest concentration of fishing vessels and fishers, 209 and 652, respectively. Zone 4 on the other hand, has the lowest concentration of fishers and vessels.

<table>
<thead>
<tr>
<th>ZONES</th>
<th>VESSELS</th>
<th>FISHERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1. Kingstown</td>
<td>209</td>
<td>652</td>
</tr>
<tr>
<td>Zone 2. South Leeward</td>
<td>132</td>
<td>521</td>
</tr>
<tr>
<td>Zone 3. North Leeward</td>
<td>61</td>
<td>340</td>
</tr>
<tr>
<td>Zone 4. Windward</td>
<td>40</td>
<td>121</td>
</tr>
<tr>
<td>Zone 5. Northern Grenadines</td>
<td>134</td>
<td>401</td>
</tr>
<tr>
<td>Zone 6. Southern Grenadines</td>
<td>75</td>
<td>213</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>651</strong></td>
<td><strong>2,248</strong></td>
</tr>
</tbody>
</table>

*Table 2. Distribution of fishing vessels and fishers among the various fish landing site/zones*
Chapter 5. Analysis of the Catch Composition of the Main Fisheries

In science, being able to combine data while using a smaller amount of descriptors makes up the first step to understanding. Therefore, when the need arises for the extraction of useful information from a complex situation implying many assumed variables and a huge database, it is expedient to be able to rely on statistical methods which help finding some sense by extracting hidden structures in the data (Kruskal & Wish, 1978). W.S. Torgerson (1952), and others came up with such a concept which was named Multidimensional Scaling (MDS).

Multidimensional scaling (MDS) has become more and more popular as a technique for both multivariate and exploratory data analyses. It is a set of data analysis methods, which allow for the inference of dimensions of the perceptual space of subjects. The raw data entering into an MDS analysis are typically a measure of the global similarity or dissimilarity of the stimuli or objects under investigation (Wickelmaier, 2003). The primary outcome of an MDS analysis is a spatial conjuration, in which the objects are represented as points. The points in this spatial representation are arranged in such a way, that their distances correspond to the similarities of the objects: similar object are represented by points that are close to each other, dissimilar objects by points that are far apart (Wickelmaier, 2003). In MDS the concept of statistical interpretation is almost absolutely absent (de Leeuw, 2000).

Another important point to note, MDS is a universal term that includes many different specific types. These types can be classified according to whether the similarities data are qualitative (nonmetric MDS) or quantitative (metric MDS). The number of similarity matrices and the nature of the MDS model can also classify MDS types. This classification yields classical MDS (one matrix, unweighted model), replicated MDS (several matrices, unweighted model), and weighted MDS (several matrices, weighted model) (Young, 1985).

This research will focus on nonmetric MDS. The MDS will be used to demonstrate the similarity or dissimilarity of catch composition in the various fishing gear used to fish in the waters of St Vincent and the Grenadines. The comparisons will be drawn in relation to the gear, year and the season, identifying the main species responsible for differences observed.

As mentioned previously, the fishing industry in St Vincent and the Grenadines is multidimensional. It employs an array of fishing gears which harvest a vast number of fish species. It must however be noted that the rate of development with regards to fishing vessel
types, technology and gear usage has been slow. While fishery managers are concerned with the state of particular stocks, management action tends to be applied to fisheries (through restrictions relating to space, time or gear). Where mixed fisheries predominate (as is the case in SVG), each fishery may catch a range of species, and particular species may be caught by a range of fisheries and gears. It is therefore important to understand to catch composition of different fisheries, and how that varies seasonally and spatially if management actions are to be effective.

5.1. Preparation of Data for Analysis

Catch and effort data were collected during the period 1994 to 2014. Due to the nature of the fisheries and the availability of data collection officers, the sampling coverage varied over the years. Catch and effort data were collected at all landing sites throughout the country (Figure 38). The 1994 fish landing data were computerised using the Trip Interview Program (TIP); then in 2001 the Caribbean Fisheries Information System (CARIFIS) database was introduced. CARIFIS is a database for fisheries; catch and effort, licensing and registration data that was developed for the Caribbean islands. The CARIFIS database has encountered several issues since its inception and St Vincent and the Grenadines was forced to find alternative means of storing its fisheries data, hence, Microsoft Excel was used from 2005 to present. Data entered into TIP and CARIFIS have since been exported into MS Excel.

Figure 38. Sample CPUE Data Collection Form
While in Excel the data had to be “groomed” and standardized so as to avoid duplication of species, quantities landed, fishing grounds and fishing gear used. Also removed from the data set were those species such as speckled crab and pipefish; and gear such as harpoon. These species and gear were of little significance in terms of contribution to the overall fisheries and usefulness to the data set and the outcome of the analysis. Further to that, a list of the top 100 species harvested was derived. This was done in a pivot table by obtaining the sum of the weights and converting the sum to percentage of the total fisheries. These top 100 species would be used as the basis for the assessment in similarity or dissimilarity of the fishing gear catches in St Vincent and the Grenadines, and make up over 99% of landings recorded by weight. Once grooming of the data set was completed, separate pivot tables of catch composition were created in MS Excel for the various fishing grounds, landing sites and fishing gears. The tables created were; species by gear, species by gear and year, species by gear, year and month, species by gear, year and season.

Upon completion of the MS Excel processes (grooming and pivot tables) the pivot tables were imported into Primer 6 (Plymouth Routines in Multivariate Ecological Research)\(^2\). Before the imported data can be used it went through a 2-step pre-treatment process. It was first standardised by total. This divided each entry on the data sheet by the total abundance in the sample, across all species, thus converting assemblage counts for each species into relative percentages and adding to all sample 100% across species. This therefore eliminates all differences in total abundance in each sample from the multivariate comparison of samples. Secondly, the now standardised data sheet was then square root transformed. The transformation is applied in an effort to down-weight the contribution of qualitatively dominant species to the similarities calculated between samples. The process is especially essential for the assemblage of the resemblance matrix using the Bray Curtis similarity.

The pre-treated data sheet was used in the assemblage of a “resemblance” matrix. This resemblance matrix is ideal for this type of analysis (multivariate) as it provided an appropriate definition of resemblance between every pair of samples based on whether the recorded fishing gear or species take similar or dissimilar values\(^3\). The assemblage of a resemblance matrix requires a particular coefficient; the Bray Curtis method is the most commonly used similarity measurement for biological community analysis.

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\(^2\) Primer 6 is a MDS computer software that encompasses numerous univariate, graphical and multivariate routines for the analysis and assessment of a range of species-by-samples data from community ecology.

\(^3\) The term resemblance includes 3 main concepts; similarity, dissimilarity and distance.
The resemblance matrix then became the base for the generation and production of non-metric Multidimensional scaling graphs (MDS), Analysis of similarity tests (ANOSIM) and Hierarchical Cluster analysis (Link tree). This process was repeated for each of the pivot tables that were imported from MS Excel. In an analysis of similarity (ANOSIM) a significance level of less than 5% would indicate that there is a difference or dissimilarity in the catch composition of the groups. While significance of 5% and above would indicate that there is a similarity in catch composition.

5.2. Assessment and Analysis of the Overall Fisheries

This assessment will concentrate on fishing activities and fish catches for the fishing period 1994 to 2014 (20 years). It must also be noted that the data used in this research were collected from all 36 landing sites throughout St Vincent and the Grenadines. First, the overall fisheries will be addressed and assessed in this section then focus will be place on 5 individual species in the section to follow. These 5 species are commercially viable to the livelihood of fishers and to the economy of St Vincent and the Grenadines. They are Big Eye Scad (Selar crumenophthalmus), Mahi Mahi/ Dolphin-fish (Coryphaena hippurus), Red Hind (Epinephelus guttatus), Spiny Lobster (Panulirus argus) and Queen Conch (Strombus gigas).

The main 10 fishing gear employed by the fishers in St Vincent and the Grenadines are beach seine, bottom longline, dropline, fish pot, gill net, hand line, palangue, scuba dive, spear gun and trolling (each gear was described in chapter 3). Figure 39 shows the fishing gears that catch similar species and therefore separating into 3 distinct groups based on their similarity in fish catches over the past 20 years (1994-2014).
Group 1 consists of beach seine and gill net; group 2 consists scuba dive, fish pot, and spear gun while group 3 includes trolling, dropline, hand line, bottom longline and palangue.

**Group 1: Beach Seine and Gill Net**

Over the 20-year period group 1 gears had a 37% similarity in catch composition. This dissimilarity is owing to 3 main species; Jacks (Bigeye Scad) and Robin harvested mainly with the beach seine and Ballyhoo, harvested using gill nets. Jacks and Robin comprise 35% and 32% of beach seine catches respectively; while, Ballyhoo only make up 7%. On the other hand, the contribution that Jacks and Robin make towards gill net catches is hardly noticeable in comparison to other species harvested (Cavalli and Tunas mainly). Meanwhile, Ballyhoo constitute 75% of gill net catches.

**Group 2: Scuba Dive, Fish Pot and Spear Gun**

For the same 20-year period, group 2 gears; scuba dive, fish pot, and spear gun individually had 44%, 38% and 40% similarity in catch composition respectively. However, as groups, fish pot and spear gun has a 52% similarity. The similarity is primarily because of the range of reef fish or demersal species that are being harvested with both gear types. For instance; Red Hind comprise 20% of fish pot catches and 16% of spear gun; also Coney comprise 11% of fish pot and 12% of spear gun. However, the dissimilarity between the 2 fishing gears stems from catches of Spiny Lobster and Parrotfish. Due to the physiology of Spiny Lobsters and
legislation being put in place against the use of spear guns for the harvesting lobsters; fish pot and scuba dive are therefore the only viable means of harvesting the species. Spiny Lobsters constitute 11% of fish pot catches and 15% of scuba dive; while the Stoplight Parrotfish constitute 16% of spear gun catches. The only means of harvesting the Queen Conch is to scuba dive for it. Queen Conch makes up 36% of species harvested by scuba diving. This thus contributes to the 49% dissimilarity between scuba dive and the fish pot- spear gun combination.

**Group 3: Bottom Longline, Dropline, Hand Line, Palangue and Trolling**

With the exception of trolling, the other 3 fishing gears in this group are used to harvest reef or demersal fish species in deep slopes or shallow shelf. There is a 45% similarity between troll catches and the other 4 gear types. This is because dropline, hand line, bottom longline and palangue typically harvest a number of species caught by trolling; mainly various tuna species. Tunas typically comprise 50% of the troll fisheries while Mahi Mahi contributes 25%. The other 25% includes Cavalli and Barracuda which further contributes the similarity between gears. When trolling is compared with each individual gear type within the group Mahi Mahi catch composition range from between 5% to 6% average abundance while Yellowfin Tuna ranges between 4% to 5% average abundance. In contrast, when compared to the catch composition of dropline, hand line, bottom longline and palangue; Mahi Mahi and Yellowfin Tuna account for less than 1% of the average catch. While demersal species such as Hind, Snapper and Groupers catch composition range between 3.5 to 5%.

Table 3 is an ANOSIM further demonstrating that there are indeed differences in catch composition among fishing gears.

<table>
<thead>
<tr>
<th>FISHING GEARS</th>
<th>BOTTOM LONGLINE</th>
<th>DROPLINE</th>
<th>FISH POT</th>
<th>GILL NET</th>
<th>HANDLINE</th>
<th>PALANGUE</th>
<th>SCUBA DIVE</th>
<th>SPEARGUN</th>
<th>TROLLING</th>
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</thead>
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<td>BEACH SEINE</td>
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<td>0.1</td>
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Table 3. Similarities between gear types. Highlighted numbers are gears with similar catch composition.
5.3. Fishing Gear and Catch Composition

Over the past 20 years there has been a general similarity in the catch composition of the individual fishing gears. Due to the nature of the fishing industry in SVG; a mixture of diverse and dynamic fisheries, there are some years that appear to be outliers. For instance; gillnet 2010 and 2011 and also palangue 2011, 2012, 2013 and 2014. However, by-and-large catch compositions have remained stable, as can be seen from the clustering of the gear compositions in Figure 40.

![Figure 40. Catch composition by gear and year](image)

Within the MDS plot it can also be perceived that palangue, dropline, bottom longline and hand line have had similarities in catch composition throughout the years. Typically, these gears are commonly used to harvest reef or demersal species which include; parrotfish, hinds, snappers and groupers. Within the fishery waters of St Vincent and the Grenadines, catch composition and use of these 4 gears is dependent on depth and the coastal shelf area where fishing activity will be occurring.

Each gear type has made significant contributions to the development of the fishing industry in St Vincent and the Grenadines (Figure 41). However, 5 in particular; beach seine, hand line, fish pot, scuba dive and trolling will be the main focus of this section of the research.
Except for Spiny lobsters of which 52% are harvested by scuba dive and 48% by fish pot, the MDS plot (Figure 42) shows that each of the 5 species considered in more detail are largely targeted by different gear types.

5.3.1 Beach Seine

The beach seine fishery is a very active fishery in St Vincent and the Grenadines and contributes 42% of the total fish catches. While other fisheries operate on a seasonal basis due to legislation, migration pattern, spawning pattern or seasonal availability, the beach seine fishery is one of the only fisheries in which fishers participate throughout the entire year. The primary species targeted by the beach seine fishery are the near-shore pelagic; these include Jacks, Robin and Skip Jack Tuna (Figure 43). Over the years the catch composition has remained relatively similar.
The catch composition of beach seine varies according to the season (summer, autumn, winter and spring); but nonetheless, this seasonal variation in the composition of catches have remained relatively similar throughout the years (Figure 44). The fishery has an average annual similarity in catch composition of 65%. The summer months when paired with the autumn months exhibited no significance in seasonal difference. Similarly, with the autumn and spring months; and also the spring and winter months, they showed no significance in seasonal difference in catch composition.
There was a difference in catch composition when the summer and spring months were compared with each other. This is because of 4 main species; Jacks and Dodger which are more abundant in the summer and Robin and Ballyhoo which are more abundant in spring. There was also difference in catch composition between the summer and winter months, this is as a result of the abundance of Ballyhoo and Robin in the winter and Jacks and Skipjack in the summer. In the same way, the autumn and winter months were also different and this is due to the abundance of Jacks and Skipjack in the autumn and Robin and Ballyhoo in the winter.

Figure 45 shows the analysis of similarity in catch composition of beach seine catches during the 4 seasons.

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Figure 45. ANOSIM of composition of Beach Seine catches according to season
Beach Seine composition in accordance with seasonal availability showed the highest catches of Robin during the winter and spring months; Jack are more abundant during the autumn and summer months. While Ballyhoo are more abundant during winter months and Skipjack Tuna more abundant during spring and summer months.

5.3.2 Hand Line

Hand lines are used to harvest a number of fish species that are found in the waters of St Vincent and the Grenadines. The fishery predominantly targets demersal species and comprise 13% of the total fisheries in the country (Figure 41). Over the past 20 years the catch composition has remained the same. The average annual similarity in the catch composition of hand line catches is 62%. The main species targeted by hand line are Blackfin Snappers, Red Hind and Coney, although Barracuda, Blackfin tuna and Silk snapper also contribute significantly (Figure 46).

![Figure 46. Species contribution to overall Hand Line catches](image)

Catch composition has been quite consistent seasonally (Figure 47), and a pairwise test represented by Figure 48 reveals that the only seasonal difference observed is between summer and winter. This difference occurs because of the availability of Red Hind, Coney, Queen Snapper and Barracuda in the winter and in the summer, because of Red Snapper, Blackfin Snapper, Blackfin Tuna and Cavalli.
Hand line fishing is especially prevalent during late spring to early autumn and over the years there were increases in the abundance of species around this time. Catch composition has been very consistent between autumn, winter and spring (Figure 48).

The seasonal catch composition is similar throughout the years and seasonal catches have been dominated by Blackfin Snapper in spring, summer and autumn months. Meanwhile Red Hind dominated the winter months. A pairwise test of hand line by season indicated that Red Hind was the most common species caught between seasons and contributed between 5% and 6% to pair similarity.
5.3.3 Trolling

The trolling fishery plays a very significant role in the fishing industry of St Vincent and the Grenadines. This fishery targets the pelagic species such as Dolphin-fish, Kingfish/ Wahoo and many Tuna species. Most times the catch composition is season dependent due to migration pattern for spawning purposes. The vast majority of the fishing vessels and registered fishers in St Vincent and the Grenadines are troll fishers. Likewise, trolling comprise approximately 19% of the total fish catches in St Vincent and the Grenadines. Over the years the composition of troll catches has remained similar with an average annual similarity of 64%. Dolphin-fish, Yellowfin and Blackfin Tuna contributed largely to this composition (Figure 49).

![Figure 49. Species contribution to overall Trolling catches](image)

Like most of the fishing activities that happen throughout St Vincent and the Grenadines, Troll fishing is also an all-year-round activity. The catch composition is very dependent on the season (summer, autumn, winter and spring); and this seasonal variation in the composition of catches have remained somewhat similar throughout the years (Figure 50).
A pairwise test showed similar catch composition for summer and autumn. Similar catch composition was also recorded for the spring and winter months and for summer and winter (Figure 51).

Seasonal catches have been dominated by Mahi Mahi during winter and spring; and the various Tuna species - Yellowfin Tuna, Blackfin Tuna and Skipjack Tuna during summer and autumn months.
5.3.4 Fish Pot

Pot fishing is done across St Vincent and the Grenadines for many different reef species. It comprises just about 2% of the total fish catches on the island; and while it primarily catches demersal species such as Snapper, Hind and Coney on mainland St Vincent, in the Grenadines it mainly targets Spiny Lobsters (Figure 52). Over the past 20 years the catch composition of fish pots has been different; with a 38% average annual similarity in catch composition. The species contributing to this low similarity are Blackfin Snapper, Red Hind and Spiny Lobster.

![Graph showing species contribution to overall Fish Pot catches](image)

**Figure 52. Species contribution to overall Fish Pot catches**

Similar to the other fishing activities that are being carried out in St Vincent and the Grenadines, pot fishing is also an all-year-round activity. The catch composition is very dependent on the season (summer, autumn, winter and spring); and this is especially so for Spiny lobsters. There is a closed season (part of spring and all of summer) and an open season (autumn, winter and the first 2 months of spring) in effect. This seasonal variation in the composition of catches for species harvest with fish pots has remained fairly similar throughout the years (Figure 53). Figure 53 also shows catch composition for pot fishing forming two distinct groups. Since the ban on fish exports to the EU was effected in 2000, the composition of fish pots between the years 2001 to 2010 have been similar. This is due to a decline in Spiny Lobster catches. However, at the beginning of the lobster season in 2010, fishers began selling their lobsters to nearby island St Lucia. The St Lucian traders subsequently sold the lobsters to the EU countries in the region. This therefore shows similarity in pot fishing composition between the years 2011 to 2014 due to increase catches.
A pairwise test showed difference catch composition for summer and autumn; this is because of large catches of Blackfin Snappers in the summer and large catches of lobsters in autumn. There is also a difference in the summer and winter months catch composition; this is owed to catches of lobsters and Red Hind in the winter while Blackfin Snapper contribute to the summer difference. Similar catch composition was recorded for the spring and winter months which were dominated by Lobster, Red Hind and Blackfin Snappers and also for summer and spring which were dominated by Red Hind and Blackfin Snapper. Similar composition was also recorded for autumn and winter; owing mainly to Lobster, Red Hind and Blackfin Snappers (Figure 54).
5.3.5 Scuba Dive

Scuba diving is used to harvest a number of demersal fish species found in the waters of St Vincent and the Grenadines. Although the fishery predominantly targets demersal species, the main species caught is Queen Conch; some fishers however, frequently toggle between Scuba Dive and Pot Fishing for the harvesting of Spiny Lobsters (Figure 55). Scuba Dive comprises 6% of the total fisheries in the country. Over the past 20 years the catch composition has been very different. The average annual similarity in the catch composition of Scuba Dive catches is 44%.

![Figure 55. Species contribution to overall Scuba Dive catches](image)

Scuba Dive is no different from most of the other fishing activities that happen throughout St Vincent and the Grenadines, it is also an all-year-round activity. The catch composition is very dependent on the season (summer, autumn, winter and spring); and this seasonal variation in the composition of catches have remained somewhat similar throughout the years (Figure 56).
Figure 56. Pattern of similarity in Scuba Dive catches composition throughout the seasons

A seasonal pairwise test showed difference catch composition for summer and autumn; this is because of large catches of Queen Conch in the summer and large catches of Spiny Lobsters in autumn. Similarly, there is a difference in the summer and winter months catch composition; this is related to catches of Spiny Lobsters in the winter while Queen Conch and Red Hind contributed to the summer difference. Similar catch composition was recorded for the spring and winter months these were dominated by Lobster and Conch; and also for summer and spring which were dominated by Red Hind and Queen Conch. Similar composition was also recorded for autumn and winter; owing mainly to Lobster and Queen Conch (Figure 57). Generally, Queen Conch is the most harvested species throughout all of the seasons with Scuba Dive.

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<thead>
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<tr>
<td>Summer</td>
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Figure 57. ANOSIM for composition of Scuba Dive catches according to season
5.4. Assessment and Analysis of Species and Fishing Grounds

Despite the importance of Jacks (*Selar crumenophthalmus*), Mahi Mahi (*Coryphaena hippurus*), Red Hind (*Epinephelus guttatus*), Spiny Lobster (*Panulirus argus*) and Queen Conch (*Strombus gigas*) to the livelihood of fishers, the fisheries in which these species are classified are poorly described or understood in St Vincent and the Grenadines. Importantly, the only description of some of the species are found in fairly standard reports such as Fishery Division reports or as national reports to the annual scientific meetings of the CARICOM Regional Fisheries Mechanism (CRFM) (observations from working at the Fisheries Division SVG 1998-2014). Red Hind is the only species that has received significant attention, and several exploratory and preliminary assessments has been conducted by the CRFM Reef and Slope Working Group (Straker & Singh-Renton, 2000).

Similar to the description and documentation of fish species, very limited documentation has been conducted with regards to the fishing areas (fishing grounds). At best, the only available map outlining the various fishing areas around St Vincent and the Grenadines is rudimentary with a lack of formal geographic coordinates establishing the exact position of the areas (Jardine-Jackson & Straker, 2003). This map was obtained based on information gathered from the fishers who were willing cooperate and offer their knowledge. The map pinpoints the location of 52 frequently used fishing grounds around St Vincent and the Grenadines (Figure 58). Fishers are very secretive about their livelihood. The tendency is for those fishers who possess such knowledge to keep the location of the fishing grounds a secret and not divulge that sort of information. Although the map lacks geographical coordinates, a number of the fishing vessels are equipped with compass which give fishers a sense of direction towards the fishing ground while other fishers are able to navigate base on special feature, such as headland and rock formations (Fisheries Division, 2014; Jardine-Jackson & Straker, 2003). For the purpose of this research, the fishing grounds on the map were organised into 5 fishing areas which were classified according to their location around St Vincent and the Grenadines. This grouping was conducted on the basis of local knowledge of the distribution of fleets and fishing activity.

In the assessment of the fishing grounds it was found that there was a combination of either too few observations in the data set, not many species in the group to draw proper comparisons or not many data to test in order to generate 999 actual permutations within an ANOSIM analysis throughout all of the fishing grounds. As a result of this, only those groups with 999 permutations will be looked at.
Figure 58. Map Showing Fishing Grounds around St Vincent and the Grenadines
5.4.1 Red Hind (*Epinephelus guttatus*)

Many species of groupers form spawning aggregations, dramatic events where 100s to 1000s of individuals gather annually at specific locations for reproduction. Spawning aggregations are often targeted by local fishermen, making them extremely vulnerable to overfishing. The red hind, *Epinephelus guttatus* forms short-term spawning aggregations and pair-spawns in single-male/multi-female Clusters (Sadovy, Rosario, & Román, 1994). According to information obtained from fishers, it is documented that red hind spawn within a specific time period surrounding the full moon in late winter, typically in January, February, or March (Sadovy et al., 1994). A number of studies have also linked spawning seasonality to simple environmental variables such as water temperature and length of day (Sadovy & Colin, 1995). However, it is beyond the scope of this analysis to dive further into the details of the life history of the species.

Although the Red Hind fishery of St. Vincent and the Grenadines uses multiple gear, hand-line is the principal gear that is being employed (Straker & Singh-Renton, 2000). The fishery is artisanal and mechanized retrieval gears are still in the experimental stages (Fisheries Division, 2014). There are a number of other targeted species in this fishery, these include Coney (*E. fulva*), Parrot fishes (Scaridae) and Grunts (Pomadosyidae) (Fisheries Division, 2014). A number of other gear are employed in the harvesting of Red Hind; however, hand line was identified as the main gear being used (Figure 59). Since 1994 hand line has been used to harvest approximately 70,000 lbs of Red Hind. The main fishing grounds for these species are the south eastern shelf of mainland St. Vincent and the eastern shelf of the Grenadines in up to 50 meters of water (Figure 60). Over the years’ hand-lines have been used to harvest 49% of all Red Hind catches. In addition, the contribution of the species to the overall fisheries amount to 6% of landings.
Fishing for Red Hind is usually conducted all year round; however, reef fish fishing effort increases at the end of the dolphin and wahoo season (Straker & Singh-Renton, 2000); that is, mid-spring to the beginning of autumn. Typically, pirogues are fitted with 45hp to 75hp outboard engines and consist of a 3 to 4-men crew (Fisheries Division, 2014). A typical fishing day is from 4 a.m. to 4 p.m. The hand line is 80-120 lb tested, usually consists of 4-5 baited hooks (No. 7-9 circular galvanized hooks). Small coastal pelagic (Robin, Jacks, Ballyhoo, etc) are used as bait. The fishermen deploy the lines by hand and wait for the fish to strike. Sometimes floating devices are used and the set-up is allowed to soak for several minutes (Fisheries Division, 2014; Straker & Singh-Renton, 2000).
Figure 60. Map showing Red Hind Fishing Grounds
Red Hind has been one of the most frequently harvested species throughout the fishing grounds. Some individual fishing grounds have yielded Red Hind catches of around 7000 lbs over the past 20 years (Figure 61). This is as opposed to other species such as Blackfin Snapper (3000 lbs), Coney (4000 lbs), Parrot fishes (2000 lbs) and Grunts (400 lbs).

Figure 61. MDS of hand line catch composition by fishing ground and year, overlaid with the catches of Red Hind.

Overall, hand line catches across fishing grounds are divided into 2 groups of similarities. There are similar catches in the Northern Grenadines and Southern Grenadines fishing grounds; and the other group includes fishing grounds on main land St Vincent (Figure 62).

Figure 62. MDS plot of Hand Line catch composition across the fishing grounds of SVG
5.4.2 Spiny Lobster (*Panulirus argus*)

Spiny Lobsters (*Panulirus argus*) can be found in the Western Atlantic; from North Carolina in the United States of America and Bermuda in the north, all the way down to Rio de Janeiro, Brazil in the south (Williams, 1986). In an east-west direction, it ranges from the Caribbean islands across to the Gulf of Mexico (Cervigón et al., 1993) (Figure 63). Lobsters are commonly found in sheltered habitat such as coral reefs and rocky areas and can occur in depths down to around 90m (Cervigón et al., 1993).

![Figure 63. Distribution of Spiny Lobsters across the Western Atlantic](image)

A diversity of predators usually feed on Spiny Lobsters during their various life stages. These include predators such as snappers, groupers, sharks, rays, octopus, dolphins and various turtle species. In the same way Spiny Lobsters also prey on a wide variety of organisms, these include hard-shelled molluscs, starfish, urchins, small crustaceans and algae (Aiken, 1984).

The Spiny Lobster fishery is one of the most vital fisheries throughout St Vincent and the Grenadines with approximately 25 tons being exported annually and an estimated 10-20% consumed locally (FAO, 2002). The lobster fishery is small scale and utilizes traditional gear, methods and vessels (Jardine-Jackson & Straker, 2003). A small number of fishing methods and gear types are employed in the harvesting of lobsters. These include Scuba dive, noose, Z-trap, bamboo trap, arrow-head trap, box trap and collection by hand (Fisheries Division, 2001).
Typically, fish pots and scuba dive are the most commonly utilized method for catching spiny lobsters (Figure 64). Although a variety of traps are built, there has been no research or data in St Vincent and the Grenadines suggesting a preference for a particular kind of trap. Since 1997 fish pots have harvested close to 30,000 lbs of lobsters, while scuba dive harvested close to 40,000 lbs. Both fishing methods always have a close relationship in terms of percentage catch composition. Fifty-five per cent (55%) of lobsters are harvested by scuba diving, while forty-five per cent (45%) are harvested by fish pots (Fisheries Division, 2014). Nonetheless, fish pot is still the most widely used method of harvesting lobsters, as not every lobster fisher has access to scuba diving gear (Fisheries Division 2001).

![Figure 64. MDS of average catch composition by gear type, overlaid with the catches of Spiny Lobsters](image)

Typically, fish pots are constructed of chicken or mesh wire, the wire is tied to wooden frames which are constructed to roughly 2.3 cubic meters in volume. The ‘arrow-head’ trap and the ‘Z-trap’ are the most commonly used method. Traps are usually baited with either fruit or fish, then set at varying depths on the reefs and are checked every 5-7 days. Being a passive method of fishing the size of the crew rarely exceeds one (Gittens & Haughton, 2008). However, occasionally it can be up to two persons. Similarly, scuba divers use hook sticks to fish on rocky sea bottom for lobsters, they dive in waters 60 feet–70 feet deep (CRFM Secretariat, 2008).
There are specific fisheries legislation in place to protect and ensure sustainability of the species. For instance, in the spring and or summer months there is an annual closed season of 4 months which usually coincide with peak spawning period (Fisheries Act, 1986). Other protection measure includes a minimum size limit, prohibition against landing molting lobsters, prohibition against landing lobsters carrying eggs (and removal of eggs) and prohibition against certain types of fishing methods (Fisheries Act, 1986). There have even been instances where persons found in possession of berried females or females that have been stripped of their eggs were prosecuted (Kirby-Straker, 2003). Most of the Spiny Lobsters are harvested and landed in the Grenadine islands (Figure 65). However, because of the geography of the islands, that is; the islands being small and disperse, adequate monitoring of lobster fishing activities is a challenge (Kirby-Straker, 2003).
Fish pots or traps are not constantly monitored while sitting on the seafloor; consequently, they tend to catch a number of other reef species other than lobsters. In like manner, fish pots are used to target a number of demersal species such as parrot fish species. Over the past 20 years the abundance and composition of fish pot catches for the fisheries has remained more or less the same. The use of fish pots has been very widespread throughout the fishing grounds in the
Grenadines, this is as a result of the fishing grounds for lobsters being located on the Grenadine bank.

Lobsters are mainly targeted by Fish pot, and the MDS plot below shows that some fishing grounds have yielded individual catches of over 7000 lbs over the past 20 years (Figure 66). Others have yielded less as these grounds are not traditionally lobster habitats.

There is substantial difference in the composition of fish species harvested at the fishing grounds where fish pots have been set over the past 20 years. During the pairwise test those groups which had enough data to generate the 999 permutations, most of them showed a less than 5% significance level. Thereby indicating a substantial difference in the abundance and composition of fish species harvested at the different fishing grounds.

![Figure 66. MDS of fish pot catch composition by fishing ground and year, overlaid with the catches of Spiny Lobster.](image)

5.4.3 Queen Conch (*Strombus gigas*)

Queen Conch *Strombus gigas* is scattered throughout the Caribbean region. It extends from Florida (US) to the northern coast of Latin America. The species can be found in the territorial waters of at least 36 countries and dependent territories (CITES Secretariat, 2003). Queen
Conch mostly inhabit sandy seafloors in clean, shallow waters, and are also known to occur in depths of up to 100 m. Since November 1992 the species has been included in Appendix II of CITES. However, even though it was classified as Commercially Threatened in the 1994 IUCN (International Union for Conservation of Nature) Red List of Threatened Animals, it is not currently classified as threatened by IUCN (Baillie, Groombridge, Gärdenfors, & Stattersfield, 1996).

For centuries the Queen Conch has been harvested for its meat which is used as food; however, within the last few decades a large commercial fishery has emerged. This development occurred largely in response to the increased international demand for the meat. Today, the species is one of the most sort after and most important fishery resources in the Caribbean. Additionally, the shells are also used and traded as novelty items and tourist souvenirs, but are generally considered a by-product of the trade in conch meat (CITES Secretariat, 2003).

The Queen conch fishing industry is artisanal in nature and is generally fished in the Grenadines along the Grenada bank (Figure 67). This bank is a shallow trans-boundary platform approximately 3000 km² stretching from Bequia to Grenada. The Shallow coastal areas of the platform consist of for the most part coralline habitat intermingled with patches of seagrass, sand and rock (Chakallal, Mahon, Ryan, & Oxenford, 1994) of which about three quarters of the platform is about 37 – 40 m deep.
Figure 67. Map of the Grenadines Bank

Source: http://www.grenadinesmarsis.com/Files_and_Maps.html
A total of roughly 45 fishers are reported to operate in the conch fishery of St Vincent and the Grenadines. These fishers also participate in the lobster fishery and demonstrate a preference of fishing for conch more extensively during the period May 1st and August 31st. This period is preferred as it coincides with the closed season for lobster (Baldwin, Punnett, & Chakalall, 2008).

The conch harvesting occur only on the Grenadines bank (Figure 67) and fishers mainly use flat transom vessels, commonly called “bow and stern” boats or “Dories”. These boats are often powered by one or two outboard gasoline engines ranging from 14 – 115 hp and the preferred method of harvesting is Scuba Dive (Fisheries Division, 2001). Over the past 20 years Scuba Dive has been used to harvest just over 70,000 lbs of conchs (Figure 68). Characteristically, a conch fishing crew will comprise of 3 persons: a boat captain, a floater and a diver. Using Scuba gear, the diver is responsible for collecting the conch of the sea floor and loading them into a basket to which a rope is attached (Baldwin et al., 2008). Typically, a basket can be in the form of a mesh bag, a canvas bag or even mesh wire shaped in the form of a basket. One basket can hold and transport roughly ten conchs. The boat captain upon instruction from the floater would hoist or lower the basket as the operation continues. The floater has the responsibility of relaying information between the diver and the boat captain (Baldwin et al., 2008).

Figure 68. MDS of average catch composition by gear type, overlaid with the catches of Queen Conch
A typical fishing trip would last anywhere between 3 - 4 hours and would utilize up to 2 - 3 Scuba tanks. Fishermen would normally depart port at about 7 a.m. to travel to the fishing grounds. These fishers operate at depths ranging between 12 – 40m and can catch an average of 100 – 120 lbs of conch per trip, with each conch averaging conch being 15 oz or 425g (Baldwin et al., 2008).

In spite of conch being a target fishery, relatively little information exists about the distribution, abundance and size structure of the Grenadine Bank queen conch population. Even more so, little is known about total landings, number of fishers, catch per unit effort, consumption patterns (for both local households and the local tourism market), its economic importance and the amount of illegal activities associated with the fishery (Baldwin et al., 2008).

Due to physiology and the location of their habitat on the seafloor, the only means of harvesting Queen Conch in St Vincent and the Grenadines is through the use of Scuba gear. The Conch fishing grounds are found mainly to the east of the Grenadines (Figure 70). The scuba dive catch composition for the Northern and Southern Grenadines show two distinct groupings, one of which also includes samples from the Windward Coast. Catch composition from the Leeward coast appears different to these, although less data is available (Figure 69).

![Non-metric MDS](image)

**Figure 69.** MDS of Scuba dive catch composition across the fishing grounds of SVG.
Figure 70. Queen Conch fishing grounds
Figure 71 shows that some fishing grounds have yielded catches of over 9000 lbs over the past 20 years. Others have yielded noticeably less as these grounds are not traditionally conch habitat. Meanwhile Figure 72 shows that the largest catches of conch originated from the fishing grounds in the Northern and Southern Grenadines.

Figure 71. MDS of scuba dive catch composition by fishing ground and year, overlaid with the catches of Queen Conch

Non-metric MDS

Figure 72. MDS plot of the origin of most Conch catches

Over the years there have been significant differences in the abundance and composition of fish species harvested through Scuba Dive in relation to the various fishing grounds around St Vincent and the Grenadines. In a pairwise test a number of groups which had enough data to generate the 999 permutations showed a less than 5% significance level. This indicated a difference in the composition of the groups of fishing grounds.
5.4.4 Mahi Mahi/ Dolphin-fish (*Coryphaena hippurus*)

The Mahi Mahi is a medium size, surface living oceanic fish (Lleonart, Morales-Nin, Massutí, Deudero, & Reñones, 1999). Its distribution stretches across tropical and subtropical waters of all the oceans with water temperature of approximately 21°C (Shcherbachev, 1973). The species is further categorized as a coastal, pelagic and oceanic fish found ordinarily on surface continental and insular waters and off the continental shelf (Lasso & Zapata, 1999). Dolphin-fish is a top-level predator, it is very agile and a fast swimmer, and has large scale migration patterns (Lleonart et al., 1999). The species is valuable to the fisheries of the regions wherever it occurs. It is targeted by both sport fishers and commercial small scale fishers. It is often the target commercial small-scale fisheries, because of the schooling behaviour which is exhibited under or around floating objects (Lleonart et al., 1999).

Similar to the other fisheries across St Vincent and the Grenadines, the off-shore pelagic fishery is still predominantly artisanal in nature and the dolphin-fish is one of the primary species targeted (Jardine-Jackson & Straker, 2003). For many years the dolphin-fish has been an important food source for the inhabitants of St Vincent and the Grenadines. It is one of the most dominant fish species caught in the fishery waters of the island chain. With catches averaging 10450 lbs annually, the species is considered an important fishery resource for the island (Fisheries Division, 2014). Dolphin-fish is commonly landed with a number of other species including Wahoo, Groupers, Marlin, Sharks, Skipjack and Bonito; these species are also targeted by the off-shore pelagic fishery (Jardine-Jackson & Straker, 2003).

Dolphin-fish are targeted using trolling and long line methods. The use of trolling gear is more extensive, and takes nearly all of the landings for the species (Jardine-Jackson & Straker, 2003) (Figure 73). Before the 1980s trolling took place from January to July each year. Traditional wooden double-enders measuring an average 20 ft. in length, powered by a 30 hp outboard engine and carrying a crew of 3 were used. In addition to these double-ender, canoes were also used. These were introduced to St. Vincent from St. Lucia (Jardine-Jackson & Straker, 2001). The main fishing grounds are in the north-east to the south-east side of the island otherwise known as the Windward Coast (Figure 74), up to 25 miles off-shore (Jardine-Jackson & Straker, 2003).

Each crew member used up to two lines roughly 150-180 ft. in length; attached to each line was a hook. The baited line would be dragged behind the boat at a very low speed (Jardine-Jackson & Straker, 2001). Bait are caught using a cast-net while the fishers are on their way to
the fishing grounds; the fishers would look for birds to help them to locate schools of fish. The fishermen would normally depart port at about 4 a.m. and would return to shore between 2-4 p.m. (Jardine-Jackson & Straker, 2001).

Figure 73. MDS of average catch composition by gear type, overlaid with the catches of Mahi Mahi

Over the years the trolling technique has remained very much the same. The main season is still from mid-winter to mid-summer (January to July). Vessels called Pirogues, constructed from fibreglass, measuring 23 ft. and powered by 75 hp engines with a crew of 3-4 are now used. Fishers now fish up to 50 miles off-shore and canoes and double-enders are no longer a part of the fleet of this fishery (Fisheries Division, 2014).

Currently fishers use stainless steel No. 6-8 straight hooks, with monofilament nylon line, usually 120-160 lbs tested. The lines are usually single hooked double baited with both artificial and real baits at times. The length of each line is 120-180 ft. but this may vary depending on the schooling behaviour of the fish. When a school of dolphin or kingfish is located the fishermen often deploy markers in the form of buoys. Chumming is also sometimes used. Birds and floating debris are typically used as guides in locating and identifying schooling fish. A typical fishing day begins at 4 a.m. and ends at 4 p.m. (Fisheries Division, 2014).
Figure 74. Map of Dolphin-fish fishing grounds in SVG
Dolphin-fish landings have contributed to 35% of all species harvested using troll line. In addition, the contribution of the species to the overall fishery is 7% of annual landings. Over the past 20 years the composition of Trolling catches across the various fishing grounds have been reasonably similar (Figure 75). Further to that, Troll fishing has been prevalent throughout the Windward coast of St Vincent and the Grenadines and composition of catches at the ground has been similar throughout.

![Non-metric MDS](image)

**Figure 75.** MDS plot of Troll catches across the fishing grounds of SVG

Dolphin-fish is not the only species that is being harvested at this ground and using the Trolling method. Figure 76 demonstrates that the species is being harvested at other fishing grounds; however, areas in and around the Windward coast have yielded catches within in range of 20,000 lbs for the past 20 years.

![Non-metric MDS](image)

**Figure 76.** MDS plot of quantities of Dolphin-fish caught at the different fishing grounds
5.4.5 Jacks/ Bigeye Scad (*Selar crumenophthalmus*)

The Jacks is a small coastal pelagic fish commonly found in the tropical and subtropical region of the world’s oceans (Roux & Conand, 2000). It has a circumpolar distribution. In the western Atlantic, it is found ranging from Nova Scotia (Canada) to the state of São Paulo (Brazil) (Rodrigues & Moraes, 2014). Research has indicated that Jacks spawn from April through October (Clarke & Privitera, 1995). Prior to spawning, the mature fish along with spawning adults move into shallow water; they form large schools in shallow, sandy, or flat-bottomed areas less than 22 m (Gosline & Brock, 1960).

The species grows relatively quickly. When it first appears in shallow coastal waters, Jacks is 10.2-17.5 cm. It further grows to 22.9 and 30.5 cm by the end of the first and second year respectively (Kawamoto, 1973). Research also indicates that the species is not migratory and tends to remain in localized areas (Kawamoto, 1973). The greater part of their diet is made up of small fishes such as anchovies and invertebrates such as crab, shrimps and foraminifera (Straker, 1997). This indicates that the species feeds primarily in the water column (Kawamoto, 1973).

Throughout the world the species plays a vital role as food for human consumption or as bait in the tuna industry (Roux & Conand, 2000). The Jacks is significant in the food chain of St Vincent and the Grenadines; so much so that it has become a cultural icon on the island as it constitutes the main ingredient in the country’s national dish Roasted Breadfruit and Jack Fish (Jardine-Jackson & Straker, 2003). Landings of Jacks in St Vincent and the Grenadines have fluctuated widely.

The species is caught in depths of 30 m inshore and is harvested using beach seine or gill net. However, the beach seine is the most popular and preferred method of harvesting (Straker, 1997) (Figure 77). Fishers experience indicates that fishing is best during the new moon. Currently, the largest fishing ground for Jacks is located along the entire west coast of mainland St Vincent stretching all the way to the southernmost tip of the island. The species is often sold as bait to Trinidadian and Grenadian fishers (Jardine-Jackson & Straker, 2003).

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4 The term ‘small pelagic fishes’ in often use in reference to a diverse group of mostly planktivorous fishes that share the same habitat. These species thrive in the surface layers of the water column, usually above the continental shelf and in waters not more than 200 m in depth (Dalzell, 1993).
At present the status of Jacks stocks across St Vincent and the Grenadines is unknown. Furthermore, seine fishing and small coastal pelagic are poorly documented across the country. This is possibly due to seine fishing being a small-scale operation occurring inshore from numerous rural villages and landing sites. Such fisheries present challenges for monitoring and are usually poorly known (McConney, 2003).

The species is harvested widely across fishing grounds of St Vincent and the Grenadines which are mainly shallow bay areas (Figure 78).
Figure 78. Map of Jacks fishing grounds in SVG
Jacks landings have contributed to 43% of all species harvested using beach seine. In addition, the contribution of the species to the overall fishery is 19% of annual landings. Over the past 20 years the composition of beach seine catches across the various fishing grounds have been very similar (Figure 79). Further to that, beach seine has been prevalent throughout the Leeward coast of St Vincent and throughout the Northern and Southern Grenadines. The composition of catches at these grounds have been the same.

Figure 79. MDS plot of Beach Seine catches across the fishing grounds of SVG

Jacks is not the only species that is being harvested at these fishing ground using beach seine. Figure 80 demonstrates that the species is being harvested at other fishing grounds; however, areas in and around the main fishing grounds have yielded catches within in range of 40,000 lbs for the past 20 years.

Figure 80. MDS plot of quantities of Jacks caught at the different fishing grounds
Chapter 6. Fish Stock Assessment (Surplus Production)

St Vincent and the Grenadines has had an active data collection program since 1979. However, in 1992 with the aid of the CARICOM Fisheries Resource Management Programme (CFRAMP) the data collection system was revised. Data are collected for each species landed and are generally catch and effort and sometimes biological (Jardine-Jackson & Straker, 2003). Experts outside of the country usually do stocks assessments periodically, mainly for the Queen Conch (Jardine-Jackson & Straker, 2003). As part of strengthening the Fisheries Division’s capabilities to conduct independent stock assessment on possibly all fisheries for which there are available data, the use of production models has been applied to 4 main species. Namely, Spiny Lobster, Queen Conch, Red Hind and Jacks. Given the migratory nature of Mahi Mahi, it is not appropriate to conduct an assessment for this species based only on data from SVG.

The main objective of conducting a fish stock assessment for St Vincent and the Grenadines is to obtain the best possible advice on the exploitation of the marine living resources and to ascertain how fish populations will respond to pressure from harvesting. As a result, the stock assessments are expected to provide scientific information, which would advise the fisheries management process. Given the limited data available, surplus production modelling approached have been applied. A linear model is fitted to the relationship between Catch per Unit of Effort and Total effort, following (Schaefer, 1954), and the coefficients from this regression are used to estimate surplus production. This is used in the determination of Maximum Sustainable Yield (MSY) and is the simplest means to express catch per unit of effort (Sparre & Venema, 1998). The MSY is determined from the input data: weight of fish catch and the fishing effort in years. These 2 parameters, when divided (Catch/Effort) generates the Catch per Unit of Effort or CPUE. As fishing effort increases, the CPUE decreases, thus creating a negative slope. The model also generates an intercept. This intercept is the hypothetical CPUE value achieved soon after the first vessel fishes on the population for the first time (Sparre & Venema, 1998). The Schaefer model also determines an equilibrium catch. The equilibrium catch suggests that for any given amount of fishing effort there is an equilibrium sustainable yield. The idea is that the fish population is at some kind of equilibrium level of biomass generating a certain amount of surplus production. The concepts and principles grasped from this research will become the platform for future analyses for other fisheries of St Vincent and the Grenadines with similar data.
6.1. Preparation of Data for Analysis

Fish catch and effort data were collected during the period 1994 to 2014 (20 years) by the fisheries data collectors. The sampling coverage varied between years with catch and effort data collected at the landing sites. The method of simple random sampling is used to select the days of the month each landing site is sampled. Sampling is not carried out on Saturdays, Sundays and major holidays; all the same, every day is considered as a potential fishing day.

As there were no total effort data collected to relate to the total landings, the catch per unit of effort (CPUE) was obtained from the sampled data by dividing the sampled landed weight (catch) by the number of hours fished (effort); that is, \( \text{catch} / \text{effort} = \text{CPUE} \). Following this, the estimated effort for the total weight of the species landed over the years was achieved by dividing the total landing by the CPUE.

6.2. Assessment of Red Hind

Over the 20 years, catches of Red Hind peaked in 2010 at 134,337 lbs landed weight. Before that total catches fluctuated noticeably every 2 – 3 years. Significant increases in catches started in 2007 and continued through to 2010 then declined in 2011 by 45%. The total catch in 2014 was 93% more than the catch in 1994, however, it is 29% lower than in 2010 (Figure 81). The general trend shows Red Hind catches increasing.

![Figure 81. Catch history for Red Hind](image)

The CPUE was at its highest in 2003 and it was lowest in 1996. During the years 1994 to 2000 it fluctuated gradually from one year to the next. After 2000 it increased significantly through
to 2003 then declined slightly the following year. There were steady increases from 2005 to 2008, then it declined again from 2009 to 2013 (Figure 82).

![Figure 82. Red Hind CPUE 1994 - 2014](image)

At just over 110,000 hours 1996 saw the most fishing effort being use for the 20 years’ period. However, this soon declined sharply between 1997 and 1999. There was a slight increase again in effort in 2000 and from then onwards Red Hind fishing effort has fluctuated moderately through to 2014. The least amount of effort put into harvesting Red Hind was in 1994 at just over 2600 hours. This is 97% lower than that of 1996. Effort for 2014 are 64% less than that in 1996, but on the other hand, it is 93% more than that of 1994 (Figure 83).

![Figure 83. Total effort for harvesting Red Hind from 1994 – 2014](image)

Figure 84 shows that CPUE decreases as fishing effort increases. The $r^2$ value (0.53) suggests a linear relationship fits this data quite well. When there are few boats fishing per hour for Red Hind, each unit of effort caught more fish. This is evident in 2003 as this year was the year with the most viability having caught an average 4lbs of Red Hind per hour. Even though the
total annual catch was small the CPUE is still feasible. At the intercept (3.7504) although there is a really small amount of effort and the total catch is quite low, the CPUE is as high as it can be at that point. It can be observed that fishing effort of up to 40,000 hours per year have yielded the most catch, while effort exceeding 50,000 hours per year have yielded less. Another observation is that between 1994 to 2000 fishing effort was at the highest while CPUE were fairly lower than the years after. This is due to Red Hind from SVG having market access into the EU at the time.

![CPUE plot against number of Effort inputted into harvesting Red Hind](image)

The equilibrium catch is an estimation that for each level of fishing effort there is an equilibrium sustainable yield. The stock is assumed to be at an equilibrium level with what is harvested and produces a particular quantity of surplus. Using this equilibrium catch the MSY also can be estimated and also the effort required to give rise to the MSY. The estimated equilibrium catch curve fits the catch and effort data reasonably well (Figure 85), and effort has generally been below the level required to take MSY. As effort increases from very low levels, the equilibrium catch increases, but at effort levels above 60,000 hours catches declined. Figure 85 shows that for the amount of effort used, Red Hind catches have been sustainable thus far.
With current efforts, the maximum amount catch that the ecosystem can sustain or the maximum sustainable yield (MSY) for the species is 117,212 lbs annually. This MSY has only been exceeded a few times in the past and this occurred from 2007 – 2010 (Figure 86).

6.3. Assessment of Spiny Lobster

It is important to note that this assessment for Spiny Lobster is based on catch and effort data collected from pot fishing only. The unit of effort used is the amount of hours that the fishers spent fishing.

Having peaked in 2014 at 111,578 lbs live weight, the total annual catch for Spiny Lobster fluctuated noticeably in all of the previous years. There was a significant decline in lobsters in 2008, then it rose sharply by 93% over the next 6 years (2014). The total catch in 2014 was 52% more the catch in 1994 (Figure 87). The general trend shows Spiny Lobster catches increasing over the period.
Figure 88 demonstrates that the CPUE for lobsters was at its highest in 1995 and it was lowest in 2001. From 1996 – 2001 there was a sharp decline; then during the years 2002 to 2014 it increased steadily onward.

For the 20 years’ period fishing effort for lobster peaked 3 times. First in 1995 at just over 18,700 hours, then in 2001 at over 25,200 hours and finally in 2004 at approximately 15,200 hours. The total effort used for harvesting Spiny Lobsters in 1994 rose from 1635 hours to over 18,700 hours in 1995. This was followed by a sudden decline to 1035 hours in 1996. Between 1997 to 2001 Fishing effort in the Lobster fishery rose steadily just over 25,000 hours and then declined suddenly again in 2002 to 6327 hours (Figure 89).
Figure 89. Total effort for harvesting Spiny Lobster from 1994 – 2014

Figure 90 shows that as fishing effort increases the CPUE decrease. It can also be observed that fishing effort of less than 10,000 hours per year have yielded the most catch, while effort exceeding 20,000 hours per year have yielded less. So in theory, when lots of effort is being spent fishing for Lobsters, each unit of effort doesn’t catch much fish. Conversely, a low amount of effort caught a low amount of fish because not enough effort is being spent fishing. At the area of intercept there is minimal effort. This intercept of 15.03 represents the CPUE at a point where it is as high as it possibly can be when the effort is at its minimal. While the regression slope is negative, the $r^2$ value (0.03) indicates the linear relationship does not account for the variability in the data well. This poor fit may relate to the difficulty in measuring effort in lobster fisheries (effort by pot is difficult to measure, and skill level is likely to vary considerably between divers). The parameters for the intercept and the slope have been used for the calculation of the equilibrium catch and the MSY, although results must be considered very preliminary.

Figure 90. Relationship between CPUE and effort for Spiny Lobster
The equilibrium catch curve does not fit the observed catch and effort data particularly well, as catches decline above about 10,000 hours of effort, while equilibrium catches are predicted to increase to about 25,000 hours (Figure 91). This may relate to the poor fit described above and a “by eye” fit to the equilibrium catch effort plot might suggest MSY at between 80 to 100,000 lbs. In order to better assess the fishery in the future, the collection of effort data should also include the number of pots used and the hours that the pots spent in the water. This would allow for the development of better assessment models.

![Figure 91. Equilibrium Analysis of Spiny Lobster](image)

On the basis of the above analysis, the maximum amount catch that the ecosystem can sustain or the maximum sustainable yield (MSY) for the species is 188,250 lbs annually (Figure 92). This MSY has never been exceeded. Catches have only recently exceeded the alternative “by eye” MSY estimate.

![Figure 92. Pattern of Total Catch vs. MSY for Spiny Lobster](image)
6.4. Assessment of Queen Conch

Over the 20 years, catches of Queen Conch peaked in 2014 at 116,555 lbs landed weight. Before that total catches fluctuated noticeably annually. There were significant increases in catches started in 2001 and 2002 then declined in 2003 by 75%. Catches also increased significantly in 2010; there was an increase of 89% in catch from 2008. The total catch in 2014 was 83% more than the catch in 1994 (Figure 93).

![Figure 93. Catch History for Queen Conch](image)

Figure 93 shows that the CPUE for conch was at its highest in 2014 and it was lowest in 2009. After declining to 19.14 in 1996 it remained steady through to 2011 then increased sharply in 2012 to 2014.

![Figure 94. Queen Conch CPUE 1994 - 2014](image)
The total effort used in the harvesting of Conchs have been fluctuating throughout the years. The most prominent years when significant effort was put forth to harvest Conch are 1998, 2001, 2002 and 2010. 2449 hours were used in 1998 to harvest Conch. The effort declined in 1999 and 2000 the made a noticeable increase in 2001 and 2002 to approximately 3800 hours. After 2002 fishing effort fluctuated for a while then began rising steadily in 2009. The maximum total effort utilized during the 20 years was 4912 hours in 2010. Even after Conch exports to EU territories were suspended in 2001, there were increases in fishing effort for conch to supply other regional markets. However, since 2010 fishing effort for Queen Conch has fallen significantly (Figure 95).

![Total Fishing Effort](image)

**Figure 95. Total effort for harvesting Queen Conch from 1994 - 2014**

The Queen Conch has significant commercial value to the people of St Vincent and the Grenadines, especially so for those living in the Grenadines. Figure 96 is demonstrating that as the fishing effort for Conch increases the CPUE decreases. It can be observed that fishing effort of up to 2000 hours per year have yielded the most catch, while effort exceeding 4000 hours per year have yielded less. So in theory, when lots of effort is being spent fishing for Conch, each unit of effort doesn’t catch much fish. Conversely, a low amount of effort (under 2000 hours) caught a low amount of fish because not enough effort is being spent fishing. At the area of intercept there is minimal effort. This intercept of 29.924 represents the CPUE at a point where it is as high as it possibly can be when the effort is at its minimal. As with the lobster analysis above, while the regression slope is negative, the r² value (0.02) indicates the linear relationship does not account for the variability in the data well. This poor fit may relate to the difficulty in measuring effort in diver fisheries (Figure 96). The parameters (intercept) 29.924 and (slope) -0.0019 have been used for the calculation of the equilibrium catch and the MSY.
Figure 96. Relationship between CPUE and effort for Queen Conch

Figure 97 shows that the equilibrium catch curve fits the observed catch and effort data reasonably well over the observed range, but only shows the left hand side of the relationship. Over this range, catches have increased as effort has increased, but there is little information available to estimate MSY, and the estimate provided is likely to be quite uncertain.

Figure 97. Equilibrium Analysis of Queen Conch

The intermediate level at which the Queen Conch population can be reduced and still remain sustainable is at MSY 117,821 lbs per year. Over the period that was assessed, only once Queen Conch came close to being fished beyond its MSY (Figure 98).
6.5. Assessment of Jacks

Over the 20 years, Jacks catches peaked in 2007 at 445,948 lbs landed weight. Prior to that it was highest in 1997. The total Jacks catch for 2007 is only 8% higher than that of 1997. Jacks catches have fluctuated a little over the years. There was a significant decline in catch in 2008, this decline was 86% less than 2007. The total catch in 2014 was 55% more than the catch in 1994, however, it is 57% lower than in 2007 (Figure 99).

The CPUE was at its highest in 1996 and it was lowest in 2008. During the years 1994 to 2004 it fluctuated slightly. After 2004 it declined drastically through to 2008 then increased moderately in 2011. There were negligible declines from 2012 to 2014 (Figure 100).
Total efforts put out to harvest Jacks have been reasonable between the years 1994 to 2006. The maximum total effort utilized during those years was 2455 hours in 2003. However, total fishing effort increased in 2007 to just over 5200 hours; this is because the species was being harvested as bait for foreign fishing vessels. It declined in 2008 then rose sharply again in 2009 to little over 6300 hours. A ban was implemented in 2010 on the harvesting of the species as bait causing fishing effort for Jacks to decline to 1493 hours in 2013. In 2014 efforts increased slightly to 1903 hours (Figure 101).

Figure 101. Total effort for harvesting Jacks from 1994 - 2014

Figure 102 shows that as fishing effort increases the CPUE decreases. The $r^2$ value (0.35) suggests a linear relationship fits this data reasonably well, although there is quite a lot of scatter around the relationship at lower effort levels. The parameters a) 174.98 and b) -0.0215
have been used for the calculation of an equilibrium catch and the MSY. It can also be observed that fishing effort of less than 2000 hours have yielded the most catch, while effort exceeding 4000 hours per year have yielded less.

![Figure 102. Relationship between CPUE and effort for Jacks](image)

The equilibrium catch curve fits the observed catch and effort data reasonably well, and effort has generally been below the level required to take MSY. As effort increases from low levels up to about 3000 hours catches have increased, but when effort has been above this level, catches have not increased further (Figure 103).

![Figure 103. Equilibrium Analysis of Jacks](image)

The intermediate level at which the Jack population can be reduced and still remain sustainable is at a MSY of 356,023 lbs per year. Over the 20 years there were only a twice Jacks was fished beyond its MSY; this was overfished in 1997 and 2007. The research shows that each time the
species was fished beyond its MSY, there were significant decline in catches for the year/s that followed (Figure 104).
Chapter 7. Summary

This research offers the first in-depth analysis of key fish species harvested in the fishery waters of St Vincent and the Grenadines. SVG is comprised of 32 islands and cays, the country is approximately 29 km long north-south and 17.7 km wide east-west and covers some 344 km$^2$. Fishing plays a pivotal role in the cultural and socio-economic lifestyle of the people of SVG. The fishing industry is mainly artisanal with over 70% of the 2500 persons employed in the industry being exclusively dependent on fishing and related activities for their livelihood. The fishing industry contributes approximately 1 - 1.5 % to the gross domestic product and a per capita consumption of about 23lbs.

The Fisheries Division, functioning under the Ministry of Agriculture, Rural Transformation, Forestry, Fisheries and Industry is responsible for the management and development of the fisheries sector. The sector is currently governed by six legal instruments. At present, there are thirty-two (32) persons employed with the Fisheries Division, this includes the Chief Fisheries Officer who oversees the day to day administration of the Division.

The fisheries and species harvested in SVG have been grouped into seven main categories to facilitate optimal management. The industry uses multiple fishing vessel types and fishing gears and target a mix of species.

Using data collected by the Fisheries Division from 1994 to 2014, a stock assessment of Red Hind, Mahi Mahi, Jacks, Queen Conch and Spiny Lobster was conducted. The research analysis also demonstrated that there is a difference in the catch composition of fishing gear, namely: beach seine, bottom longline, dropline, fish pot, gill net, hand line, palangue, scuba dive, spear gun and trolling. The catch composition of each individual fishing gear individually has been similar throughout the 20 years. Beach seine catches have an average similarity of 65%, hand line 62%, trolling 64%, fish pot 38% and scuba dive 44%.

It was observed that each fishing gear made significant contribution to the overall fish catches across SVG with notable catches from beach seine, trolling and hand line. 97% of Jacks species were caught by beach seine, 94% Mahi Mahi were caught by trolling, 48% Red Hind were harvested using hand line, 99% Queen Conch were harvested by scuba diving, meanwhile 47% and 50% of Spiny Lobsters were caught using traps and scuba dive respectively. Similarly, of all the species harvested using beach seine Jacks accounted for 43%, those harvested by trolling Mahi Mahi accounted for 34%, those harvested by hand line Red Hind accounted for 22%,
those by scuba dive Queen Conchs accounted for 49% and fish pot accounted for 66% of Spiny Lobster catches.

Seasonal catches have been dominated by Mahi Mahi during winter and spring, Jacks in the summer and autumn, Red Hind, Queen Conch and Spiny Lobster dominated the autumn and winter months. The main fishing grounds for Red Hind are the south eastern shelf of mainland St. Vincent and the eastern shelf of the Northern and Southern Grenadines with some grounds producing up to 7000 lbs from 1994 to 2014. Similarly, the main fishing grounds for Spiny Lobsters and Queen Conchs are also in the Northern and Southern Grenadines and individual grounds have also produced up to 7000lbs of lobsters and 9000lbs conchs during the period assessed. The main fishing grounds for Mahi Mahi are in the north-east to the south-east side of the island also known as the Windward Coast and some of these areas have yielded catches within range of 20,000 lbs during the 20 years. The Jacks fishing grounds are prevalent throughout the Leeward coast of St Vincent and throughout the Northern and Southern Grenadines in shallow bay areas. Some areas have yielded within range of 40,000 lbs for the past 20 years.

The total Red Hind catch in 2014 was 93% more than the catch in 1994. Red Hind catches peaked at 134,337 lbs landed weight in 2010; the general trend is that catches are increasing. The CPUE was at its highest in 2003 and it was lowest in 1996. The CPUE decreased as fishing effort increased so when there were few boats fishing per hour for Red Hind, each unit of effort caught more fish. It was observed that fishing effort less than 40,000 hours per year showed the highest catches, while effort exceeding 50,000 hours per year had reduced catch. The estimated equilibrium catch curve fits the catch and effort data reasonably well, and effort has generally been below the level required to take MSY. With the amount of effort currently exerted, the maximum amount catch that the ecosystem can sustain or the maximum sustainable yield (MSY) for Red Hind is 117,212 lbs annually.

In 2014 Spiny Lobster peaked at 111,578 lbs live weight. There was a significant decline in lobster catches for 2008, then by 2014 it rose sharply by 93%. The total catch in 2014 was 52% more the catch in 1994. The CPUE for lobsters was at its highest in 1995 and it was lowest in 2001. However, between the years 2002 to 2014 the CPUE increased steadily but the general trend was as the fishing effort increased the CPUE decreased. Within the regression a poor $r^2$ value indicated the linear relationship did not account for the variability in the data properly. This is probably due to poor method being used to measure the effort in the lobster fisheries.
Although the equilibrium catches and the MSY were generated, the results must be considered very preliminary.

Catches of Queen Conch peaked in 2014 at 116,555 lbs landed weight and the total catch in 2014 was 83% more than the catch in 1994. The CPUE for conch was at its highest in 2014 and it was lowest in 2009. The total effort used for harvesting Conchs have fluctuated throughout the years, with fishing effort decreasing significantly as of 2010. When a lot of effort is spent fishing for Conch, each unit of effort doesn’t catch much. Similar to lobsters, a poor $r^2$ value in the regression is indicative that the linear relationship did not account for the variability in the data properly. This too is probably due to poor method being used to measure the effort in the diver fisheries. Although the equilibrium catches and the MSY were generated, the results must be considered very preliminary.

Jacks catches peaked in 2007 at 445,948 lbs landed weight, this was 57% more than what was landed in 2014. The CPUE was at its highest in 1996 and it was lowest in 2008. During the earlier years of the assessment period the total effort used to harvest Jacks was reasonable, with the maximum total effort utilized was 2455 hours in 2003. As the fishing effort increased the CPUE decreased and fishing effort of less than 2000 hours suggested an increase in catch, while effort exceeding 4000 hours per year suggested a decline. The equilibrium catch curve fits the observed catch and effort data reasonably well, and effort has generally been below the level required to take MSY. The intermediate level at which the Jack population can be reduced and still remain sustainable is at a MSY of 356023 lbs per year.
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