A thesis submitted to the Department of Environmental Sciences and Policy of Central European University in part fulfillment of the Degree of Master of Science

Protected Area Management Effectiveness in Grenada: A Modified Threat Reduction Assessment of the Molinière/Beauséjour Marine Protected Area

Erin LOUGHNEY

May 2013

Budapest

Erasmus Mundus Masters Course in Environmental Sciences, Policy and Management

MESPOM

This thesis is submitted in fulfillment of the Master of Science degree awarded as a result of successful completion of the Erasmus Mundus Masters course in Environmental Sciences, Policy and Management (MESPOM) jointly operated by the University of the Aegean (Greece), Central European University (Hungary), Lund University (Sweden) and the University of Manchester (United Kingdom).

Supported by the European Commission's Erasmus Mundus Programme

Education and Culture

Erasmus Mundus

Notes on copyright and the ownership of intellectual property rights:

(3) For bibliographic and reference purposes this thesis should be referred to as:

Loughney, E.M. 2013. *Protected Area Management Effectiveness in Grenada: A Modified Threat Reduction Assessment of the Molinière/Beauséjour Marine Protected Area.* Master of Science Thesis, Central European University, Budapest.

Author’s declaration

No portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

Erin LOUGHNEY

ABSTRACT OF THESIS

Submitted by:

Erin LOUGHNEY for the degree of Master of Science and entitled:

Protected Area Management Effectiveness in Grenada: A Modified Threat Reduction Assessment of the Molinière/Beauséjour Marine Protected Area

May 2013.

Protected Areas(PAs) and Marine Protected Areas (MPAs) are a crucial part of the conservation of our terrestrial and aquatic world; unfortunately, simply setting aside these areas does not mean that they are doing what they were set out to do. Protected Area Management Effectiveness (PAME) investigations are a tool that allows staff to see how these areas are functioning so they can best allocate their scare time and resources to the most important issues. While there are many ways to conduct these investigations, the Modified Threat Reduction Assessment, or MTRA is ideal in that it is accessible, inexpensive, and is able to produce results even when faced with a paucity of baseline data. This thesis will use the MTRA to investigate the management effectiveness of the Molinière/Beausejour Marine Protected Area (MBMPA) in Grenada. The researcher utilized qualitative investigations, such as interviews with stakeholders, and quantitative research, including the MTRA Workshop with experts of the MBMPA in this investigation. The result was an MTRA Index of -36.25; it was found that the MBMPA faces 13 direct, human induced threats. The drivers, impacts, and possible solutions for these threats were also investigated.

Keywords: Biodiversity, Protected Area Management Effectiveness, MTRA, Grenada, PA, MPA

ACKNOWLEDGMENTS

To paraphrase a wise man, I would like to say this: a thesis is not something you can do all on your own. Many, many people contributed to my thesis.

I'd first like to thank Brandon Anthony for being such a fantastic advisor. I am so thankful to have had your encouragement, patience, guidance, and advice throughout this process. I love this field and this specific subject so much; I feel honored to have been able to conduct research using the tool you pioneered with your oversight.

I'd also like to thank Aleh Cherp: thank you for giving me a chance in this program; for providing me with guidance in my career and my field; for reading my numerous, lengthy emails; and for making me feel that my voice was always heard and considered. To Kriszta and Irina, thank you for making MESPOM run. You are truly the backbone and heart of this program, and I'm constantly in awe of your patience, kindness, and efficiency.

I am so thankful to the entire staff of the MBMPA for allowing me to conduct research at their MPA. I'd like to thank Roland Baldeo, for accepting my proposal; Steve Nimrod, for allowing me to use his amazing research on nutrients and sedimentation; and Anne-Marie, for your kind words. CJ, I would not have this thesis if it wasn't for you. Thank you for for answering every question up until the very end, no matter how much time it took you to find the answer; thank you also for showing me how to hunt lionfish. Ashaki, thank you so much for showing me around Grand Etang. Same to you McKell; thank you also for taking me on so many patrols; for letting me drive the boat; and for introducing me to so many Grenadian foods (and drink). I'd especially like to thank Cecil: your knowledge of the country and the MPA was one of the most integral components to my thesis. Thank you for showing me around; for the hours you spent talking to me and answering my questions; for cooking me some of the most delicious food I've ever had; and for introducing me to Tiger.

Sabrina and Julie, I could not have gotten into school without your support and supreme grammar skills. Mono, Aneesha, Emily, Catherine, Iman, and Clarissa: thank you for the many ways you have boosted my spirits in the last few months. Calvin, thank you for how often you make me smile; study breaks with you and Flannel have kept me sane, even when thousands of miles apart. And to Meredith: thank you for always giving me a home away from home (even if neither of us actually have a home at the time), and for taking such wonderful care of me as I arrive from and leave to all of my travels.

Thank you to all of my classmates; I feel so lucky to have been part of this kindle of kittens, and to learn beside you as we grow into cats. I'd especially like to thank Paroma, Sarah, and Daniel, for making me laugh. To my Bremily, - I feel so lucky to be friends with such intelligent, inspiring, badass women. Brittny, thank you for doing this last year; I am in awe of the quality of your work, and have used it as my guide (and also my proof that it really can be done). Emily, thank you for being my compatriot in this process even from half a world away. And to Jacob: thank you for the comfort, encouragement and love you give me, and for always being on my wavelength.

Lastly, I'd like to thank my family. Andy and Hanna, thank you for letting me share in Tapalou; it's a comfort to know that even if I don't have a place of my own, when I am with you up on the hill my soul feels at home. Thank you for believing in me and my goals from the very beginning. Most importantly, I'd like to thank my parents. To my Dad, whose memory has sustained me along the way, and whose loving words of encouragement I can hear just as clearly as if he were speaking them to me now. And to my Mom – I don't have words to thank you for all that you have done for me. Thank you for supporting me emotionally, physically, and fiscally through this entire process. Thank you for giving me a home, and for taking such good care of my crazy cats so that I could go to school. Thank you for making me laugh, no matter how I am feeling. Thank you for making me feel loved; and for believing in me, always.

TABLE OF CONTENTS

LISTS OF TABLES AND FIGURES

List of Figures

List of Tables

LIST OF ABBREVIATIONS

CaMPAM	Caribbean Marine Protected Area Management Network and Forum
CBD	Convention on Biological Diversity
CIA	Central Intelligence Agency
CMP	Conservation Measures Partnership
GoG	Government of Grenada
IFAD	International Fund for Agricultural Development
IUCN	International Union for Conservation of Nature
MBMPA	Molinière/Beauséjour Marine Protected Area
MBMPA-MB	Molinière/Beauséjour Marine Protected Area Management Board
METT	Management Effectiveness Tracking Tool
MPA	Marine Protected Area
MTRA	Modified Threat Reduction Assessment
NBSAP	National Biodiversity Strategy and Action Plan
NDC	National Democratic Congress
NNP	New National Party
NTFP	Non-Timber Forest Product
OAS	Organization of American States
PA	Protected Area
PAME	Protected Area Management Effectiveness
RAPPAM	Rapid Assessment and Prioritization of Protected Areas Management
TRA	Threat Reduction Assessment
UN	United Nations
USAID	United States Agency for International Development
WCPA	World Commission on Protected Areas
WI	Windward Islands
WWF	World Wildlife Fund

CHAPTER 1 INTRODUCTION

1.1 Background

The 2011 report *Reefs at Risk Revisited* states that on a global scale, 73% of our coral reefs are unprotected. Of the 27% that are located within the bounds of a Marine Protected Area (MPA), only 6% are protected by an MPA that is effectively managed (Burke *et al.* 2011; Figures 1). This same report goes on to list the 27 countries worldwide that are most vulnerable to reef degradation based on the drivers of reef dependence, threat exposure, and adaptive capacity. Just nine countries are considered vulnerable in all three areas; Grenada is one of these countries (Burke *et al.* 2011; Figure 2).

Grenada is surrounded by 1,250 hectares of coral reefs, an estimated 8% of which are currently under protection (Grenada Ministry of Finance 2009; Turner 2009a). It isn't just Grenadian's reefs that are threatened; rather, their overall coastal and marine ecosystems face a host of issues from threats like habitat destruction, pollution, and overexploitation of resources (Grenada Ministry of Finance 2009). Two severe hurricanes in 2004 and 2005, followed by the global economic crisis, have only exacerbated these stressors (Thomas 2011). Despite these issues, Grenadians have prioritized environmental conservation: in 2006 the government signed the Grenada Declaration, pledging to set aside 25% of terrestrial areas and 25% of marine areas as Protected Areas (PAs) by 2020. Grenada is working toward that goal, with two active MPAs, the Sandy Island/Oyster Bed MPA in Carriacou and the Moliniere/Beausejour MPA in Grenada, and two more MPAs that are in the planning and preoperational stages (Grenada Marine Protected Areas 2012).

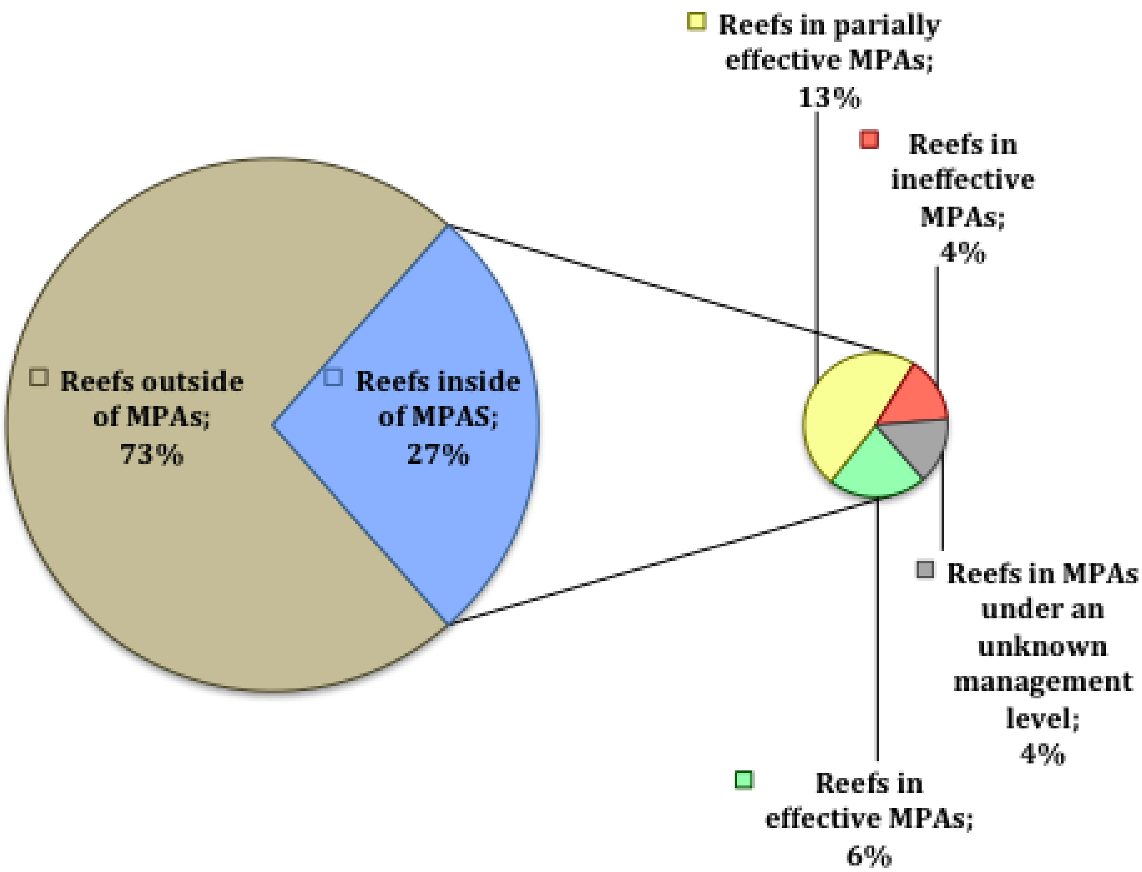


Figure 1: Coral Reefs by Marine Protected Area Coverage and Effectiveness Level
Source: Burke *et al.* 2011

Setting aside land (or water) is a vital first step, but is not enough on its own to ensure that nature is truly being conserved (Lockwood *et al.* 2006). According to Hocking (2004) "to maximize the potential of protected areas, we need to understand the strengths and weaknesses in their management and the threats and stresses that they face". PAs and MPAs require evaluations of their Protected Area

Management Effectiveness (PAME) to ensure that they are achieving their goals and making the best use of their resources (Lockwood *et al.* 2006; Chape *et al.* 2005).

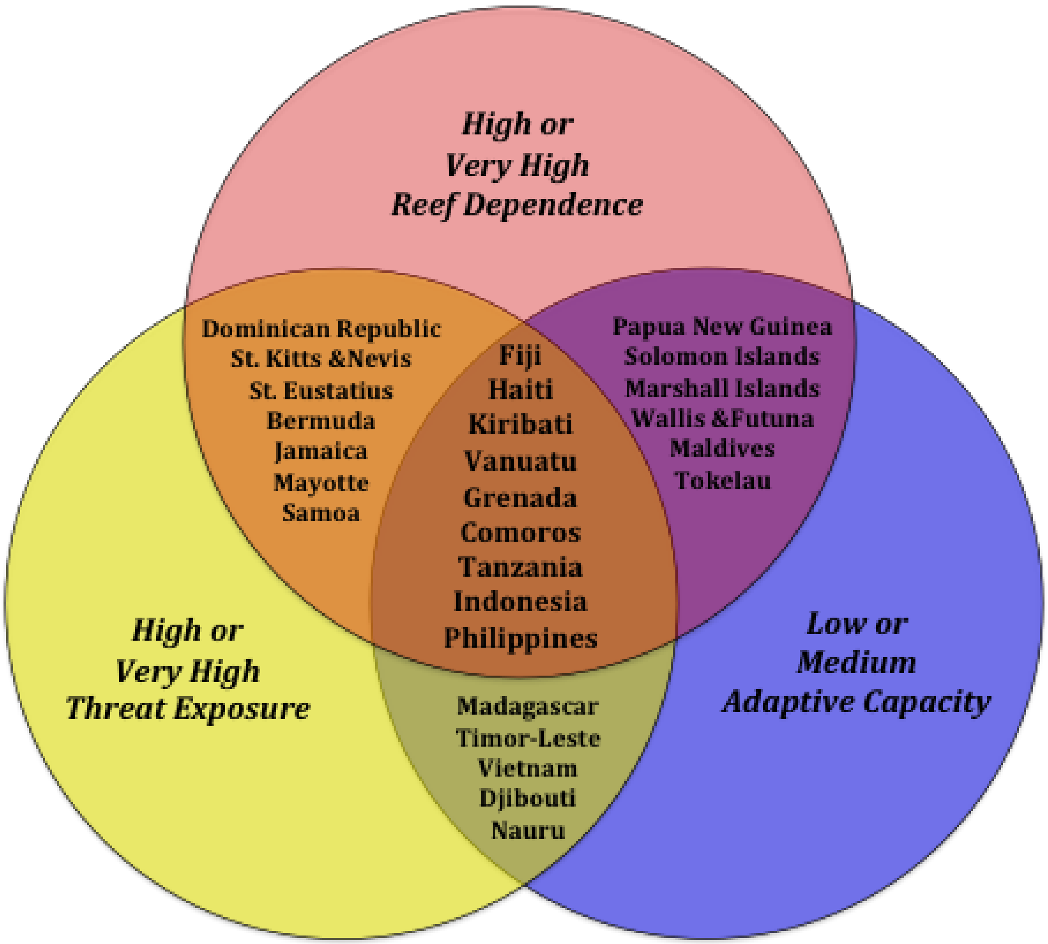


Figure 2. Drivers of Vulnerability in the 27 Nations and Territories Most Highly Vulnerable to Reef Destruction
Source: Burke *et al.* 2011

1.2 Justification and objective

The MBMPA was first gazetted in 2001, but it wasn't until 2010 that Wardens were hired and the laws of the MPA were enforced, making the MPA operational (Grenada Ministry of Agriculture, Forestry, and Fisheries 2010). While assessments related to management effectiveness have previously been carried out on the MBMPA, they were conducted prior to active management, which began in 2010 (Gombos *et al.*

2011; Niles 2010; Byrne 2005?). A management capacity assessment carried out by Gombos *et al.* in early 2011 reported that the MBMPA had "no ongoing effectiveness monitoring and evaluation program in place". A comprehensive evaluation of the management effectiveness of the MBMPA now that it is operational will be a valuable contribution to academia and the MBMPA Management. Thus the objective of this research is to utilize a Modified Threat Reduction Assessment (MTRA) in order to assess the effectiveness of the MBMPA management in mitigating threats to the MBMPA from the years 2010 – 2013.

1.3 Organizational structure

This report consists of five written components the first of which is this section, the introduction, and the second of which is the literature review. The literature review is an archival analysis of two main areas, Biodiversity and PAME, and Grenada, both of which are broken down into subsections. The aim of this section is to inform the reader of all the background necessary to understand the research that was undertaken. The third section is the methodology, which is broken up into an overview, a section on qualitative research, and a section on quantitative research; the methodology is based off of MTRA Method developed by Anthony (2008). The fourth section is the results and discussion, where first the results from the MTRA Workshop are given in tabular form. The rest of the section describes the various threats faced by the MTRA; the threats are organized into groups by their corresponding standardized classifications, which are taken from Salafsky *et al.* (2008). Discussion related to the threats, such as their impacts, drivers, and possible solutions, are included in this section. The final section is a conclusion which includes some ideas for future study as well as a statement on the fulfillment of the research objective.

CHAPTER 2 LITERATURE REVIEW

2.1 Biodiversity and Protected Area Management Effectiveness

2.1.1 Biodiversity

In 1992 the United Nations (UN), in the seminal Convention on Biological Diversity (CBD), defined biodiversity, as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" (UN 1992). The Convention continues by referencing biodiversity's "ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values" and its importance "for evolution and maintaining life sustaining systems of the biosphere" (UN 1992).

The CBD came into being to address a global biodiversity crisis. While much has been done in the past 20 years, including some notable conservation successes at various levels (Sodhi et al., 2011), on a global scale we are not much better off than we were: according to most indices, biodiversity has continued to deteriorate. We failed to reach the 2010 Biodiversity Target (Secretariat of the CBD 2010), which had the overarching goal of reducing biodiversity loss to a significant degree. The world has now moved on, entering into the United Nations Decade for Biodiversity with the new Strategic Plan for Biodiversity 2011-2020 (Secretariat of the CBD 2012).

2.1.2. Protected Areas

One of the mechanisms currently in place to aid in the conservation of biodiversity is the Protected Area (PA), which is a "clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley 2008). PAs have been called "the cornerstone of biodiversity conservation" (Chape *et al.* 2005; Ervin *et al.* 2010), as well as "the fundamental building blocks of virtually all national and international conservation strategies" (IUCN 2008).

While the primary goal of all PAs is the conservation of nature, PAs have myriad functions (IUCN 2008). They allow for nature to perform its vital processes, such as the hydrological cycle and carbon sequestration. They provide habitats for the worlds creatures, both plants and animals. This does not exclude humans: PAs provide drinking water for more than 1/3 of the largest cities in the world. They are a source of work and income for more than 1.1 billion people. They are also often exquisitely beautiful, a benefit that, while intangible, is important nonetheless (Secretariat of the CBD n.d.).

Though the current incarnation of a Protected Area is relatively modern, PAs are not a new phenomenon. On the contrary, the earliest can be traced back 2,000 years to India, where land was set aside specifically to conserve natural resources, while a thousand years ago in Europe people began preserving tracts of land to be used as hunting grounds (Eagles *et al.* 2002).

The modern form of Protected Areas came about in the mid 19th century, with land being set aside by national and regional governments around the world. The general idea behind these first areas was to preserve the natural wildness of these lands so they could be enjoyed by the public at large. As more and more parcels of land were being designated as protected, it became clear that it was not enough to simply set aside tracts of land, it would also be necessary to actively manage them. Canada was the first to create such a management agency in 1911, followed by the US in 1916 (Eagles *et al.* 2002).

In the past century there has been a veritable explosion of Protected Areas (Figure 1), and the definition of a PA has grown right along with them. Although the lands were originally simply set aside for the preservation of nature without human influence, "when the best and most interesting natural and cultural sites in a country are placed in a protected area framework, there is a natural tendency for people to want to experience these environments." (Eagles *et al.* 2002)

PAs began to differ as countries began to imbue them with what was important to them both culturally and regionally; for example, it was the Europeans who first began protecting areas that were already inhabited (Eagles *et al.* 2002), whereas the first Marine Protected Area (MPA) was likely the Fort Jefferson National Monument in Florida, a state with an ample amount of coastline and aquatic resources (NOAA's National Marine Protected Areas Center 2012, Gubay 1995). While PAs were originally set aside, and thus controlled by, governments, the management of modern PAs runs the gamut. They can be governed singularly or jointly; by all levels of government, from regional to national; by NGOs and private citizens; or by local communities and indigenous groups (IUCN 2008).

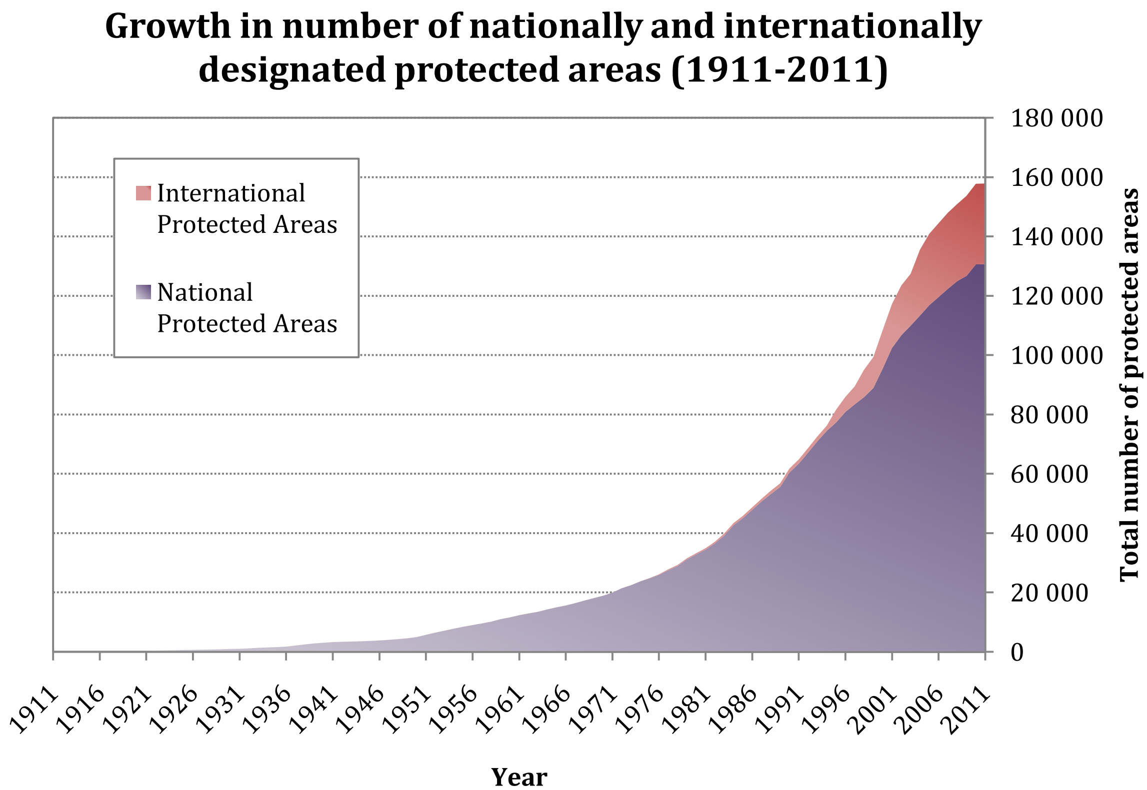


Figure 3. Growth of Protected Areas 1911-2011
Source: WDPA 2012.

The PAs themselves are even more diverse than their governing bodies, yet it is still possible for their management to categorize them into one (or more) of 6 distinct IUCN categories, based on the goals of the park. Not all countries or managers adhere to this exact system, and thus many PAs are either uncategorized or classified by another organization. That being said, it is far and away the most accepted system, employed and extolled by state governments as well as premier international bodies such as the UN and the Convention on Biological Diversity CBD (IUCN 2008).

2.1.3. Marine Protected Areas

One of the UN's goals is to not just increase the total number of PAs, but to do so in a way that is more representative of the global distribution of biomes. Currently, a disproportionate number of PAs have been set up in rural or remote areas such as tundra, with gaps left in "forest and grassland ecosystems, in deserts and semi-deserts, in fresh waters and, particularly, in coastal and marine areas" (IUCN 2008). There is a special designation for some of these aquatic PAs: Marine Protected Areas, or MPAs.

An MPA is, in its most widely accepted definition, "[a] clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Protected Planet Ocean 2010). In their general aims, MPAs are the aquatic equivalent of terrestrial PAs; beyond this, they provide a host of benefits and face myriad challenges that are entirely unique.

The scope of what MPAs protect is perhaps even more broad than terrestrial PAs. "MPAs include marine parks, nature reserves and locally managed marine areas that protect reefs, sea grass beds, shipwrecks, archaeological sites, tidal lagoons, mudflats, saltmarshes, mangroves, rock platforms, underwater areas on the coast and the seabed in deep water, as well as open water (the water column)" (Government of Australia 2003). MPAs are categorized similarly to their terrestrial counterparts. Some MPAs, called "no-take MPAs", have strict rules prohibiting human interference, including fishing and harvesting. These MPAs are especially helpful in providing a control of sorts, to use in comparing similar, less stringently protected sites. Other MPAs allow for normal human activities to take place under more lax guidelines (Government of Australia 2003).

Properly planned and managed MPAs reduce some human-induced stresses, which in turn can allow for biodiversity to flourish both within and beyond the bounds of the MPA itself. Another benefit of MPAs is their contribution to tourism by helping provide "clear water, clean sandy beaches and opportunities to view marine life" (Government of Australia 2003). Ecosystems that attract the most tourists with their teeming marine life and beauty, such as mangroves and coral reefs, are also generally the most sensitive to changes brought about by that form of tourism. The protection provided to these ecosystems by MPAs is vital for both the biodiversity as well as the local economy (Government of Australia 2003).

It is well-known that overfishing has devastated many fish populations (Worm *et al.* 2006, 2009). MPAs that permit sustainable fishing, as well as those with no fishing at all, allow populations to regenerate. Without being overly stressed, fish live longer, grow larger, and have increased reproductive capabilities. These bigger, healthier fish don't stay contained within MPAs, and are known to "spillover" outside the protected bounds, meaning the positive effects of MPAs expands beyond their borders (Gell and Roberts 2003). In addition to the overt economic benefits that accompany MPAs like better fishing and tourism, humans often overlook the many ecosystem services provided by a healthy ocean. These include the processing of wastes and the protection of coasts and shorelines, especially from floods and tidal surges (Gell and Roberts 2003).

A main issue faced by MPAs is what Peter Jones refers to as scale and connectivity (Jones 2001), namely that unlike terrestrial ecosystems, marine systems are large, homologous, and without geomorphic features to differentiate between distinct areas. Even so, those physical distinctions matter much less in the ocean, where the interconnectivity is so great (Jones 2001). Another issue MPAs face related to boundaries is when there aren't any. The deep ocean and high seas are nearly always considered international waters, making accountability and control even more difficult (Breide and Saunders 2005). This is especially true since oceans are used by more groups of stakeholders for a higher variety of reasons than most individual tracts of land (Kelleher 1999).

It appears that the international community is growing more conscious of the importance and vulnerability of MPAs and the many stressors they face. This is reflected in the fact that in 2012, three of the CBD's twenty Aichi Targets (Targets 6, 10, and 11) for 2020 focused specifically on issues related to MPAs (Secretariat of the Convention on Biological Diversity 2012; Table 1).

Target Number	Goal Year	Aim
6	2020	"all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits"
10	2015	"the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning"
11	2020	"at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascapes"

Table 1. Aichi Targets Related to Marine Protected Areas
Source: Secretariat of the Convention on Biological Diversity 2012

2.1.4 Protected Area Management Effectiveness

It is clear that PAs are extremely important. Yet in order to reach the goals they were set up to achieve, PAs cannot merely exist in the world; they must effectuate positive change (Ferraro and Pattanayak 2006). The process of judging any complex system is difficult, but evaluating PAs is made all the more difficult because of the variety found both within and among them. Protected Area Management Effectiveness (PAME) was born from this need to define success in such multifarious environments (Hockings and Phillips 1999).

Effective management has become so important that in its new definition of what a Protected Area is, the IUCN specifically added the phrase "to achieve" to show that calling a place a Protected Area inherently implies a certain level of effectiveness (IUCN 2008). Additionally, in the CBD's Conference of the Parties 10 Decision X/31, signatories were called upon to perform assessments of management effectiveness on 60% of their PAs by 2015 (CBD Conference of the Parties 2010).

In the past, gauging whether or not a PA was successfully conserving biodiversity was generally done using the monitoring of particular biological indicators. This was done by monitoring the health of one or multiple specific species and using the success of that species to gauge the overall success of the PA. This method is still used frequently utilized today; and while it is a very important and useful tool, there are four main issues with this approach. First, it is slow: biological indicators require a long timeframe to show changes, whereas most managers not only require a shorter timeframe in order to collect the data, but rarely have the baseline to compare it against. Second, it is expensive: monitoring frequently requires specific equipment or specially trained professionals to carry out and analyze the process. Third, it is impractical, as it requires extra work on top of all that the PA is already in charge of. And fourth, it's too specialized: it's difficult for non-specialists to apply the results to impact change in the PA, and it rarely allows for comparison between PAs (Margoluis and Salafsky 2001; Salafsky and Margoluis 1999).

While there are seemingly innumerable ways to evaluate the effectiveness of a PA, there are around six that have become the most well-known and most frequently used. One such method is the World Commission on Protected Areas (WCPA) Framework. It is based on the idea that PAs go through six stages during their development from unprotected area to fully-functioning PA (Hockings and Phillips 1999). It is not a tool, but rather a framework that allows researchers to create their own PAME based on what is best for that unique PA. It recommends the use of indicators in evaluating effectiveness (Hockings and Phillips 1999; Hockings *et al.* 2006). A second method is the Nature Conservancy's 5-S Framework which, as the name suggests, is based off of 5 steps toward conservation. They are Systems, Stresses, Sources, Strategies, and Successes (Lockwood *et al.* 2006). The Nature Conservancy incorporates this framework as the foundation for the various tools that it has created (Lockwood *et al.* 2006).

In addition to frameworks, there are a few oft-used tools. One such tool is the World Wildlife Fund's (WWF) Rapid Assessment and Prioritization of Protected Area Management, known as RAPPAM. It is best used as a comparison between multiple PAs, rather than for one site specifically. WWF also recommends that RAPPAM be used in conjunction with other methods of evaluation (Ervin 2003). Another of WWF's tools is their Management Effectiveness Tracking Tool, known as METT. Based on the WCPA Framework, METT is a 30 question survey that is a fast and simple progress reporting tool, which is possible to use at a multitude of sites (Hockings *et al.* 2006; WWF International 2007). A third assessment tool, which was used to conduct research for this thesis, is the Threat Reduction Assessment, or TRA.

2.1.5 TRAs and MTRAs

TRAs developed based on the idea that, no matter their size or location, a commonality shared by all PAs is threats. TRAs rely on three basic assumptions:

1. Threats to biodiversity are caused by humans
2. It is possible for every threat to be quantified at every site
3. It is possible to measure the reduction of these threats (Salafsky and Margoluis 1999)

In place of monitoring biodiversity, TRAs monitor the threats themselves and their changes over time. Before undertaking a TRA, it is important to define how the system (in this case the PA) works – a lack of understanding of the system can lead to erroneous assumptions regarding causality and direct/indirect relationships, making evaluation and subsequent remediation of the system nearly impossible (Salafsky and Margoluis 1999).

There are 10 steps in a TRA:

1. Define the PA (or area of assessment) spatially and temporally
2. List every direct threat
3. Create a definition for what complete mitigation of this threat would be
4. Rank the threats based on area
5. Rank the threats based on intensity
6. Rank the threats based on urgency
7. Add together the scores above (4-6) to calculate each threat's total rank
8. Decide how much (in percent) the threat has been mitigated since the chosen baseline time
9. Calculate each threat's raw score (total rank multiplied by percent change)
10. Calculate the threat reduction index, which accounts for mitigation changes of all the listed threats in the PA (Margoluis and Salafsky 2001)

TRAs have many strengths, one of which is that they are based on the knowledge already possessed by the park managers, thus creating a low-cost way to evaluate effectiveness. There is no need to have baseline data before performing the evaluation, as a TRA can be performed using a "historical prospective" method (Salafsky and Margoluis 1999). TRAs are also quite malleable, allowing PA staff to tailor parts of the process to fit their individual needs (Persha and Rogers 2002). TRAs are able to identify changes over short periods of time. The end result of a TRA provides a measurement that is "unitless and yet meaningful" (Salafsky and Margoluis 1999). This outcome is simple to understand and relatively easy to parlay into positive changes in the PA. This also means the results can be used not only to assess one individual site throughout time, but also to compare PAs to one another (Salafsky and Margoluis 1999).

There are weaknesses inherent in TRAs , one being that they are prone to bias and imprecision, particularly when categorizing the percent that a threat has been reduced (Salafsky and Margoluis 1999). A huge flaw in the TRA is that it doesn't provide an easy way to calculate for new or worsening threats, leaving it as a static tool trying to quantify a dynamic system (Anthony 2008). Pioneered by Brandon Anthony, the Modified Threat Reduction Assessment, or MTRA, incorporates changes to the original model that help ameliorate these weaknesses. The first significant change between the two tools is the inclusion in the MTRA of negative values as part of the scoring system to represent new or worsening threats. This allows for a more accurate representation of the state of the PA both spatially and temporally (Anthony 2008).

One of the strengths of the TRA is its applicability and comparability across different PAs. While it is already possible to juxtapose PAs through the TRA by comparing final indices, Anthony makes this an even more tangible facet of the MTRA by standardizing the threats according to the IUCN-CMP classification of threats. While standardization does inherently involve some simplification, doing so allows PAs to compare the threats they share in more detail, and the sharing of problems begets the sharing of solutions (Anthony 2008).

MTRAs have been performed in Ghana, Lebanon, Mongolia, South Africa, and Ukraine (Anderson 2012; Matar 2009; Matar and Anthony 2010; Ganbaatar 2011; Anthony 2008; Kovalenko 2012). As of yet an MTRA has not been performed in the Americas, nor has one been performed on a Marine Protected Area, thus justifying the relevance of this thesis' selection to focus on the Molinière/Beauséjour Marine Protected Area (MBMPA) in Grenada.

2.2 Grenada

2.2.1. Background

Figure 4. Map of Grenada

Source: http://www.thecommonwealth.org/YearbookHomeInternal/138551/

Grenada is a sovereign Caribbean island nation. With a total land area of 348.3 km2, Grenada is the 46th smallest country in the world (CIA 2013; Grenada Ministry of Finance 2000). It is part of the chain of islands known as the Windward Islands (WI), and is located between the Atlantic Ocean and the Caribbean Sea, north of Trinidad and Tobago and South of St. Vincent and the Grenadines (CIA, 2013). It is composed of 3 main islands, the largest being Grenada (312 km2), followed by Carriacou (34km2) and the tiny Petite Martinique (2.3km2) (Grenada Ministry of Finance 2000).

The climate in Grenada is tropical. There is little seasonal fluctuation in temperature: the hottest month is May, with an average temperature of 27.5°C, and the coolest months are

January and February, both with an average temperature of 25.1°C. The driest month is March, when Grenada receives an average of 35.3mm of rain; a shift in the northeast trade winds gives way to the wet season, the wettest month of which is August, with 207.6mm of rain (The World Bank 2013; Grenada Ministry of Finance 2000). Grenada is on the edge of the Caribbean's hurricane belt, with hurricane season lasting from June through November, though given the country's southerly placement, the general threat of hurricanes is relatively low (CIA 2013).

All three Grenadian islands are of volcanic origin. There are a variety of soil types in Grenada, the most common being the clay loams, which account for 84.5% of the soil. The soil that is best for agricultural purposes is also the least common type: the sandy loams make up just 2.9% of Grenada's soil (Grenada Ministry of Finance 2000). The main island of Grenada alone boasts 121km of coastline, and the country has claim on 12nm of territorial sea. It's lowest point is 0m (sea level), and its highest point is at 840m, the peak of Mount Saint Catherine. Its natural resources include its deep harbors, fish, timber, and tropical fruit and spices. Its electric supply is based entirely on refined petroleum, making it one of 47 countries in the world that get 100% of their electricity from fossil fuels (CIA 2013).

Grenada is a Commonwealth realm, meaning that while they are an independent nation, Queen Elizabeth II of England is the chief of state. She is represented by a Governor General which she appoints, the current being Carlyle Arnold Glean who has been in office since 2008 (CIA 2013). The current Prime Minister is Dr. Keith Mitchell of the New

National Party (NNP). He was the Prime Minister for 13 years before being defeated in 2008 by Tillman Thomas of the National Democratic Congress (NDC), and was reelected this past February (Caribbean 360 2013).

Grenada has 7 administrative divisions: the parishes of Saint Andrew, Saint David, Saint George, Saint John, Saint Mark, and Saint Patrick, and the dependency of Carriacou and Petite Martinique. The capital, Saint George's (located in the parish of the same name), is also its most populace city, home to around 40,000 of the country's roughly 109,000 inhabitants (CIA 2013; UNdata 2011). St. George's also has the most development in the way of tourism and industry; the combination of these things means it plays an exceptional role in Grenada's environmental issues (Grenada Ministry of Finance 2009).

2.2.2 Grenadian Flora

Grenada, like many small islands, is susceptible to damage from natural disasters such as hurricanes. A healthy breadth of genetic diversity allows for the various terrestrial and aquatic parts of the island to successfully recolonize after these disasters. Biodiversity is crucial for the continued health and vitality of the environmental systems that are relied upon by industries such as agriculture, fisheries, and tourism (Grenada Ministry of Finance 2009). In 1955 Hurricane Janet hit Grenada and wreaked absolute havoc on the country's biodiversity. Many reports claim that forests were entirely destroyed, and the current status of the forests overall is unknown (Grenada Ministry of Finance 2009). Certain areas were replanted and others have recovered, though overall regrowth is hindered by the thick vine cover(Grenada Ministry of Finance 2009).

There are 6 distinct forest communities in Grenada: Mangrove Woodlands (around 21 patches exist); Littoral Woodlands (nearly entirely decimated); Deciduous Forest and Cactus Scrub; Evergreen and Semi-Evergreen Forests; Rain Forest and Lower Montane Rain Forest (much are protected by the Grand Etang Forest Reserve); and Cloud Forest, Montane Thicket, Palm Break, and Elfin Woodlands (not under threat from humans due to their high elevation) (Grenada Ministry of Finance 2000, 2009).

There are a variety of reports of the number of plant species in Grenada; IUCN lists just 27 species while a recent report from Grenada estimates there are around 2,000 (IUCN 2012, Turner 2009b). Of these species, 3 are endemic: the Grand Etang Fern, the Cabbage Palm, and the Maythenus grenadensis Tree (Turner 2009b). Of the 27 plant species that IUCN attributes to Grenada, 10 exist in marine systems; 9 in freshwater systems; and 22 are terrestrial. Three of these plants (11%), Cedrela odorata (cedar tree), Guiacum officinale (guaiac tree), and Swietenia mahagoni (mahogany tree), are considered threatened (IUCN 2012). Among aquatic plants, mangroves and sea grass are extremely important for the maintenance of the ecosystem. It is estimated that there are 3.4 km2 of mangroves in Grenada, including Avicennia germinans (black mangrove), Conocarpus erectus (buttonwood mangrove), Laguncularia racemosa (white mangrove), and Rhizophora mangle (red mangrove). Of the sea grasses, Thalassia testudinum (turtlegrass) is among the most plentiful (Turner 2009b).

In addition to threats from hurricanes and forest fires, the other main natural hazard to the flora is pests. The impacts of pest infestation have been exacerbated by monocultural plantings of trees (Grenada Ministry of Finance 2009). As the use of forests for timber have decreased, their use for Non-Timber Forest Products (NTFP) have increased. These products are generally produced by a poorer section of society for general subsistence and use, as well as to sell to tourists. The main products that are used for these purposes are "bamboo, screwpine, poles, fruits, charcoal, medical plants, crayfish and wildlife" (Grenada Ministry of Finance 2009) While it appears that the only species seriously threatened by the current use are the Pandanus, or screw pines, it's important to note that there is no baseline data to use as a way to monitor present and future use (Grenada Ministry of Finance 2009).

2.2.3 Grenadian Fauna

There is a paucity of data related to Grenadian fauna, lacking in everything from the species distribution to their current status, particularly following the 2004 and 2005 hurricanes (Grenada Ministry of Finance 2009). The IUCN lists 387 species of animals living in Grenada, of which 295 species are part of the marine system, 137 species are terrestrial, and 60 inhabit freshwater (IUCN 2012). The majority of these species, 296, are considered Least Concern, 18 are Near Threatened, and 33 are Data Deficient. This leaves 40 species of animals that are considered threatened. Of these threatened species, the overwhelming majority are marine species: 14 species of fish followed by 10 species of coral, 5 species of sharks, and 4 species of turtles (IUCN 2012; Figures 5 and 6).

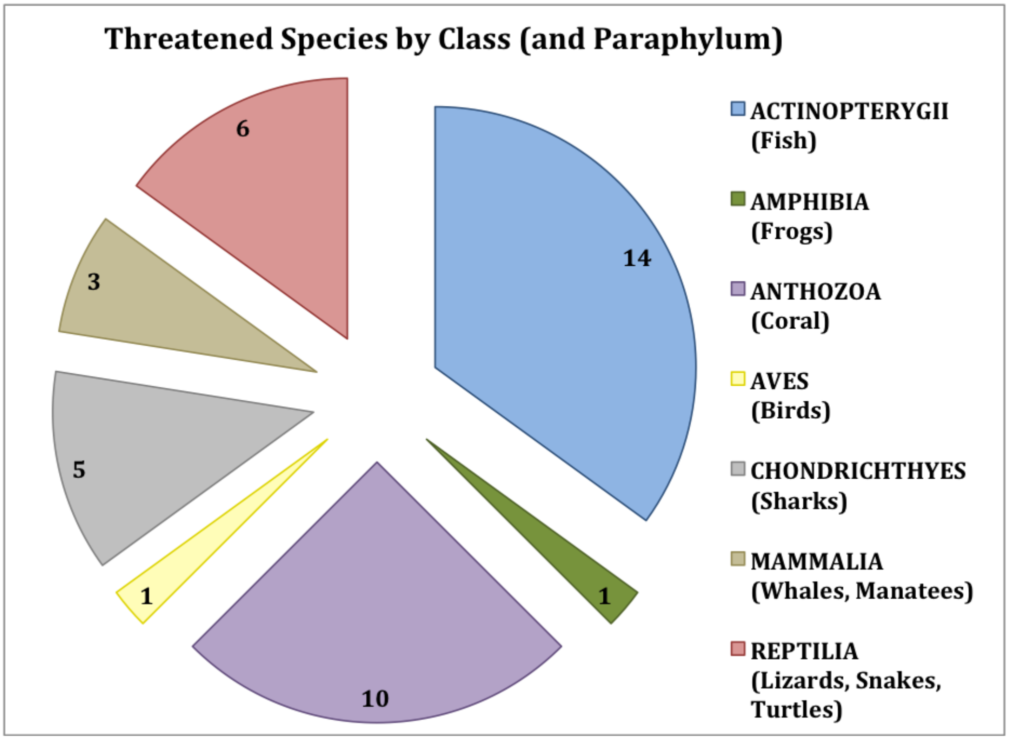


Figure 5. Total Threatened Grenadian Animals by Class (and Paraphylum)
Source: IUCN 2012

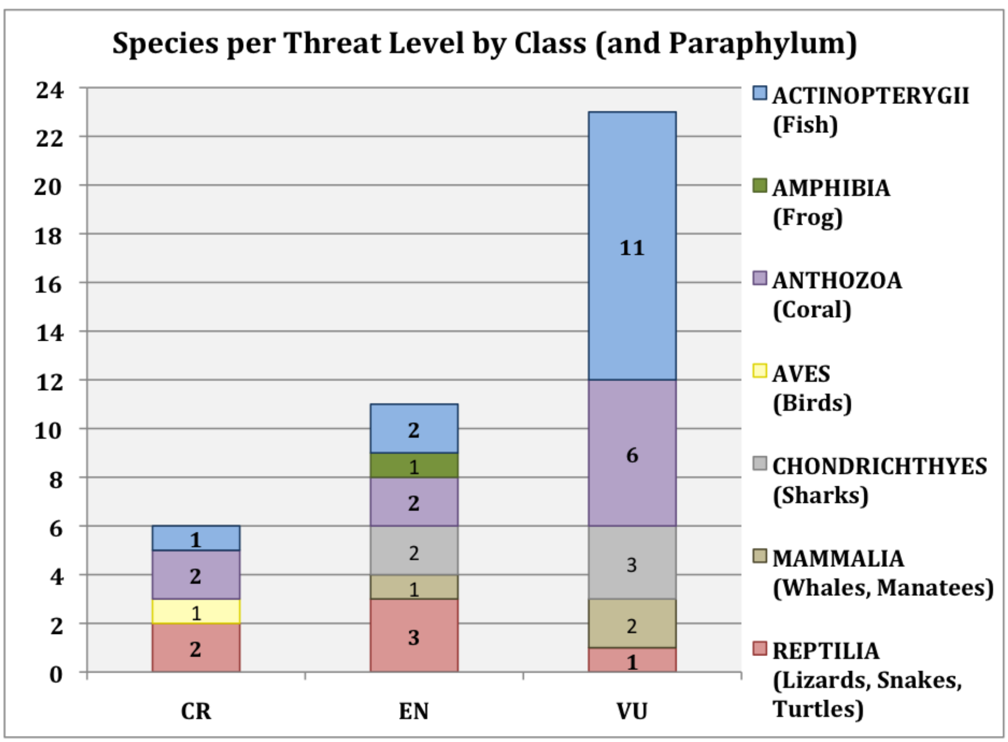


Figure 6. Species per Threat Level by Class (and Paraphylum)
Source: IUCN 2012

Animals are hunted in Grenada both for subsistence as well as income. The main species that are hunted are the Iguana delicatissima (Lesser Antillean iguana; see Figure 7), Columba palumbus (ramier pigeon), Dasypus novemcinctus (armadillo), Cercopithecus mona (mona monkey, an introduced species; see Figure 8), and Marmosa robinsoni (opossum) (Grenada Ministry of Finance, 2000). It is estimated that there are 12.5 km2 of coral reef surrounding Grenada. The most common types include Acropora palmate (elkhorn), Colpophyllia natans (boulder brain), Porites furcata (finger), and Porites astreoides (mustard) (Grenada Ministry of Finance 2009). The corals are negatively impacted by algae, bleaching, ocean surges, and sedimentation (Grenada Ministry of Agriculture, Forestry, and Fisheries 2010).

Figure 7. Iguana delicatissima
Source: author

Figure 8. Cercopithecus mona
Source: author

2.2.4 Tourism and Sustainable Development

In 2004 Grenada was hit by Hurricane Ivan, which destroyed 95% of the buildings, ruined the nutmeg plantations (and subsequently the income generally received from them), and damaged important natural elements such as coral reefs. The following year saw even more damage from Hurricane Emily (CIA, 2013; Grenada Ministry of Agriculture, Forestry, and Fisheries 2010). These events, in addition to the erratic growth of the tourism industry, has resulted in a significant growth of new construction (Singh 2010, GOG 2013).

Tourism has become an important, albeit unpredictable component of Grenada's economy. In their first *National Biodiversity Strategy and Action Plan* the Ministry of Finance (2000) laid out 10 specific goals for the development of sustainable tourism in the country. They further defined the role of the Grenadian Government in this area as being to provide

"the infrastructure and the institutional and regulatory framework which will facilitate private sector investment and activity in the tourism sector. The pace of tourism development will be ordered, gradual and in balance with the development of the physical and social infrastructure so as to ensure high standards in amenities and service" (Ministry of Finance 2000).

Unfortunately, according to Singh (2010), this has not actually been the case: development planning has been lacking, while oversight and monitoring of the projects have been poor. This issue is exacerbated by the fact that approximately 85% of land in Grenada is privately owned (Singh 2010).

Number	Goal
1	Be in harmony with the resource endowments of the country
2	Provide maximum linkages with other sectors
3	Minimize any adverse effects on the physical, social environmental character of the country
4	Maximize the contribution of stayover and cruise tourism to the economy
5	Distribute the benefits of tourism more evenly and equitably throughout the country
6	Develop stronger linkages between the tourism sector and other economic sectors such as agriculture, fisheries, manufacturing, handicrafts and services
7	Ensure that tourism development is consistent with the protection and conservation of the country's natural and cultural resources, built environment and the nation's moral values
8	Foster the most appropriate form and scale of tourism development in harmony with the resource endowment of the islands and the aspirations of the people
9	Ensure that the tourism plant and essential infrastructure services keep pace with the demands of the sector within the context of the established carrying capacity
10	Enhance the country's reputation as a safe and friendly destination for visitors and nationals

Table 2. Grenada's Goals for Sustainable Tourism Development
Source: Grenada Ministry of Finance 2000, Pp 22

As of 2000, tourism in such a concentrated area (namely, St. George's) had created, among other issues, "demands on water supplies, problems of beach erosion, damage to coral reefs, pollution of coastal waters and destruction of mangrove resources." (Grenada Ministry of Finance, 2000). Beach resorts, yachting, fishing, and, to a lesser extent cruises and water sports, continue to have direct negative impacts on terrestrial and aquatic flora and fauna, particularly mangroves, coral reefs, and sea grass beds (Singh 2010, Grenada Ministry of Finance 2009, 2000).

2.2.5 Agriculture

Grenada is known as the Island of Spice, with nutmeg being a historically and culturally important crop that still plays a key role in the country's economy (The Observatory of Economic Complexity, n.d). The nutmeg industry was the keystone of Grenada's agriculture, until it was devastated by the 2004 and 2005 hurricanes (GOG 2013). Nutmeg is also of cultural importance, and can even be found on the country's flag.

Twenty years ago, Grenada's economy was based largely off of agriculture; and while its financial role related to exports has diminished compared to the past, agriculture still plays a vital, though troubled, role in the country (Thomas 2011, GOG 2013). There is some form of agriculture occurring on 75% of Grenada's land (see Figure 9), though 90% of farms are small, taking place on plots of land less than 5 acres (IFAD 2010?, Grenada Ministry of Finance 2009). The majority of farmers, as many as 87%, farm on their own, rather than as part of a family or group (IFAD 2010?).

As of 2011, agriculture accounted for only 5.3% of the national GDP, compared to the services sector (encompassing tourism, among other things), which dominates at 80.5% (CIA 2013). The agricultural sector faces significant challenges, including a dearth of investments, antiquated farming systems, and poorly organized markets (Thomas 2011). The result is that there are less farmers; those that remain are older, with an average age of 48 for men and 54 for women. In 2008, 25% of Grenada's population was unemployed, with reports of unemployment in 2012 being as high as 40% (CIA 2013, Caribbean News Now! 2012). Despite this fact, young Grenadians are not entering the agricultural sector.

According to IFAD (2010?) “the results are a downward spiral: a large proportion of uncultivated land, low productivity and the loss of traditional farming knowledge and techniques.”

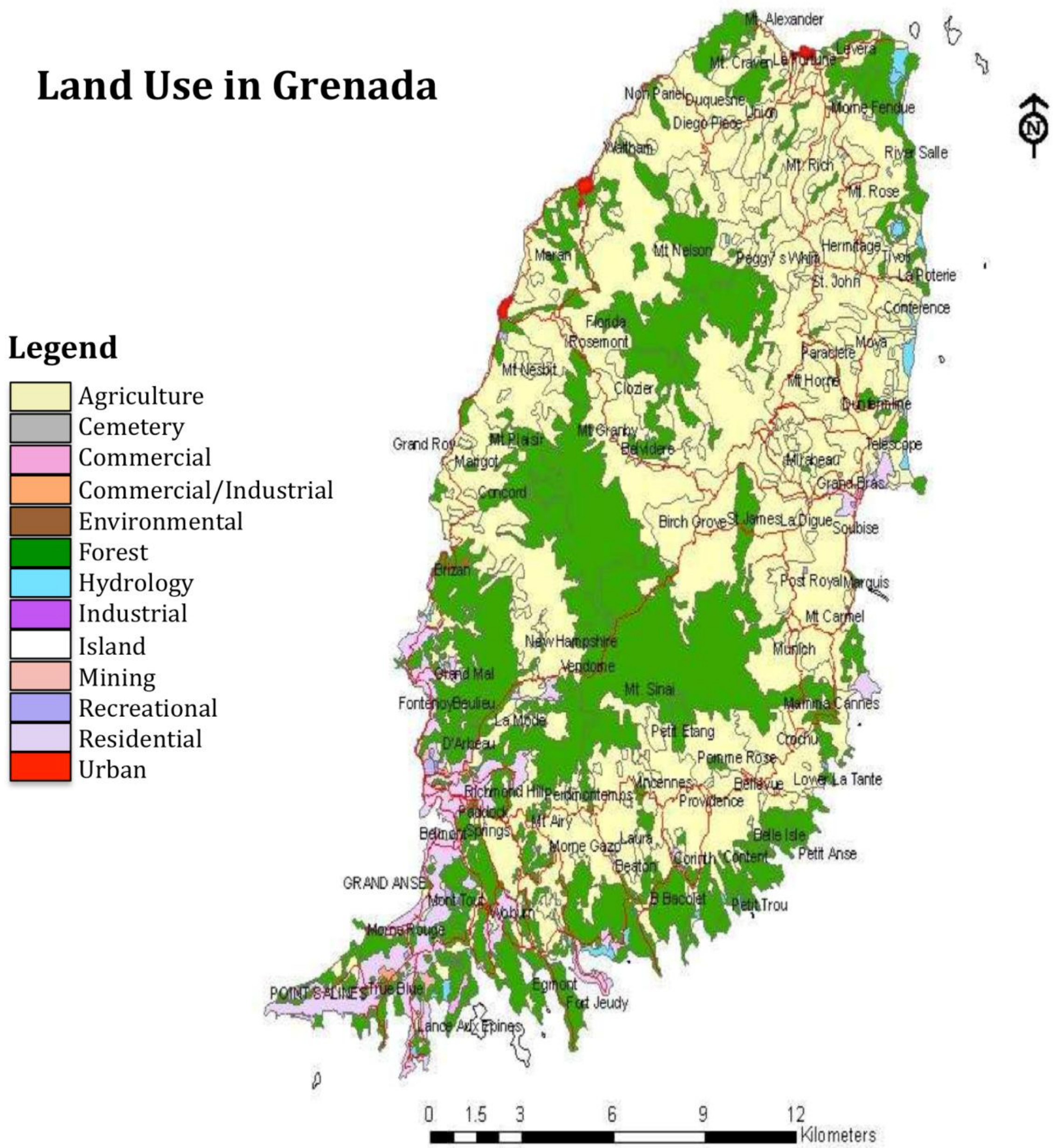


Figure 9. Land use in Grenada
Source: Grenada Ministry of Finance 2009

2.2.6 Environmental Policy and Management

Grenada signed the Convention on Biological Diversity in 1992, the first year it was open for signatories, and ratified the Convention in 1994. Their first National Biodiversity Strategy and Action Plan (NBSAP) in 2000, "Strengthening Management of Key Ecosystems" was listed as one of the chief project concepts to aid in the achievement of the country's top biodiversity objectives; since then there have been four subsequent reports to the CBD, the most recent in 2009 (Grenada Ministry of Finance 2000, 2009).

Grenada believes that the environment can be utilized to support and serve society while still leaving biodiversity intact. Failures to successfully achieve this goal of sustainable use is generally resultant of 6 main factors:

1. Ownership and management of land
2. A lack of proportionality between the growths of population and its supporting infrastructure
3. Shortsightedness regarding land use and environmental costs
4. Misdirected Economic Incentives
5. Overexploitation of vital resources such as fish, wetlands, and freshwater
6. Failures of National Policy and lack of enforcement (Grenada Ministry of Finance, 2000)

There are a number of governmental and non-governmental bodies that share the management and legislation of Grenada's environment. As of 2000, these organizations appeared to be troubled by mundane quotidian issues, such as problems with human resources, databases, and general operations (Grenada Ministry of Finance 2000). As of

2009, there were still issues; the NBSP was not fully in place because of "the impact of hurricanes on the ecosystem and economy, the lack of political will and adequate funding for implementation, the lack of appropriate focus on environmental issues vis a vis socioeconomics consideration and the lack of clarity on the roles of the different stakeholders and the associated turfism" (Grenada Ministry of Finance 2009).

Despite this, Grenada has made progress towards conservation, especially with the 2005 approval of the National Environmental Policy and Management Strategy and the 2007 approval of the National Strategic Development Plan; both documents commit the country to considering, maintaining, and improving the environment, especially with regard to development (Grenada Ministry of Finance 2009). In 2010, the country also finally approved a management plan for the MBMPA (Grenada Ministry of Agriculture Forestries and Fisheries 2010). Interestingly, the majority of positive advances to Grenada's biodiversity may have come out of the hurricanes themselves. The impact of these hurricanes was so great, their damage so widespread and severe, that it presented "a unique opportunity to integrate environmental management concerns into the country's development vision, strategy and program" (Grenada Ministry of Finance 2009).

2.2.7 Grenada: Protected Areas

Grenada first began considering a system of PAs in 1988, when they invited the Organization of American States (OAS) to assess the existing policies and recommend sites for future protection, at various levels. OAS recommended protection of a total of 43 sites, 27 on Grenada and 16 on Carriacou. Including the Grand Etang Forest Reserve that was already in existence, the suggested PAs would cover an area of 13% of the country. This report served as the basis for Grenada's environmental plan until 2006, when Grenada signed the Grenada Declaration, committing themselves to protect 25% of all terrestrial areas and 25% of marine areas by 2020 (Turner 2009a). Current percentages of marine and terrestrial areas that are protected can be seen in Table 3.

Terrestrial Ecosystem	Percent Protected		Marine Ecosystem	Percent Protected
Transitional Cloud Forest	66		Seagrass	10
Cloud Forest	27		Intertidal Reef Flat	5
Evergreen Forest	25		Rocky Shore	4
Emergent Wetlands	22		White Sand Beach	2
Grenada Dove Habitat	11		Shelf Structure	2
Dry Deciduous Forest	1		Mangroves	1
Semi-deciduous Forest	2		Reef Flat	1
Drought Deciduous Forest	1		Fore Reef	2
Mixed Wood Agriculture	1		Leatherback nesting site	0
Streams	5		Hawksbill nesting site	0
Rivers	1		Black Sand Beach	0
Fresh Water bodies	1		Lagoonal Habitat	0
			Shallow Terrace	0
			Shoal	0

Table 3. Percent Area Protected in Grenada by Ecosystem
Source: Turner 2009a

Grenada's system of categorizing its PAs is somewhat different than that of the IUCN; a comparison chart can be seen in Table 4. There are currently 5 PAs and 2 MPAs in Grenada. PAs include the Grand Etang Forest Reserve; Annandale Forest Reserve; High North Forest Reserve; Perseverance Protected Area; and Unspecified Crown lands at Pears. There are currently 2 MPAs in the works in Grenada: Woburn/Clark's Court's MPA is established but not yet operational, while the Grand Anse MPA is still in the planning stages (Grenada Marine Protected Areas 2012). The two functional MPAs are Sandy Island/Oyster Bay MPA in Carriacou and the Molinière/Beauséjour MPA (Turner, 2009b).

IUCN Category		Grenada Protected Area Category
Ia	Strict Nature Reserve	• Marine Protected Area - marine sanctuary • National Park • Protected Area - preservation for scientific importance
Ib	Wilderness Area	• National Park
II	National Park	• National Park • Marine Protected Area - marine park
III	Natural Monument or Feature	• Marine Protected Area - marine historical site • Heritage Conservation Area • Protected Area - preserving a historic event or historic or cultural object
IV	Habitat/Species Management Area	• Marine Protected Area - marine reserve • Protected Area - preserving natural beauty
V	Protected Landscape/Seascape	• Marine Protected Area - marine park • Protected Area - preserving natural beauty • Protected Area - creating a recreation area
VI	Protected Area with sustainable use of natural resources	• Marine Protected Area - marine park • Marine Protected Area - marine reserve • Forest Reserve

Table 4. Comparison of IUCN Categories with Grenada PA Legislation
Source: Turner 2009a

2.2.8 Molinière/Beauséjour MPA

The Molinière/Beauséjour Marine Protected Area (MBMPA) is a multiuse, multi-zone MPA located in the parish of St. George's in the Southeast of Grenada (Grenada Ministry of Agriculture, Forestry, and Fisheries 2010). The only MPA in mainland Grenada, the MBMPA has a diverse stakeholder group that includes adjacent communities, businesses, and industries (Gombos *et al.* 2011; Baldeo *et al.* 2012b; Robertson, 2003). The park is rich in biodiversity: a reef complex, including coral, gorgonians, and sponges, proliferates in approximately 2/3 of the park, fostering a rich community of reef species, particularly fish (Gombos *et al.* 2011; Baldeo *et al.* 2012b; Tables 5 and 6, Appendix 1).

Genus	Species	Common name
Agaricia	agaricites	Lettuce coral
Agaricia	fragilis	Fragile saucer coral
Agaricia	lamarcki	Lamack's sheet coral
Colpophyllia	natans	Boulder brain coral
Dendrogyra	cylindrus	Cathedral or pillar coral
Dichocoenia	stokesii	Elliptical star coral
Diploria	clivosa	Encrusting brain coral
Diploria	labrynthiformis	Grooved brain coral
Diploria	strigosa	Symmetrical brain coral
Eusmilia	fastigiata	Smooth flower coral
Favia	fragum	Golf ball coral
Isophyllastrea	rigida	Rough star coral
Madracis	auretenra	Yellow pencil coral
Madracis	decactis	Ten ray star coral
Manicina	areolata	Rose coral
Meandrina	meandrites	Maze coral
Millepora	complanata	Blade fire coral
Montastrea	annularis	Boulder star corarl
Montastrea	cavernosa	Great star coral
Mussa	angulosa	Spiney flower coral
Mycetophyllia	danaana	Low ridge cactus coral
Palythoa	caribaeorum	White encrusting zoanthid
Porites	astreoides	Encrusting coral
Siderastrea	radians	Lesser starlet coral
Siderastrea	siderea	Massive starlet coral
Stephanocoenia	intersepta	Blushing star coral

Table 5. Reef Building Coral (Phylum Cnidaria) species recorded in the MBMPA in 2006
Source: Grenada Ministry of Agriculture Forestry and Fisheries 2010

Genus	Species	Common name
Amphimedon	compressa	Erect rope sponge
Aplysina	fistularis	Yellow tube sponge
Aplysina	fulva	Scattered pore rope sponge
Callyspongia	plicifera	Azure vase sponge
Callyspongia	vaginalis	Branching vase sponge
Iotrochota	birotulata	Green finger sponge
Ircinia	felix	Stinker sponge
Ircinia	strobilina	Black ball sponge
Neopetrosia	subtriangularis	Sprawling sponge
Pseudoceratina	crassa	Branching tube sponge
Scopalina	ruetzleri	Orange lumpy encrusting sponge
Spheciospongia	vesparium	Loggerhead sponge
Verongula	gigantea	Netted barrel sponge
Verongula	rigida	Pitted sponge
Xestospongia	muta	Giant barrel sponge

Table 6. Marine Sponges (Phylum Porifera) species recorded in the MBMPA in 2006
Source: Grenada Ministry of Agriculture Forestry and Fisheries 2010

The MBMPA encompasses approximately 160 hectares and is spread over 4 bays: Molinière, Dragon, Flamingo, and Beauséjour (MBMPA Warden 2013). The MBMPA falls under the jurisdiction of the Fisheries division and follows an adaptive management plan. It was originally designated in 2001, but had no management plan, and thus no enforcement, until 2010 (Grenada Ministry of Agriculture, Forestry, and Fisheries 2010). The MPA has an incredible coral reef system and is most commonly used for fishing, yachting and boating, and snorkeling and SCUBA diving. It is home to the world's first underwater sculpture park, located in Molinière Bay(Grenada Ministry of Agriculture, Forestry, and Fisheries 2010).

The long term goal for the MPA was defined as the sustainable use of its resources so as to promote and provide "livelihoods and a viable ecosystem for current and future generations" (Grenada Ministry of Agriculture, Forestry, and Fisheries 2010). The main objectives of the MPA are:

1. "Protection, rehabilitation, and management of coral reefs and other coastal ecosystems,
2. Protection, and management of biodiversity, stocks, habitats and nursery areas,
3. Provide educational opportunities for the locals and visitors alike,
4. Provide aesthetic enhancement of the area, and
5. Minimize user conflicts among the resource users." (Robertson 2003)

Stakeholders of the MPA include the surrounding communities of Brizan (population 367); Beauséjour (pop. 417); Happy Hill (pop. 786); Molinière (pop. 356); Grand Mal (pop. 717); and Mt. Moritz (pop. 596). There are also formal organizations: the Grenada SCUBA Diving Association (GSDA); Mooring and Yachting Association of Grenada (MAYAG); Grenada Community Development Agency (GRENCODA); and the Molinière/Beauséjour Marine Protected Area (MBMPA) Stakeholder Committee. Lastly there are unofficial groups who utilize the MPA, such as fishermen; tourists; students; and local Grenadians using the MPA for recreation (Baldeo et al., 2012b; Robertson, 2003).

The MBMPA faces threat to its resident species, especially mangroves, sea grass, coral, turtles, and fish (Grenada Ministry of Agriculture, Forestry, and Fisheries, 2010). Some of these threats are natural – for example, much coral has been destroyed in the last 10 years due to strong storm surges. However, the majority of the threats come, either directly or indirectly, from human use of the park and the surrounding areas (Grenada Ministry of Agriculture, Forestry, and Fisheries, 2010). Before the MBMPA was put into place, fishing had greatly impacted the local fish populations; sand mining led to increased erosion; and polluted tributaries contributed to the degradation of coral reefs (Grenada Ministry of Agriculture, Forestry, and Fisheries, 2010). These threats and others will be covered in more detail during the analysis of the MTRA.

CHAPTER 3: METHODOLOGY

3.1 Overview

Research was conducted at and around the MBMPA over the span of 4 weeks; both quantitative and qualitative research methods were utilized. Quantitative methods included the execution of the MTRA workshop. Qualitative methods that began before the on-site study in Grenada were mainly comprised of archival analysis. Further on-site qualitative methods included interviews and meetings with staff and stakeholders as well as participant observation. The research resulted in an MTRA index for the MBMPA accompanied by an analysis of the threats, their context, and their drivers.

3.2 Qualitative Research

3.2.1 Archival research and literature review

In order to fully understand the research question, the first step in the research process was to perform an archival review. The goal of the literature review was to better understand the background and milieu of both the research question and location. To investigate background on the research question, books, journals, reports, scholarly articles, and reputable websites were utilized to review areas such as biodiversity, PAs and MPAs, Protected Area Management Effectiveness, TRAs, and MTRAs. Previous MTRA reports were consulted, most notably Anthony 2008; Matar 2009; Matar and Anthony 2010; Anthony and Matar 2012; and Anderson 2012.

To contextualize the location of the research, the researcher explored Grenadian geography, history, economy, environmental policies, and biodiversity, as well as Grenada's

PAs, MPAs, and the MBMPA. Literature consulted included scholarly articles and journals, reputable websites, an IUCN Redlist Report on Grenadian Biodiversity, and reports provided by the staff of the MBMPA. Google Earth was consulted to gain an orientation of the geography of the MBMPA and its surrounding area before research in the country began.

3.2.2 Participant Observation

Much information about the park was gained through participant observation, by joining the MBMPA staff on their daily patrols of the park. The researcher accompanied a total of 4 staff members (3 wardens, 1 Jr. warden), the chairman of the MBMPA Management Board (MBMPA-MB), and 1 staff member of the Agriculture Division on a total of 8 patrols. Patrols of the MBMPA are performed once or twice daily, 7 days a week, for a duration of 2-5 hours; the patrols occur during the day, as the MPA does not currently possess the necessary equipment for night patrols. Patrols involve a minimum of 2 staff members driving the MBMPA patrol boat around the MBMPA with the purpose of monitoring activity in the MBMPA, testing and recording the physical characteristics of the various bays, and collecting fees from non Grenadian MBMPA users (Grenada Ministry of Agriculture Forestry and Fisheries 2010).

Patrols were an invaluable portion of the research, as it allowed for the threats to be witnessed firsthand: of the thirteen threats, nine were seen occurring while out on patrol. It was possible to see the threats while they happened in real time, to watch the wardens respond, and hear the wardens discuss the threats with each other and/or with stakeholders. The wardens would explain in detail the circumstances surrounding the threat; any applicable history; and the direct and indirect drivers of the threats. Inevitably every explanation led to a host of new questions, and the wardens painstakingly answered every last one. It was through the time on patrols that it became evident why the threats were occurring, and what existing factors were helping or hindering the management from effectively mitigating that threat. Additionally, the wardens introduced local stakeholders and pointed out notable features of the park and the surrounding geography. In order to record these events, the researcher took more than 500 photographs and some written notes while on the boat. Off the boat, the researcher recorded notable events and their locations.

3.2.3 Interviews

Nine interviews were conducted while in Grenada: 1 meeting with the owner of the only Grenadian-owned dive shop on the island, Native Spirit Scuba; 2 meetings with the dive owner and dive staff of the shop, including a tour of the Southern portion of the island to see the University and the Coast Guard station; 1 meeting with the MPA coordinator and the Sr. Warden; 1 meeting with the wardens and the coordinator of the Melville St. and Gouyave Fish markets; and 4 meetings with wardens that included excursions to Beauséjour, Grand Etang Forest Reserve, and a tour of the Gouyave fish processing plant.

All people were aware of the researcher's purpose in Grenada as a student researching the Management Effectiveness of the MBMPA, and key points or areas for further investigation were noted during or immediately following the meetings. The structure of the interviews was based on the subject of the interview as well as the situation itself. For this reason, the majority of interviews were semi-structured or unstructured and often occurred organically, rather than being planned beforehand. Relaxing and having a snack after a scuba dive turned into an opportunity to discuss the issues that the divers saw with the workings of the MPA, while an outing to a local fair led to a tour of the Gouyave fish market.

3.2.4 Stakeholder meeting

Additionally, the researcher attended a presentation and meeting led by the chairman of the MBMPA-MB, Stephen Nimrod of St. George's University. The presentation, titled "Consultation workshop with Farmers Organization in the Beauséjour Watershed area, Grenada" was held on March 18, 2013 at the Willis Community Centre, St. George's (Nimrod 2013). Mr. Nimrod's work focuses on the abundance of macroalgae growth on coral in the MBMPA; he is researching the nutrient and sediment levels in the MBMPA watershed and the MBMPA itself and investigating the direct and indirect causes of this pollution (Nimrod 2013). The meeting was an interesting look into how seriously indirect issues can impact MPAs.

It was also an exemplary show of stakeholder education, engagement, and involvement; following the meeting, both Mr. Nimrod and the Farmer's Organization had come to mutual agreements of some potential solutions and ideas for future investigation. As a majority of the farmers had never been to the MBMPA, despite living about 15 minutes away, an excursion to the MBMPA was planned for the near future; since many of the farmers also couldn't swim, it was decided that a glass-bottomed boat tour would be organized. The researcher took notes during the meeting and spoke with wardens and Mr. Nimrod following the meeting; Mr. Nimrod also kindly provided the researcher with a copy of the presentation.

3.3 Quantitative Research

3.3.1 MTRA Workshop

The basis of the quantitative portion of research was the Modified Threat Reduction Assessment (Anthony 2008). The MTRA workshop was held on Tuesday, March 19 in the MPA Office located above the Melville St. Fish Market in St. George's; the meeting lasted for 3.5 hours. Experts were selected based upon recommendations made by the MPA Coordinator and the Sr. Warden in a preliminary meeting. The experts were chosen based on their knowledge of the area and their expertise related to the MPA, and attended based on their availability. Experts included two wardens; one Sr. Warden; the Operations Manager of the MPA; a colleague and future employee of the Woburn/Clarke's Court Bay MPA; the head of the North West Developer's Association,; and the coordinator of the MPA, (who was only able to join for a portion of the workshop).

The meeting began with an introduction of the facilitator and the research project; after receiving permission from all of the experts, the facilitator used a small handheld audio recorder to record the duration of the meeting. Experts were each given a packet of information, which included 4 documents:

1. "Modified Threat Reduction Assessment Workshop" which included an explanation of the project as well as the steps that would be taken during the workshop. It was

based on information from Margoluis and Salafsky 2001, Anthony 2008, Matar and Anthony 2010, Anderson 2012, and Salafsky and Margoluis 1999 (Appendix 2)

2. "A Standard Lexicon for Biodiversity Conservation: Unified Classifications of Threats and Actions" (Salafsky, *et al.* 2008) which listed the threats and numbers of the IUCN classification scheme (Appendix 3)
3. "Definitions of Threats and Mitigations" which included spaces for the experts to log the threat name and description as well as its rank and the percent it had reduced or increased (Appendix 4)
4. "MTRA Index" which was a chart experts could fill in regarding the threat's name, corresponding IUCN Threat Number, and other ranks and percentages related to the final MTRA Index (Appendix 5)

The experts were given some time to look over the documents, and any questions were clarified. Then the parameters of the MTRA were defined per Salafsky and Margoluis' (1999) TRA approach. The chosen baseline year was 2010, as September 7, 2010 was the date that the MBMPA first engaged in active management (Baldeo *et al.* 2012b). The target condition "is assumed to be the biodiversity of the site where the group is working" and more specifically "the species present (individual species), the area of habitat present and degree to which it is intact (habitat area and condition), and the degree to which the habitat is able to maintain target systems and processes (ecosystem functioning) (Salafsky and Margoluis 1999). The target condition was defined as the biodiversity of the MBMPA, and the extent of the area to be discussed was defined as the boundaries of the MBMPA.

The experts were led through the steps of the MTRA, first enumerating all threats, with the facilitator helping to discern between those that were pertinent and those that were indirect or from natural causes (Salafsky and Margoluis 1999). Even those threats which did not fit as part of the MTRA Index were important to note, as these threats frequently drive or exacerbate the direct, human-induced threats. As the threats were listed, experts were asked to determine what 100% mitigation of the threat would look like; if it was anything outside of a complete disappearance or removal of the threat, this was noted on the worksheet (Salafsky and Margoluis 1999).

Next the experts were asked to collectively rank the threats based on how they impacted the MPA related to three separate criteria, area, intensity, and urgency; they were also asked to supplement their opinions on these ranks with concrete examples from the PA (Salafsky and Margoluis 1999). This discussion frequently led to experts elaborating on possible solutions to the threats, and their opinions on the impediments to reaching these solutions. While off-task, these discussions were not off-topic; the solutions implicitly highlighted mechanisms that were not yet in place for the park, while the impediments generally shared the same underlying leitmotif.

Once a consensus was reached on the rankings, the threats were gone through one by one and individuals were asked to consider how the threat had changed since the baseline year. Using the MTRA model, a positive percentage was assigned to any threat that had been reduced and a negative value was assigned to any threats that had worsened (Anthony 2008). Experts were informed that while 100% was the largest positive number a threat could receive, there was no upper limit for negative numbers. They were also told that any new threats should be noted, and would automatically receive a -100% (Anthony 2008).

It was agreed that the facilitator would calculate the final MTRA Index; this is done using the formula ***(∑ Raw Score) / (∑ Final Rank) * 100*** (Salafsky and Margoluis 1999). The facilitator would also assign each threat with a corresponding standard threat number using Salafsky et al.'s Index (2008). Both the index and the standardization of the threats actions increase the comparability of the results to other PAs (Anthony 2008). Standardization can also be useful when analyzing. Before closing the workshop, there was an opportunity for the experts to give feedback and reflect on the MTRA process.

3.4 Limitations

As the MTRA uses the change in threats as the measurement for conservation success, it inherently relies on human opinion, and this can lead to both subjectivity and bias (Salafsky and Margoluis 1999). The results may be skewed if the participants allow their personal opinions and emotions to influence their answers; in order for the results to be accurate, the participants must attempt to stay honest and unbiased. The experts were chosen for this workshop as they were deemed to possess the most knowledge about the activities and threats to the MPA. Another limitation, however, is the extent of information available to anyone, including the experts and the researcher.

During the process of creating a map to investigate the locations of the various threats, the researcher realized that the coordinates given in the MBMPA Management Plan (Grenada

Ministry of Agriculture, Forestry, and Fisheries) were incorrect. Furthermore, there were inconsistencies between the maps in the Management Plan (one from the Ministry and one from USAID) and the maps that the parks and the board members were using on signs and public outreach media. The inconsistencies can be seen in Figure 10. After discussing these inconsistencies with an MPA Warden, it was confirmed that the coordinates in the MPA Plan were incorrect, as were the maps in the document. The correct border of the MPA is the one delineated by the demarcation buoys in the MPA (Figure 11); the closest correct representation of that is the map used on the signs and in presentations (e.g. Nimrod 2013), and can be seen in Figure 12.

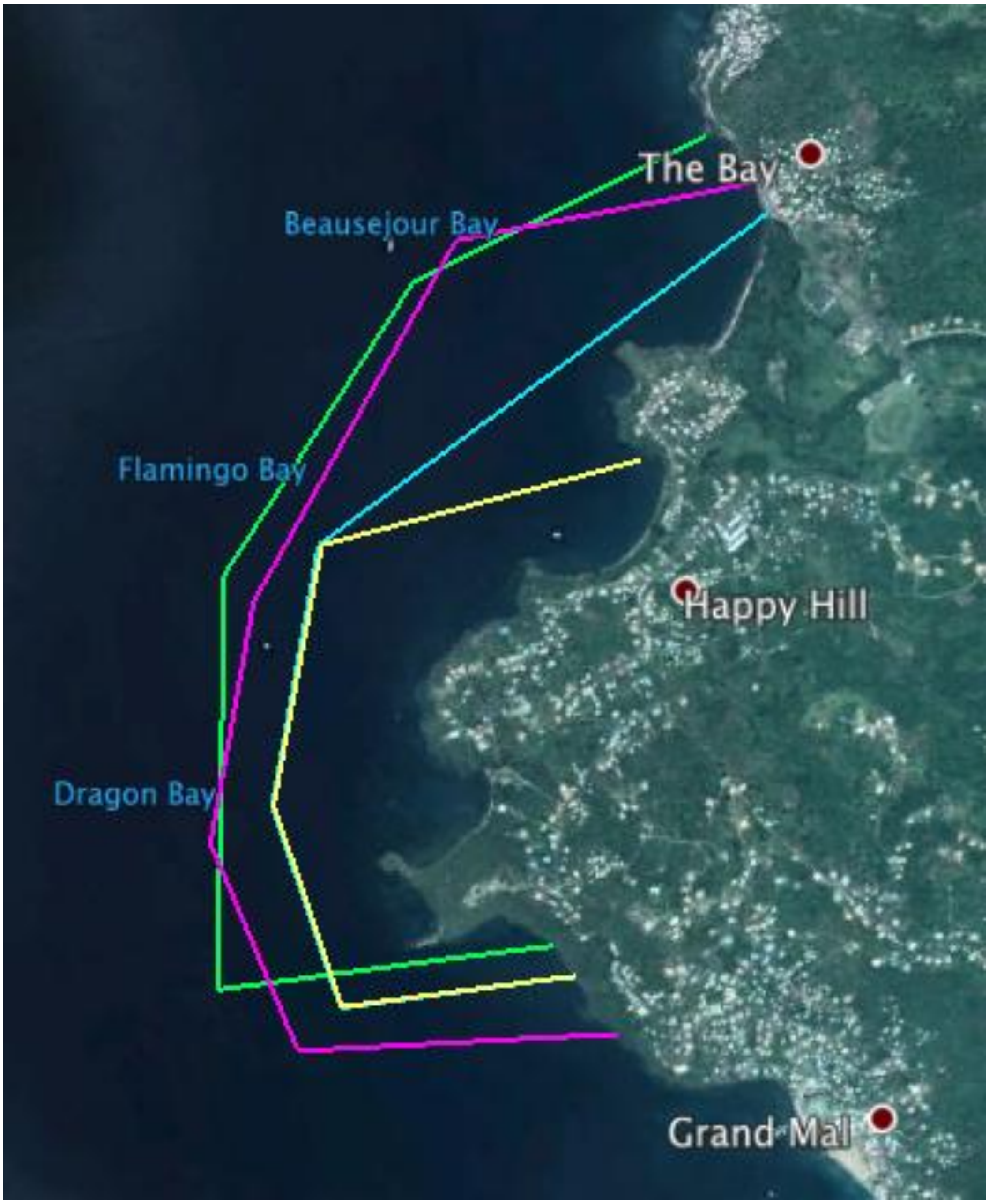


Figure 10. Inconsistencies in the MBMPA Maps
Sources: The researcher produced the map in Google Earth using maps from Ministry of Agriculture, Forestry, and Fisheries 2010; Nimrod 2013; and the researcher's photographs of maps at the MPA.

Figure 11. Sula leucogaster (Brown booby) on an MPA demarcation buoy
Source: author

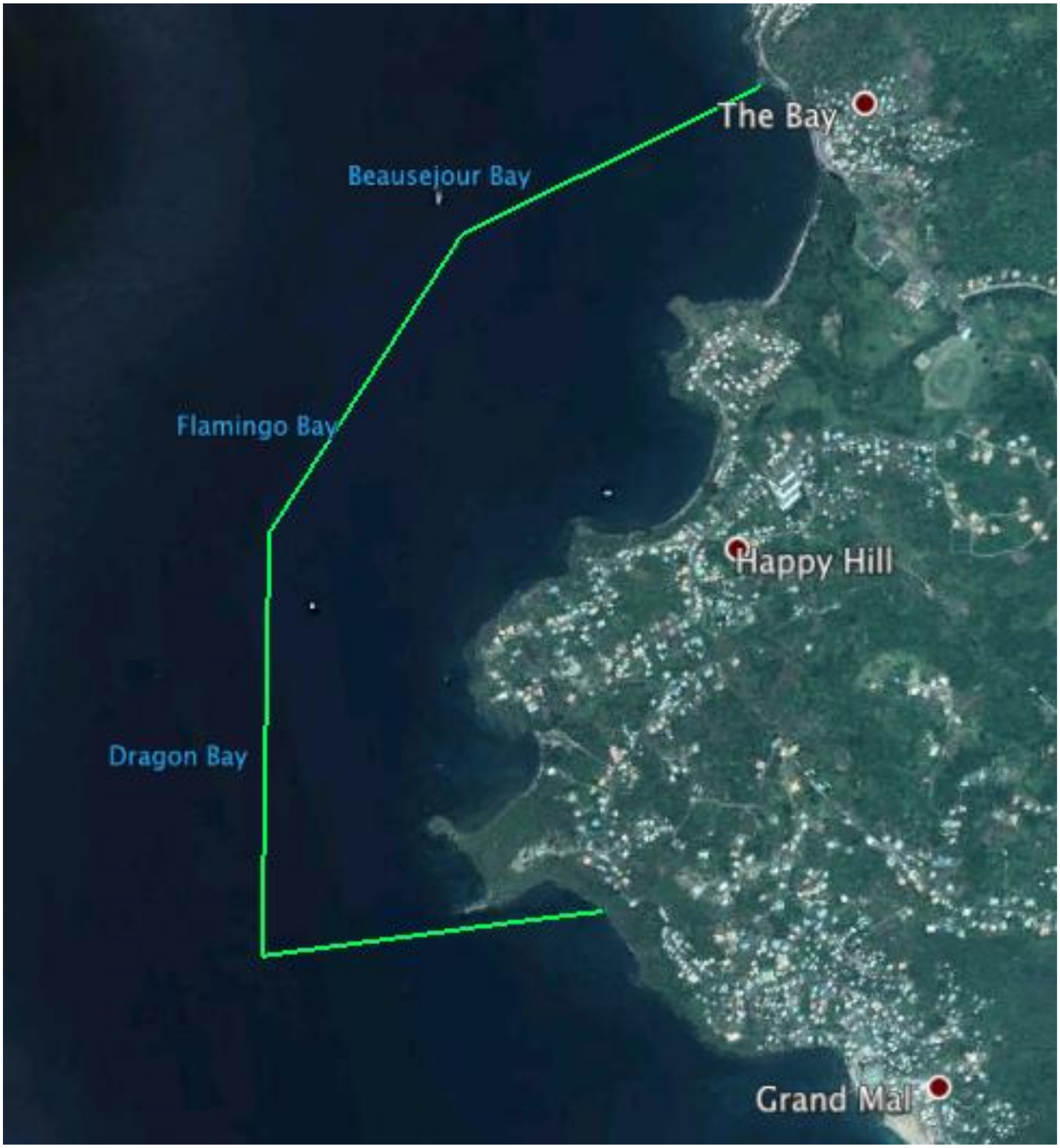


Figure 12. Correct map of the MBMPA
Source: author

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This section presents the results of the MTRA Workshop. First the MTRA Index is shown in table form. Then threats are discussed, organized by the first standard classification level (Salafsky *et al.* 2008; Appendix 3). Each threat is presented with its final rank score as well as the percent change ascribed to it by the experts. The threats are then described, and an explanation of what 100% mitigation of that threat would look like is given. External threats and drivers are also given. This section includes photographs that the researcher took; these photographs are included to be illustrative of the points given, and should be seen as supplementary qualitative, not quantitative, representations of the threats. A section will follow with other threats that did not fit the specifications of the MTRA. Finally, there is a discussion of the research and the results.

No.	Threat Name	Threat Description	100% Mitigation	IUCN Category	IUCN Threat	Rank: Area	Rank: Intensity	Rank: Urgency	Rank: Final	% Threat Change	Raw Score
1	Perserverence Landfill	Pollution of water via runoff and air via fires.	Total elimination of pollution of MPA by Landfill	9	9.1	13	13	13	39	-40%	-15.6
2	Runoff from homes, farms, and industy	Pollution of water from homes and farms, as well as untreated drainage from nearby industry	Total elimination of polluted runoff into the MPA and into water surrounding the MPA	9	9.1 9.2 9.3	12	12	12	36	-30%	-10.8
3	Uncontrolled development	Excavation and construction on homes and roads surrounding MPA lead to runoff and sedimentation	Total elimination of development without planning	1	1.1	11	11	10	32	-90%	-28.8
4	Sand mining	Mining destroys habitats, increases erosion and sedimentation	Total elimination of sand mining	5	5.4	10	10	11	31	-55%	-17.1
5	Beach seine fishing	Seine destroys seagrass bed and reefs	Total stoppage of beach seine fishing	5	5.4	8	8	9	25	-100%	-25
6	Invasive species: Lion Fish	Lion Fish - new to MPA since 2010	Total erradication of lion fish	8	8.1	9	9	5	23	-100%	-23
7	Spear fishing	Directly destroys the reef and reduces grazing species which also impacts reef health	Total erradication of spear fishing	5	5.4	7	7	6	20	75%	15

8	Habitat destruction	Any destruction of habitat from non-fishing human use of the MPA; mainly destruction of reefs from improper mooring	Total stoppage of habitat destruction	6	6.1	6	6	7	19	60%	11.4
9	Boat waste	Human effluent from yachts and solid litter from party boats when moored in the MPA	Total elimination of waste from boats entering the MPA	9	9.1 9.4	5	5	8	18	-60%	-10.8
10	Wildlife poaching	Turtles, turtle eggs, sea eggs	Total elimination of poaching	5	5.4	4	4	4	12	45%	5.4
11	Fires	Uncontrolled fires, frequently the result of slash and burn practices pollute air and water	Total elimination of uncontrolled fires	7	7.1	3	3	3	9	35%	3.15
12	Excessive tourism	Exceeding the carrying capacity of the park, particularly in the sculpture park	Not exceeding the carrying capacity of the MPA	1	1.3	2	2	1	5	-25%	-1.25
13	Rock fishing	Lines from rock fishing are dangerous to other species; e.g. recently found a dead turtle from a line	Total elimination of rock fishing within the MPA	5	5.4	1	1	2	4	-40%	-1.6
					TOTAL	91	91	91	273		-99

MTRA Index: Formula	**Σ Raw Score**	**Σ Rank**	**Raw Score / Rank**	**Convert to %**	**Final Index**
MTRA Index: Calculation	-98.95	273	-0.36	-36.2454	**-36.25%**

Table 7. MTRA Index with definition of threats and 100% mitigation

4.2 Pollution

Classification: "9. Pollution: threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources" (Salafsky *et al.* 2008). Pollution is far and away the most intense threat that the MBMPA faces; three of the 13 threats, including the top two threats that experts at the workshop listed, were related to pollution, from both point and nonpoint sources. A problem with the pollution that the MBMPA faces is that the sources are frequently outside of the bounds, and thus outside the jurisdiction, of the MBMPA. It is the waterways that flow into the MBMPA that bring the worst pollution. Some pollution does occur in the park, but experts rank this as less impactful than that from outside.

4.2.1 The Perseverance Landfill

The MBMPA experts listed the Perseverance Landfill as the number one threat to the MBMPA, with a final rank of 39. The threat has increased by 40% since 2010; experts see 100% mitigation of this threat as entirely eliminating pollution from the Perseverance Landfill. The landfill falls under classification 9.1: "Household sewage and urban waste water: water-borne sewage and nonpoint runoff from housing and urban areas that include nutrients, toxic chemicals and/or sediments" (Salafsky *et al.* 2008).

The landfill is located directly north of the MBMPA in Brizane. It has been plagued by fires in the past. People dig in the landfill for scrap metal; this exposes corroded metal, which exacerbates the issue of polluted runoff. Ammonia concentrations recorded from the mouth of the Salle River, which runs by the landfill, are off the charts at greater than 900µg/L (Nimrod 2013; Appendix 6). The water quality there is markedly different to the naked eye (see photos below); it is important to reiterate that these photos are a qualitative, not quantitative, addition to the research.

Figure 13. Comparison of water outside of the Perserverance Landfill (L) and in Dragon Bay within the MBMPA (R)
Source: author

4.2.2 Runoff from homes, farms, and industry

Pollution via runoff from homes, farms, and industry was found to be the second biggest threat to the MBMPA, with a final rank score of 36. It was found to have increased by 30% since 2010. Experts view 100% mitigation of this threat as being the total elimination of pollution from all point and nonpoint sources of runoff. Like the landfill, runoff also falls under classification 9.1 (Salafsky *et al.* 2008).

Upriver from the MBMPA, citizens use the river for a myriad of uses, including washing clothes and waste disposal. This isn't always far upriver either; directly at the mouth of the Beauséjour river, people frequently bring dirty bottles and cans to wash them before exchanging them as recycling (Figure 14). Directly south of the MPA there are two fish processing and packing plants. Waste from these plants flows through pipes directly into a drainage ditch, which flows into the sea (Figure 15).

Figure 14. People cleaning recycling at the mouth of the Beausejour River
Source: author

Figure 15. Waste from two fish processing plants' pipes empty in a rivulet (L) and drain into Grand Mal Bay (R)
Source: Author

In this category, farming is seen as the biggest culprit. The majority of farms are small scale; they are tended to by one or two people without much mechanized equipment for help. For this reason, many of the farms occur directly next to a water source – it cuts down on the distance that the farmer needs to travel to collect water for his or her crops. Grenada is naturally quite hilly, and terracing is not always utilized; thus, much fertilizer and sediments run directly and indirectly into the rivers. This is evidenced by the elevated concentration of phosphates in the local rivers. While the recommended levels of phosphorus vary depending on the body of water and the region it is in, here the recommended maximum level is 5μg/L. Phosphate levels near the MBMPA were recorded between 200 and 900μg/L (Nimrod 2013; Appendix 6).

The normal level of ammonia found in groundwater is between 2-12µg/L, depending on the location and the composition of the surrounding area. Levels higher than 12µg/L are indicative of fecal pollution (WHO 1996); the levels at the mouth of the Beauséjour River are 6-8 times that much. Many rural parts of Grenada lack proper water disposal and treatment systems, thus human waste is often disposed of as runoff to rivers and streams. This is a salient point, as ammonia can greatly impact fish health; fish subjected to low levels of ammonia are more prone to bacterial infections and show decreased growth rates (Francis-Floyd *et al.* 2012).

4.2.3 Boat Waste

Boat waste is the 9th most impactful threat to the MBMPA. It had a final rank score of 18 and was said to have worsened by 60% since 2010. Total mitigation of this threat would mean there would no longer be pollution from any of the boats in the MBMPA. This threat can fall under category 9.1 as well as "9.4. Garbage and solid waste: rubbish and other solid materials including those that entangle wildlife" (Salafsky *et al.* 2008).

Waste from the boats is particularly bad when yachts choose to release human effluent into the MPA. Wardens have reported seeing toilet tissue floating near yachts. From April 2011 – April 2012, 14,426 people paid to use the MBMPA in the form of snorkelers, scuba divers, and sailors (yachts) (Baldeo *et al.* 2012 *Laying the*

Groundwork). Of these three activities, yachts account for only 7% of park users, making their impact on pollution in the park disproportionately large (Baldeo *et al.* 2012 *Laying the Groundwork*).

4.2.4 Impacts, Drivers, and Solutions

On a global scale, two of the four biggest local threats faced by coral reefs are related to pollution: watershed-based pollution and marine-based pollution and damage (Burke *et al.* 2011). In Grenada, the eutrophication caused by the high nutrient content has caused a drastic increase in macroalgae in the MPA (see Figure XX). The macroalgae competes with the corals and also covers them, hindering photosynthesis; these both lead to a reduced growth rate, which makes the coral more vulnerable to breakage (Nimrod 2013).

A main driver to the issue of smaller scale pollution is a lack of awareness and a lack of knowledge. When Stephen Nimrod presented his findings about sedimentation and nutrients that were arriving in the MBMPA from upriver, the farmers were surprised. The majority of them had no idea that this was occurring; once they did, they were willing to take steps to modify their behavior in order to prevent the pollution of the park. It follows that a solution to help mitigate pollution would be more widespread education.

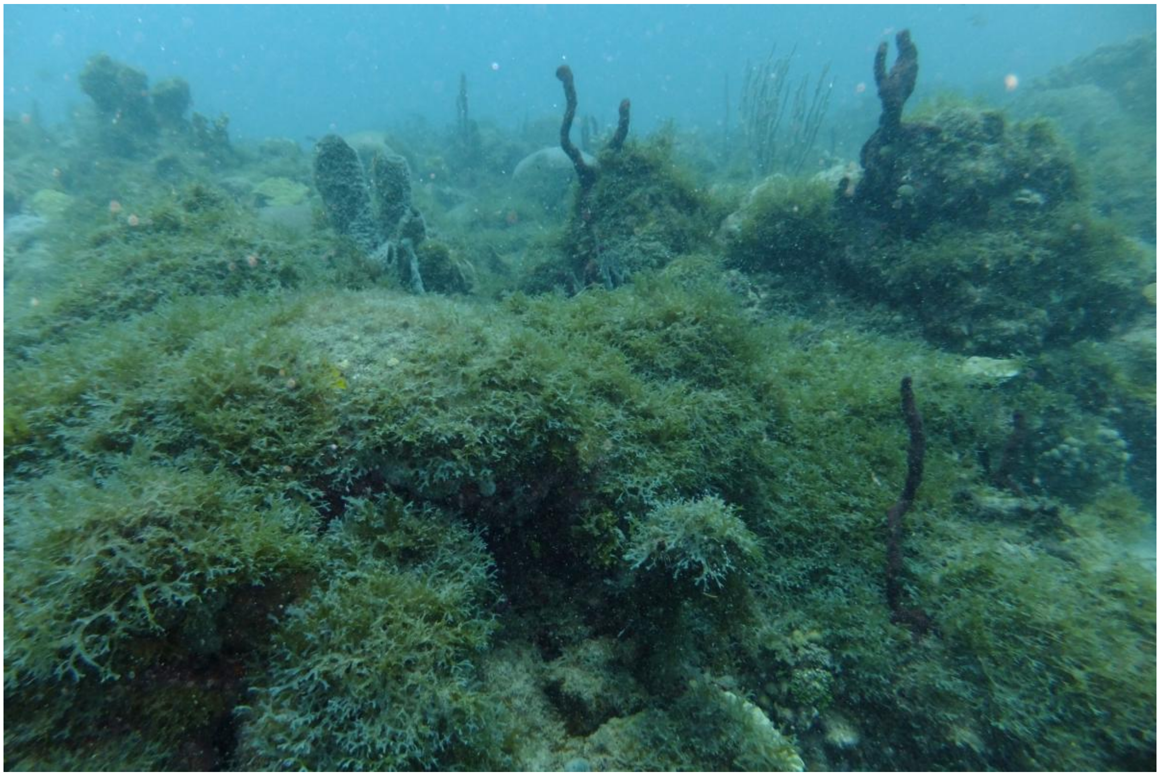


Figure 16. Microalgae in the MBMPA
Source: Steve Nimrod

This is something that the MBMPA is aware of; in the 2010 MBMPA Management Plan, "lack of awareness and ownership from users and local communities" was listed as an issue as was pollution, particularly "land-based and through watersheds: oil spills; Perseverance dump; Plastic; Nutrients from fertilizers; Untreated domestic sewage; Siltation; Litter from MPA users and adjacent settlements." (Grenada Ministry of Agriculture Forestry and Fisheries 2010). Suggestions to mitigate these issues included "public information campaigns" and "educate people about opportunities for waste reduction and develop recycling". Experts also frequently listed this as a key solution to improving the MBMPA. While this is occurring, as evidenced by Mr. Nimrod's presentation to the Farming Organization, it doesn't seem to be a common occurrence, as it was the only form of public outreach during the four weeks the researcher spent at the MBMPA.

4.3 Biological Resource Use

Classification "5. Biological resource use: threats from consumptive use of 'wild' biological resources including deliberate and unintentional harvesting effects; also persecution or control of specific species" (Salafsky *et al.* 2008).

Biological resource use is the most prevalent threat that the MPA faces, with five of the 13 threats falling into this category. Of the five activities, three are legal in certain capacities and areas of the park; this makes the category particularly tricky, as it requires finding a balance that adequately cares for the MBMPA ecosystem as well as its stakeholders.

4.3.1 Sand mining

Sand mining was 4th among threats, with a final rank score of 31. Overall it has increased by 55% since 2010. 100% mitigation of this threat would mean no sand mining whatsoever within the MBMPA. This threat can be classified as "5.4 Fishing and harvesting aquatic resources: harvesting aquatic wild animals or plants for commercial, recreation, subsistence, research, or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch" (Salafsky *et al.* 2008).

Sand mining is the extraction of sand to be used in the construction business to make concrete; it was traditionally done by hand, but in recent times may also be done with large machinery. Thirty years ago, the intense sand mining that was occurring in Beauséjour Bay was enough to support the families doing it. Since then, the coastline has receded by 6-9 meters (Grenada Ministry of Agriculture, Forestry, and Fisheries 2010). While interviewing stakeholders, one mentioned that when he was a child in the 60s, the beach at Dragon Bay was long and wide enough to hold two full soccer matches. While the length remains, erosion has reduced the beach to a couple meters in width. This is problematic, as coastlines are vital in stopping saltwater intrusion into freshwater sources and protecting from flooding associated with hurricanes and tidal surges (Singh 2010, Secretariat of the CBD 2010). The eastern portion of the island, including settlements such as Beauséjour, are already more prone to flooding since they are flatter than the majority of the country.

Unlike all other threats, the change reported for this threat was very erratic, with the threat steadily decreasing over time before an increased spike in the previous month. The main driver behind this is political. Sand mining was legal in designated sites under the NNP, but was banned under the National Democratic Party, who took power in 2008. In February of 2013 the NNP regained power, and ended the ban on sand mining. Experts reported that while illegal sand mining still continued during the ban, particularly in Beauséjour Bay, they saw it steadily decrease. When the ban ended, the market increased drastically, and there was a spike in illegal mining activity bad enough to negate the decreasing trend of the last years.

Figure 17. Dragon Bay
Source: Author

4.3.2 Beach seine fishing

Beach seine fishing (Figure 18) was 5th among threats, with a final rank score of 25. Experts saw seine fishing increase by 100% since 2010. Seine fishing also falls under classification 5.4 (Salafsky *et al.* 2008). The experts defined 100% mitigation of the threat as the total elimination of seine fishing.

Figure 18. Seine Fishermen in Dragon Bay
Source: author

Beach seine fishing is permitted in the MBMPA, provided that the mesh of the net is not smaller than regulation (Baldeo *et al.* 2012 Strengthening Stakeholder). Seine fisherman in the MBMPA utilize basic seine nets and purse seine nets. Small areas in Dragon and Flamingo Bays and the entirety of Beauséjour Bay are designated as fishing priority areas. Some seine fisherman commonly target smaller fish, such as Caran latus (Jacks) and Decapterus macarellus (Scad) which can be eaten or used as bait for larger fish. Grenada Ministry of Agriculture, Forestry, and Fishery's 2010 report listed Couvalli, Robin, and Bonita as the other main targets of seine.

When the experts decided that total mitigation of this threat would mean no more seine fishing in the MBMPA, they understood that this is unlikely to happen since the MBMPA is a multi-use area. Furthermore, seine fishing is an important part of the local economy and the local culture, and the experts recognize its importance. However, they believe that the level of fishing is unsustainable, and that too many fish are being taken by too many fisherman. They described the detrimental impacts that seine nets have on the ecosystem, namely the broad destruction caused to seagrass beds and coral reefs from the nets dragging along them. They also noted that there had been an increase in seine fishing since 2010.

4.3.3 Spear fishing

Spear fishing was 7th of the 13 threats with a final rank score of 20. Spear fishing decreased by 75% since the year 2010, one of only four threats that saw positive change. Spear fishing is illegal in the MBMPA, and so 100% mitigation would be if the ban was followed and there was no further spear fishing. Spear fishing falls under classification 5.4 (Salafsky *et al.* 2008).

Spear fishing directly and indirectly destroys the coral reefs in the MBMPA. Directly, the impact of the spears can cause damage to the reefs by breaking or dislodging pieces of coral. Indirectly, spear fishing reduces the population of grazer fish, which changes the structure of the trophic levels. A reduced grazer fish population allows the already overabundant macroalgae population to continue to grow unchecked, which is extremely detrimental to the health of the coral.

Spear fishing has been difficult to enforce in the past. Experts report that it is hard to catch the illegal fishermen in the act; recently the staff noticed a man who was spear fishing, but the man dropped his bag and spear before they reached him, thus making a conviction impossible. It is also difficult to apprehend spear fishermen because it is frequently an activity that occurs at night and in the very early morning, and the MBMPA patrol boat and staff are not equipped for night patrols.

However, there has been some progress. First, the experts believe that through education and public awareness of the laws, spear fishing in the MBMPA has fallen greatly. For those that continue to spear fish illegally, there have been some ramifications; in April 2013 two men were convicted of spear fishing in the MBMPA. The men were fined more than $2000EC each (Grenada Advocate 2013).

4.3.4 Wildlife poaching

Wildlife poaching is 10th of 13 threats, with a final rank score of 12. Since 2010, poaching in the MBMPA has decreased by 45%. Poaching falls under classification 5.4 (Salafsky *et al.* 2008). The poaching in the MBMPA relates mainly to turtle eggs, though the poaching of sea eggs and conch have also been problematic.

Tripneustes ventricosus (sea eggs) and strombus gigas (conch) are two other species which are illegally poached within the MBMPA. Both are collected for food, and the conch shell is also sold as a decoration. Sea eggs are grazers, and serve an important role in keeping the health of the ecosystem in balance; a dearth of sea eggs is one of the contributors to the overabundance of algae in the park. The MBMPA has worked to educate the public, particularly fishermen, about the regulations relating to sea eggs and conch both within and outside the park (see educational flyers, Appendix 7).

According to the 2010 MBMPA Management Plan, Dermochelys coriacea (leatherback turtles) have used Beauséjour Bay as a nesting site and Eretmochelys imbricata (hawksbill turtles) have nested in Flamingo Bay. Stakeholders who have long lived in the area say that leatherbacks used to frequently use Dragon Bay as a nesting site as well, and that in March 2013 a leatherback came onto the shore and dug around, but did not lay her eggs. The stakeholder reported something very promising – that when young men in the area realized a turtle had come onto the shore, they went out of their way to ensure that no humans disturbed it. It is this changing attitude, combined with successful patrol of the area, that are the reasons behind the decrease in wildlife poaching.

4.3.5 Line fishing

Rock fishing is the threat of least concern in the MPA. It has a final rank score of 4 and has increased by 40% since 2010. Like the other threats in this category it falls under classification 5.4 Fishing and Harvesting Aquatic Resources, but could also fall under 9.4 Garbage and Solid Waste (Salafsky *et al.* 2008). Experts said that total eradication of line fishing to achieve 100% mitigation of the threat.

In the MBMPA, to fish with a hook and line you must be on land: it is illegal to fish with a line from a boat, as boats are only allowed to be used in seine fishing. The fishermen generally fish from the rocky cliffs that jut out between the bays, thus the name rock fishing. Rock fishermen fish both for subsistence as well as to sell at market, with catches mainly consisting of reef and pelagic fish. Like seine fishing, rock fishing is both culturally and economically important to the communities surrounding the MBMPA.

Experts report that since restrictions have been put in place on the types of fishing that can occur in the MBMPA, the number of rock fishermen have increased substantially. They believe that the current take from the rock fishermen is unsustainable and negatively impacting fish populations and thus the balance of the reef ecosystem. A second issue with rock fishing is the line. Lines frequently get caught and lost, tangling on reefs and rocks and endangering wildlife. Experts report that quite recently a dead turtle was found wrapped in fishing line, and the researcher witnessed a Sula leucogaster (Brown booby) with fishing line hooked to its wing.

4.3.6 Impacts, Drivers, and Solutions

The harvesting of sand has resulted in a loss of beaches, while fishing and poaching has lead to a loss of aquatic animals. The overall impact of these threats is a degradation of the MBMPA via the harvesting of resources; in all cases, the removal of biotic and abiotic components result in a disruption or an imbalance, and leaves the ecosystem less able to function. In some areas MBMPA staff have been able to make important strides forward with education and patrols. A hindrance to further mitigation of these threats is that these threats can be happening during the night and in the early hours of the morning, while the MBMPA staff are only able to patrol during the day, and only have the staff to patrol for a third of the day, at most. Another issue with some of these threats, like seine and rock fishing is that they are legal; the activities have grown as people follow the regulations of the MPA.

One of the drivers of these threats is a lack of awareness. The majority of Grenadians care about their country and their wildlife; when they are informed, they are often willing to make changes to care for the environment, as seen with the turtles and the poaching. The main driver behind these threats, however, is economic. There have always been many fisherman in Grenada, but experts and stakeholders agree that with the economic downturn more people are fishing, both as income and subsistence.

Experts recognize the importance of fishing to the communities that surround the MBMPA (some of the experts are fishermen themselves), and don't expect that the fishing will ever be totally eliminated from the MBMPA; however, they do believe that as long as there is fishing it will remain a threat. In order to ameliorate the impact, it will be important to really understand the carrying capacity of fishing in the MBMPA, and to adapt the regulations accordingly. In order to mitigate the threats that are occurring illegally, a huge step would be to have night patrols. To do this the MPA would need to invest in lights for the boat, staff may require special training, and schedules would need to be reorganized to accommodate the new hours. Experts believe this is possible to achieve, as the MPA in Carriacou has been successfully carrying out night patrols.

4.4 Residential and commercial development

Classification: "1. Residential and commercial development: human settlements or other nonagricultural land uses with a substantial footprint" (Salafsky *et al.* 2008).

4.4.1 Uncontrolled development

Only one threat falls into the category of residential and commercial development, and that is uncontrolled development. Uncontrolled development is the 3rd biggest threat to the MBMPA; it has a final rank score of 32 and has gotten 90% worse since 2010. Experts define this threat as excavation and construction on homes and roads in the surrounding area, which leads to runoff and sedimentation within the MPA. 100% mitigation would be total elimination of development without planning.

This threat can fall under classifications 1.1, 1.2, and 1.3.
Classification 1.1 is "housing and urban areas: human cities, towns, and settlements including nonhousing development typically integrated with housing"; classification 1.2 is "commercial and industrial areas: factories and other commercial centers"; and classification 1.3 is "tourism and recreation areas: tourism and recreation sites with a substantial footprint (Salafsky *et al.* 2008).

In 2004 and 2005, hurricanes Ivan and Emily caused severe damage to Grenada decimating much of the country. Ivan was particularly bad: infrastructure was destroyed, crops and trees were ruined, and more than 90% of homes were damaged (Associated Press 2004). Following these hurricanes, there was a nationwide rebuilding effort that is still ongoing. All parts of Grenada are dotted with the cement skeletons of houses, either abandoned after the hurricanes or in the process of being built. This rebuilding effort is coupled with some new construction that is occurring in the travel industry, though that has slowed compared to previous years thanks to the global recession (Grenada Ministry of Finance 2009).

Singh (2010) states that the construction "is done with relatively weak planning control and weak enforcement and monitoring for compliance within the EIA process". This is the concern raised by experts as well; a lack of planning is leading to waste and pollution, which is washed into the rivers and into the MBMPA. Their suggestion for fixing the problem is stronger enforcement of building regulations; unfortunately, the construction all occurs outside of the bounds of the MBMPA, and so they cannot take an active role in mitigating this threat.

4.5 Human intrusions and disturbance

Classification: "6. Human intrusions and disturbance: threats from human activities that alter, destroy and disturb habitats and species associated with nonconsumptive uses of biological resources" (Salafsky *et al.* 2008).

Two threats fall under the umbrella of human intrusions and disturbance: habitat destruction and excessive tourism. While these two threats are similar in that they result in the degradation of the MBMPA from the use of mostly foreign users, the experts felt they were distinct enough to keep them as two separate threats.

4.5.1 Habitat destruction

Habitat destruction is 8th among the 13 threats. It has a final rank score of 19 and has improved by 60% since 2010. The experts defined this threat as any destruction of habitat from non-fishing human use of the MPA; the most common and impactful example of this threat is the destruction of reefs from improper mooring. 100% mitigation of this threat would mean total stoppage of habitat destruction. Habitat destruction is classified as "6.1. Recreational activities: people spending time in nature or traveling in vehicles outside of established corridors, usually for recreational reasons" (Salafsky *et al.* 2008).

An errant anchor can cause vast destruction to coral reefs and seagrass beds; management recognized this, and in the 2010 Management Plan made outlined the installation of sufficient moorings for the yachts and charters as a main priority (Grenada Ministry of Agriculture Forestry and Fisheries 2010). Since 2010, more moorings have been installed, and the experts believe that they have been somewhat effective, to the point that the threat has seen a 60% improvement. However, some yachts use the moorings improperly, and some still don't use them at all. On patrol with the wardens, the researcher frequently witnessed people improperly tying their yachts to the mooring; this allows the boat to drift and can damage the moorings. Once on patrol the wardens came upon a yacht that had just illegally dropped anchor in Dragon Bay. The wardens had them immediately pull up the anchor, and luckily it appeared that the anchor had been on a sandy strip.

The main driver behind this is a lack of awareness on the part of the sailors of the yachts, and they are certainly partially to blame for this. However, part of the issue is incorrect information that the sailors are receiving; the sailors who anchored in the MPA said they were unaware of the mooring regulations, despite having an up-to-date nautical chart. A solution for this problem would be to contact the main nautical chart companies and request that they update their charts to include the MBMPA.

4.5.2 Excessive tourism

Excessive tourism is the 12th of the 13 threats. It has a final rank score of 5 and has gotten 25% worse. Experts define the threat as tourists exceeding the carrying capacity of the park, particularly in the sculpture park. 100% mitigation would be not exceeding the carrying capacity of the park. This threat also falls under classification 6.1

Experts explained that when the Sculpture Park was first proposed, one of the reasons behind it was to take some tourist pressure off of the other areas of the MPA, particularly Dragon Bay, which has a beautiful coral reef very suitable for snorkeling and diving. The plan certainly worked, with the caveat that now Molinière is suffering from the same problem. Molinière is a compact are, approximately 220m across the widest part of the bay, and the experts are concerned with the number of tourists in the park, and the subsequent impact this tourism will have on the regeneration of the coral here. Since tourism is an important part of the MBMPA, the goal here isn't to eliminate tourism, but rather to ensure that the MBMPA can handle the amount of tourism it is receiving. A solution to this would be to investigate what the carrying capacity of the MBMPA is, both overall and of its individual Bays. This information can be utilized to continually assess the tourism situation in the MBMPA and impose restrictions on access if necessary.

4.6 Invasive and other problematic species and genes

Classification: "8. Invasive and other problematic species and genes: threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance" (Salafsky *et al.* 2008).

4.6.1 Invasive Species: Lionfish

Pterois volitans, or the lionfish, is an invasive species in Grenada. It is listed as 6th of the 13 threats with a final rank score of 23. Lionfish were not present in Grenada in 2010, thus according to the MTRA guidelines the threat has worsened 100% since the baseline year (Anthony 2008). Eradication of the threat would be totally eliminating lionfish from the MBMPA and surrounding areas. This threat is classified as 8.1 "Invasive non-native/alien species: harmful plants, animals, pathogens and other microbes not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities" (Salafsky *et al.* 2008).

Lionfish are native to the South Pacific and Indian Oceans, but in recent years have been invading the Atlantic, particularly the Caribbean. Lionfish are beautiful and exotic to look at thanks to their red and white striped color and large, poisonous spines. The experts explained that they are a fish that tourists are often excited to see; they are also hugely detrimental to the environment. Lionfish are a highly predatory species without any natural predators; they feast on any fish they find, particularly juveniles. Their voracious feeding habits, lack of natural predators, and high reproductive rate allow them to quickly takeover in a reef community.

The only legal spear fishing in the MBMPA is when the wardens go spear fishing for lion fish, as the only way to control their population is to kill them. Lion fish like to stay toward the sides and bottoms of the reef; it's common to find them tucked into crevices, either singularly or in clusters. They are, overall, unfamiliar with the spear, so it is possible to swim close to them without much difficulty. The problem is that lionfish are smart; one expert said that if you miss the lionfish once, you won't have another shot at it. Once speared, the fish are collected in a large plastic sack (see Figure XX); even with large holes in their body, they are capable of surviving for over an hour, as the researcher witnessed firsthand.

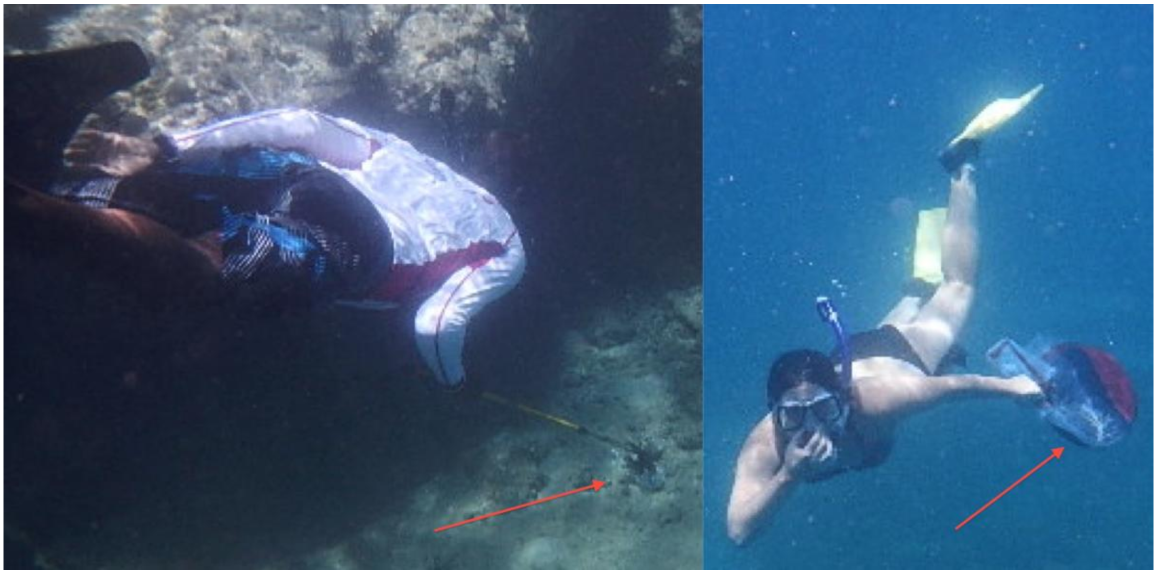


Figure 19. Spearing a lionfish (L) and carrying a bag of dying lionfish (R)
Source: Coddington Jeffrey and author

A few people killing lionfish won't control the population; but if all fishermen started targeting lionfish, there might be a better chance. Since they are newly arrived in the Caribbean, and they are covered with large, poisonous spines, there is not yet a market for lionfish. Thus, one of the initiatives of the nonprofit Reef, which is being championed by the MBMPA staff, is to market lionfish as a delicious food (Appendix 8).

4.7 Natural system modification

Classification: "7. Natural system modification: threats from actions that convert or degrade habitat in service of 'managing' natural or seminatural systems, often to improve human welfare" (Salafsky *et al.* 2008).

4.7.1 Fires

Fires are ranked 11th out of 13 threats. They have a final rank score of 9 and have decreased 35% since 2010. Experts define this threat as uncontrolled fires, frequently the result of slash and burn practices, that pollute the air and water of the MBMPA. 100% mitigation of this threat would be the total elimination of uncontrolled fires. Fires can be classified as "7.1 Fire and fire suppression: suppression or increase in fire frequency and/or intensity outside of its natural range of variation" (Salafsky *et al.* 2008).

Slash and burn techniques are still very common-practice in Grenada, even in the very dry season. This isn't always accepted as an intelligent decision, as both wardens and stakeholders made comments about fires they saw being started in the hills; but it is still a common practice. There is generally always a breeze blowing in Grenada and, particularly in the dry season, fires frequently get out of control. Grenadians explained that unless a house was in immediate danger of being burned, no one would bother trying to put out the fire just because it was burning vegetation; and even if a house was in danger of burning, it would need to be accessible to the firetrucks, and many are not.

While on patrol, the researcher witnessed a boat fire less than 1km south of the MBMPA. The boat, a fishing boat, had responded to a mayday call and towed a second boat in to the nearby dock. This was necessary in the first place because the Coast Guard is seriously understaffed and underfunded, and rarely responds to any calls at all; in fact, they frequently outsource many of their rescue efforts to the only dive shop owned by a Grenadian, Native Spirit Scuba. Unfortunately this job was too much for the first boat, and it caught fire. The fire could not be put out because the fire department didn't have the proper equipment; the type of fire in the boat required a special chemical foam to stop, and that's not something any fire departments have anywhere on the island. The firemen attempted to put out the fire anyway, but they ran out of water and had to leave the scene for around 10 minutes to drive to the nearest water source to refill their truck.

The experts at the MBMPA are concerned about the pollution that arrives in the MPA from these fires. As they are outside of the MBMPA, the staff cannot do much to mitigate these threats, and the infrastructure that is in place to deal with these things is severely lacking.

4.8 Indirect threats and other driver

During the MTRA Workshop, the staff listed two additional threats to the MBMPA: Effective management, and waste from the Orinoco flow. Upon further investigation, it became clear that these threats did not fit in the framework of the MTRA: the Orinoco flow is a natural ocean stream, thus negating it on the basis that it is not a human-induced threat. The other main threat was effective management.

4.8.1 Effective Management

It is worth noting that staff actually listed management – the lack of efficacy of management – as the number one threat to the MBMPA. They felt this way because they see this from keeping the MBMPA safe from all other threats, as well as keeping the wardens from effectively performing their jobs. This is an indirect threat, not a direct threat, and so it was removed from the MTRA table; but it is still seen as a driver and influence behind all other threats.

An example of this is the boat that the wardens use (Figure 20). It is small; does not effectively protect them from inclement weather; does not have an inside spot to stay warm or dry; does not have a toilet (particularly an issue to female passengers); and has very little space to keep things dry. This makes it difficult for the wardens to do their job in normal conditions. Additionally, the engines are extremely smoky; a local stakeholder mentioned that it is difficult to take the wardens seriously, when their boat is constantly producing so much smoke in the MPA.

The staff also think that the focus of the MBMPA management is focused too much on reactionary methods, and not enough on proactive methods. The wardens spend the vast majority of their time collecting fees from users of the MBMPA. This doesn't leave them much time to do their other purported duties. While the Management Plan (Ministry of Agriculture, Forestry, and Fisheries 2010) states that the wardens will frequently take water samples, the wardens confirmed that it is a task they rarely are able to undertake. A change in the infrastructure of the park – better reporting from dive shops and day charts, more signage for users of the park, collection stands at the terrestrial entrance of the park, and more outreach to nautical charts and guidebooks about the bounds and rules of the MBMPA would allow the wardens to do more than simply collect money from users.

Figure 20. Two wardens on patrol on the MBMPA Boat
Source: Author

4.9 Discussion

4.9.1 Feedback from experts and bias

The experts found the workshop helpful. They thought it was a great way quantify the issues that they saw occurring with the MPA. They believed that it would be a useful exercise to use in the future; they are constantly thinking about the issues of the MPA, but this format allowed them to come together to discuss the issues, and to arrange them in a way that led to more understanding of their impact and their drivers.

During the workshop the researcher did encounter some bias. This bias was encountered among the experts related to distinguishing how threats differ by area, urgency, and intensity. Even with the help of the facilitator, experts noted at first that it was difficult for them to assign threats different ranks for the distinct categories, as they were accustomed to gauging the severity of a threat as one cohesive issue. In order to combat this bias, the researcher continued to question the experts in detail about the threats; generally upon a little further investigation, the experts were better able to tease out the distinctions among the threats. Another way to allow for clarifications was using comparisons were among smaller groups of threats. While this did not entirely eliminate all bias, something that, according to Salafasky and Margoluis (1999) is inherent in these types of investigations, it helped to the point that it did not compromise the validity of the experts' opinions.

CHAPTER 5: CONCLUSION

5.1 Fulfillment of research objective and going forward

Going forward, it would be ideal to sit down with the staff of the Woburn/Clark's Court's Bay MPA to investigate baseline threats before the MPA begins active management. It would also be helpful to conduct an MTRAs with the staff at the Sandy Island/Oyster Bed MPA in Carriacou An idea would be to create an internal database that staff could use to compare both threats and best practices to mitigate those threats. This is a successful procedure that occurs in the healthcare field in the United States, and might be an interesting way to have the staff continue to utilize their best resources: each other.

The goal of this research was to utilize a Modified Threat Reduction Assessment (MTRA) in order to assess the effectiveness of the MBMPA management in mitigating threats to the MBMPA from the years 2010 – 2013. The MTRA Workshop was carried out with experts from the field, and qualitative research methods were utilized to further investigate the findings. It was found that the MBMPA has an index of -36.25; the MBMPA is faced with thirteen general threats, with drivers that are specific and nonspecific, located within and far beyond the borders of the MPA.

REFERENCES

Anderson, B. 2012. Assessing biodiversity threat mitigation efficacy: a case study of Kakum Conservation Area (2004 to 2012). Master's thesis, Department of Environmental Sciences and Policy, Central European University, Budapest.

Anthony, B. 2008. Use of modified threat reduction assessments to estimate success of conservation measures within and adjacent to Kruger National Park, South Africa. *Conservation Biology*, 22(6): 1497–1505.

Associated Press. 2004. Hurricane Ivan devastates Grenada. *Guardian* (London), September 9. URL: http://www.guardian.co.uk/environment/2004/sep/09/naturaldisasters.climatechange [consulted 10 May 2013]

Baldeo, R., Jeffrey, C., Samuel, B., *et al.* 2012. *Laying the groundwork for the Molinière/Beauséjour Marine Protected Area business plan.* Report prepared for the MPA Governance Project. St. George's.

Baldeo, R., Jeffrey, C., & Khan, Z. 2012. *Strengthening stakeholder organization of Molinière/Beauséjour Marine Protected Area (MBMPA).* Report prepared for the MPA Governance Project. St. George's.

Breide, C., and Saunders, P. 2005. *Legal challenges for the conservation and management of the high seas and areas of national jurisdiction including a case study of the grand banks*. Gland: WWF International.

Burke, L., Reytar, K., Spalding, M., *et al.* 2011. *Reefs at risk revisited*. Washington, D.C.: World Resources Institute.

Byrne, J. 2005?. Grenada national protected area system gap assessment. St. Croix: The Nature Conservancy.

Caribbean 360 (St. George's). 2013. Keith Mitchell sworn in as new Grenada Prime Minister. February 13. URL: http://www.caribbean360.com/index.php/news/grenada_news/667054.html#axzz2PvI2Apnw. [consulted 10 May 2013]

Caribbean News Now (St. George's). 2012. Grenada opposition concerned about rapidly increasing unemployment. 31 October. URL: http://www.caribbeannewsnow.com/topstory-Grenada-opposition-concerned-about-rapidly-increasing-unemployment-13203.html [consulted 25 May 2013]

CARICOM Secretariat. ND. *The Caribbean Community.* Information on the formation of The Caribbean Community, or CARICOM . Georgetown, Guyana: CARICOM. URL: http://www.caricom.org/jsp/community/community_index.jsp?menu=community. [consulted 10 May 2013]

CBD Conference of the Parties. 2010. COP 10 Decision X/31. URL: http://www.cbd.int/decision/cop/?id=12297 [consulted 10 May 2013]

Chape, S., Harrison, J., Spalding, M. and Lysenko, I. 2005. Measuring the extent and effectiveness of protected areas as an indicator for meeting global biodiversitytargets. *Philosophical Transactions of the Royal Society B: Biological Sciences* 360(1454):443-455.

CIA. 2013. The World Factbook: Grenada. Washington, D.C.

Dudley, N. 2008. *Guidelines for Applying Protected Area Management Categories.* IUCN: Gland, Switzerland.

Eagles, P., McCool, S., and Haynes, C. 2002. Protected areas, biodiversity, and conservation. *Sustainable Tourism in Protected Areas: Guidelines for Planning and Management*. Gland and Cambridge, UK: IUCN,UNEP, and the World Tourism Organization. Pp. 5–12.

Ervin, J. 2003. *WWF: Rapid assessment and prioritization of protected area management (RAPPAM) methodology*. Gland: WWF International.

Ervin, J., Mulongoy, K., Lawrence, K., *et al.* 2010. *Making protected areas relevant: a guide to integrating protected areas into wider landscapes, seascapes and sectoral plans and strategies*. CBD Technical Series No. 44. Montreal: CBD.

Ferraro, P., and Pattanayak, S. 2006. Money for nothing? A call for empirical evaluation of biodiversity conservation investments. *PLoS Biology*, 4(4), 482-488.

Francis-Floyd, R., Watson, C., Petty, D., *et al.* 2012. Ammonia in Aquatic Systems. Miami: University of Florida.

Ganbaatar, A. 2011. Influence of tourism in protected areas: case of Khar Us Nuur National Park, Mongolia. Master's thesis, Department of Environmental Sciences and Policy, Central European University, Budapest.

Gell, F., and Roberts, C. 2003. Benefits beyond boundaries: the fishery effects of marine Reserves. *Trends in Ecology & Evolution*, *18*(9), 448–455.

Global Finance. 2012. Grenada GDP Data & Country Report.
URL: http://www.gfmag.com/gdp-data-country-reports/265-grenada-gdp country-report.html#axzz2N4vFaxd9. [consulted 8 April 2013].

Gombos, M., Arrivillaga, A., Wusinich-Mendez, D., *et al.* 2011. A management capacity assessment of selected coral reef marine protected areas in the Caribbean. A report for NOAA, Coral Reef Conservation Program (CRCP), the Gulf and Caribbean Fisheries Institute (GCFI) and CaMPAM.

GOG. 2013. About Grenada: Economy. 18 March 2013. St. George's. http://www.gov.gd/economy.html. Last accessed: 8 April 2012.

Government of Australia. Department of the Environment and Heritage. 2003. *The benefits of marine protected areas: 5th IUCN World Parks Congress Discussion Paper*.

Grenada Advocate (St George's). 2013. Two Charged for Violating MPA Law. Grenada Advocate. April 10

Grenada Marine Protected Areas. 2012. URL: http://www.grenadampa.org/frontpage a.html. [consulted 10 March 2013].

Grenada Ministry of Agriculture, Forestry, and Fisheries. 2010. *Molinière-Beauséjour Marine Protected Area Management Plan August 2010*. St. George's: USAID.

Grenada Ministry of Finance. 2000. *Grenada National Biodiversity Strategy & Action Plan*. *New directions for youth development*. St. George's.

Grenada Ministry of Finance. 2009. *Fourth National Report of Grenada to the CBD* St. George's.

Gubay, S. 1995. Marine Protected Areas - Past, Present and Future. Marine Protected Areas: Principles and Techniques for Management. Ed. Gubbay, S. Chapman and Hall. London.

Hockings, M., and Phillips, A. 1999. How Well Are We Doing? - Some Thoughts on the Effectiveness of Protected Areas. *Parks*, *9*(2), 5–14.

Hockings, M., Stolton, S., and Dudley, N. 2004. Management Effectiveness: Assessing Management of Protected Areas? Journal of Environmental Policy and Planning. 6(2): 157-174.

Hockings, M., Stolton, S., Leverington, F., *et al.* 2006. *Evaluating Effectiveness: A Framework for Assessing Management Effectiveness of Protected Areas 2nd Edition*. P. Valentine, Ed. 2nd ed.

IFAD. 2010?. Rural Poverty in Grenada. http://www.ruralpovertyportal.org/country/home/tags/grenada

IUCN. 2008. *Guidelines for Applying Protected Area Management Categories*. N. Dudley, Ed.. IUCN. doi:10.2305/IUCN.CH.2008.PAPS.2.en

IUCN. 2012. *The IUCN Red List of Species: Grenada. Version 2012.2*. http://www.iucnredlist.org. Downloaded on 1 April 2013.

Jones, P. 2001. Marine Protected Area Strategies: Issues, Divergences and the Search for Middle Ground. *Reviews in Fish Biology and Fisheries*, *11*(3), 197–216. doi:10.1023/A

Kelleher, G. 1999. *Guidelines for Marine Protected Areas*. A. Phillips, Ed. Gland and Cambridge, UK: IUCN.

Kovalenko, O. Setting the priorities for threat reduction management in protected areas in Ukraine. 2012. Master's thesis, Department of Environmental Sciences and Policy, Central European University, Budapest.

Lockwood, M., Vorboys, G., and Kothari, A. Eds. 2006. *Managing Protected Areas: A Global Guide*. London: Earthscan.

Margoluis, R., and Salafsky, N. 2001. *Is Our Project Succeeding? A Guide to Threat Reduction Assessment for Conservation*. (S. Donoghue, Ed.). Washington, D.C.: Biodiversity Support Program.

Matar, D. 2009. New insights into monitoring protected area management in Lebanon. Master's thesis, Department of Environmental Sciences and Policy, Central European University, Budapest.

Matar, D. and Anthony, B. 2010. Application of modified threat reduction assessments in Lebanon. Conservation Biology. 24(5): 1174-1181.

MBMPA Warden. Phone conversation. 25 May 2013.

Niles, E. 2010. *Grenada Disaster Vulnerability Reduction Project: Environmental Impacts Assessment.* Report prepared for GOG: Ministry of Finance, Planning, Energy and Corporative. St. George's.

Nimrod, S. 2013. Consultation workshop with Farmers Organization in the Beausejour Watershed Area, Grenada. A presentation and accompanying PowerPoint document. Willis Community Center, St. George's, Grenada. March 18.

NOAA's National Marine Protected Areas Center. (2012). *Marine Protected Areas Brochure*. Silver Springs, MD. URL: http://www.mpa.gov/pdf/mpa-center/mpa_center_brochure_october2012.pdf [consulted 8 April 2013]

The Observatory of Economic Complexity. n.d. *Learn More About: Trade in Grenada.* Harvard Center for International Development. URL: http://atlas.media.mit.edu/country/grd/. [consulted 8 April 2013]

O'Shaughnessy, H. 1997. Obituary: Sir Eric Gairy. *The Independent*. London. August 25. URL: http://www.independent.co.uk/news/people/obituary-sir-eric-gairy-1247273.html# [consulted 8 April 2013]

Persha, L., and Rogers, A. 2002. Threat Reduction Assessment in the UNDP-GEF East African Cross Borders Biodiversity Project: Experiences with a New ICDP Monitoring Tool. *ArcJournal* (14). URL: http://easternarc.or.tz/downloads/South-Pare/Threat reduction assessment Arc Journal Article.pdf [consulted 8 April 2013]

Protected Planet Ocean. 2010. *What are marine protected areas (MPAs)?* http://www.protectplanetocean.org/introduction/introbox/mpas/introduction-item.html

Robertson, L. 2003. Integrated Management of Marine Protected Areas in Grenada. *Proceedings of the 53rd Gulf and Caribbean Fisheries Institute*, pp 716–723. URL: http://procs.gcfi.org/pdf/gcfi_54-61.pdf [consulted 8 April 2013]

Salafsky, N., and Margoluis, R. 1999. Threat Reduction Assessment: a Practical and Cost-☐Effective Approach to Evaluating Conservation and Development Projects. *Conservation Biology*, *13*(4), 830–841.

Salafsky, N., Salzer, D., Stattersfield, A., *et al.* 2008. A Standard Lexicon for Biodiversity Conservation: Unified Classifications of Threats and Actions. Conservation Biology. 22(4): 897-911.

Secretariat of the CBD. n.d. *Protected Areas – An Overview.* URL: https://www.cbd.int/protected/overview/. Last accessed: 7 December 2012

Secretariat of the Convention on Biological Diversity. 2010. *Global Biodiversity Outlook 3*. *The FEBS journal* (Vol. 280, p. 94). Montreal, Canada: Secretariat of the Convention on Biological Diversity. doi:10.1111/febs.12139

Secretariat of the Convention on Biological Diversity. 2012. *Strategic Plan for Biodiversity 2011 – 2020 and the Aichi Targets: "Living in Harmony with Nature"* (Vol. 1). Montreal, Canada. Retrieved from http://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-EN.pdf

Singh, A. 2010. National Environmental Summary: Grenada. Report prepared for UNEP.

Sodhi, N., Butler, R., Laurance, W., et.al. 2011. Conservation successes at micro-, meso- and macroscales. *Trends in Ecology and Evolution*, 26(11): 585-594.

Thomas, K. 2011. *Annual Agriculture Review, W.I.* Report prepared for GOG Ministry of Agriculture, Forestry and Fisheries. St. George's.

Turner, M. 2009a. *Grenada Protected Area System Plan Part 1: Identification and Designation of Protected Areas*. Report prepared for OECS. Vancouver Castries, Saint Lucia.

Turner, M. (2009b). *Grenada Protected Area System Plan Part 2: Legislation, Institutional Organization, Management Planning, Financing, Capacity Development and Training*. Report prepared for OECS. Vancouver Castries, Saint Lucia.

UN. 1992. *Convention on Biological Diversity*. Rio de Janeiro. URL: http://treaties.un.org/doc/Treaties/1992/06/19920605 08-44 PM/Ch_XXVII_08p.pdf [consulted 8 February 2013].

UNdata. 2011. *Country Profile: Grenada*. United Nations Statistics Division. URL: http://data.un.org/CountryProfile.aspx?crName=Grenada [consulted 13 March 2013].

UNDP. 2013. Grenada Country Profile: Human Development Indicators. URL: http://hdrstats.undp.org/en/countries/profiles/grd.html. [consulted 13 March 2013].

WHO. 1996. Ammonia in Drinking-water. Guidelines for drinking-water quality, 2nd ed. Vol. 2. Geneva: WHO.

The World Bank. 2013. *Country Data: Grenada.* Washington, DC. URL: http://data.worldbank.org/country/grenada [consulted 13 March 2013].

Worm, B., Barbier, E., Beaumont, N., *et al.* 2006. Impacts of Biodiversity Loss on Ocean Ecosystem Services. Science 314(5800): 787-790. URL: http://www.sciencemag.org/content/314/5800/787.abstract

Worm, B., Hilborn, R., Baum, J., *et al.* 2009. Rebuilding Global Fisheries. Science 325(5940): 578-585.URL: http://www.sciencemag.org/content/325/5940/578.abstract

WWF International. 2007. *Management Effectiveness Tracking Tool: Reporting Progress at Protected Area Sites 2nd Edition*. Gland: WWF International.

Zunes, S. 2003. The US Invasion of Grenada. *Global Policy Forum*.URL: http://www.globalpolicy.org/component/content/article/155/25966.html#author [consulted 26 February 2013].

APPENDICES

Appendix 1: Fish recorded in the MBMPA in 2006

Genus	Species	Common Name	Functional Group
Acanthurus	bahianus	Ocean surgeonfish	Herbivores
Acanthurus	chirurgus	Doctor fish	Herbivores
Acanthurus	coeruleus	Blue tang	Herbivores
Antennarius	muliocellatus	Longlure frogfish	Carnivores
Aulostomus	maculatus	Trumpetfish	Carnivores
Balistes	vetula	Queen Triggerfish	Carnivores
Melichthys	niger	Black durgon	Carnivores
Platybelone	argalus	Keeltail needlefish	Piscivores
Ophioblennius	macclurei	Red lipped blenny	-
Bothus	lunatus	Peacock flounder	Carnivores
Caranx	latus	Horse eye jack	Carnivores
Decapterus	macarellus	Mackeral scad	Carnivores
Elagatis	bipinnulata	Rainbow runner	Carnivores
Acanthemblemaria	maria	Secretary blenny	Benthic Carnivore
Chaetodon	aculeatus	Longsnout butterflyfish	Coralivores
Chaetodon	capistratus	Foureye butterflyfish	Coralivores
Chaetodon	ocellatus	Spotfin butterflyfish	Coralivores
Chaetodon	striatus	Banded butterflyfish	Coralivores
Heteroconger	longissimus	Brown garden eel	Planktivores
Dactylopterus	volitans	Flying gurnard	Benthic Carnivore
Diodon	holocanthus	Balloonfish	Benthic Carnivore
Diodon	hystrix	Porcupinefish	Benthic Carnivore
Coryphopterus	personatus	Masked goby	Benthic Carnivore
Ctenogobius	saepepallens	Dash goby	Benthic Carnivore
Gobiosoma	genie	Cleaning goby	Benthic Carnivore
Gobiosoma	horsti	Yellowline goby	Benthic Carnivore
Gramma	loreto	Royal basslet	Specialists
Anisotremus	surinamensis	Black margate	Benthic Carnivore
Anisotremus	virginicus	Porkfish	Benthic Carnivore
Haemulon	album	White grunt	Benthic Carnivore
Haemulon	carbonarium	French grunt	Benthic Carnivore
Haemulon	chrysargyreum	Smallmouth grunt	Benthic Carnivore
Haemulon	macrostomum	Spanish grunt	Benthic Carnivore
Haemulon	sciurus	Bluestriped grunt	Benthic Carnivore
Holocentrus	adscensionis	Squirrelfish	Benthic Carnivore
Holocentrus	rufus	Longspine squirrelfish	Benthic Carnivore

Genus	Species	Common Name	Functional Group
Myripristis	jacobus	Blackbar soldierfish	Planktivores
Sargocentron	coruscum	Reef squirrelfish	Benthic Carnivore
Inermia	vittata	Boga	Planktivores
Kyphosus	sectatrix	Bermuda chub	Omnivores
Bodianus	rufus	Spanish hogfish	Benthic Carnivore
Clepticus	parrae	Creole wrasse	Planktivores
Halichoeres	bivittatus	Slippery dick	Benthic Carnivore
Halichoeres	garnoti	Yellowhead wrasse	Benthic Carnivore
Halichoeres	maculipinna	Clown wrasse	Benthic Carnivore
Halichoeres	radiatus	Puddingwife	Benthic Carnivore
Thalassoma	bifasciatum	Bluehead wrasse	Planktivores
Lutjanus	analis	Mutton snapper	Carnivores
Lutjanus	apodus	Schoolmaster	Carnivores
Lutjanus	campechanus	Red snapper	Carnivores
Lutjanus	jocu	Dog snapper	Carnivores
Lutjanus	mahogoni	Mahogany snapper	Carnivores
Lutjanus	synagris	Lane snapper	Carnivores
Ocyurus	chrysurus	Yellowtail snapper	Carnivores
Malacanthidae	plumieri	Sand tilefish	Benthic Carnivore
Aluterus	schoepfii	Orange filefish	Herbivores
Aluterus	scriptus	Scribbled leatherjacket filefish	Herbivores
Cantherhines	macrocerus	American whitespotted filefish	Spongivores
Monacanthus	tuckeri	Slender filefish	Omnivores
Mulloidichthys	martinicus	Yellow goaltfish	Benthic Carnivore
Echidna	catenata	Chain moray	Carnivores
Gymnothorax	funebris	Green moray	Carnivores
Gymnothorax	milaris	Goldentail moray	Carnivores
Gymnothorax	moringa	Spotted moray	Carnivores
Myrichthys	ocellatus	Goldspotted eel	Benthic Carnivore
Ophichthus	ophis	Spotted snake eel	Carnivores
Opistognathus	macrognathus	Banded jawfish	Benthic Carnivore
Acanthostracion	polygonius	Honeycomb cowfish	Omnivores
Acanthostracion	quadricornis	Scrawled cowfish	Omnivores
Lactophrys	bicaudalis	Spotted trunkfish	Omnivores
Lactophrys	triqueter	Smooth trunkfish	Omnivores
Holacanthus	ciliaris	Queen angelfish	Spongivores
Holacanthus	tricolor	Rock beauty	Spongivores
Pomacanthus	arcuatus	Gray angelfish	Spongivores
Pomacanthus	paru	French angelfish	Spongivores
Abudefduf	saxatilis	Seargent major	Omnivores
Chromis	cyanea	Blue chromis	Planktivores
Chromis	multilineata	Brown chromis	Planktivores

Genus	Species	Common Name	Functional Group
Microspathodon	chrysurus	Yellowtail damselfish	Omnivores
Stegastes	adustus	Dusky damselfish	Omnivores
Stegastes	diencaeus	Longfin damselfish	Omnivores
Stegastes	leucostictus	Beaugregory damselfish	Omnivores
Stegastes	partitus	Bicolor damselfish	Planktivores
Stegastes	planifrons	Threespot damselfish	Omnivores
Stegastes	variabilis	Cocoa damselfish	Omnivores
Heteropriacanthus	cruentatus	Glasseye	Carnivores
Priacanthus	arenatus	Atlantic bigeye	Carnivores
Scarus	iserti	Striped parrotfish	Herbivores
Scarus	taeniopterus	Princess parrotfish	Herbivores
Scarus	vetula	Queen parrotfish	Herbivores
Sparisoma	aurofrenatum	Red Band parrotfish	Herbivores
Sparisoma	rubripinne	Yellowtail parrotfish	Herbivores
Sparisoma	viride	Stoplight parrotfish	Herbivores
Equetus	lanceolatus	Jacknife fish	Benthic Carnivore
Equetus	punctatus	Spotted drum	Benthic Carnivore
Scomberomorus	cavalla	King mackerel	Piscivores
Scomberomorus	maculatus	Atlantic Spanish mackerel	Piscivores
Scorpaena	plumieri	Spotted scorpionfish	Benthic Carnivore
Scorpaenodes	caribbaeus	Reef scorpionfish	Benthic Carnivore
Cephalopholis	cruentatus	Graysby	Carnivores
Cephalopholis	fulva	Coney/Butterfish	Carnivores
Epinephelus	adscensionis	Rock hind	Carnivores
Epinephelus	guttatus	Red hind	Carnivores
Rypticus	saponaceus	Greater soapfish	Carnivores
Serranus	tigrinus	Harlequin bass	Carnivores
Hypoplectrus	guttavarius	Shy hamlet	Carnivores
Hypoplectrus	nigricans	Black hamlet	Carnivores
Hypoplectrus	puella	Barred hamlet	Carnivores
Calamus	calamus	Saucereye porgy	Benthic Carnivore
Archosargus	probatocephalus	Sheepshead porgy	Benthic Carnivore
Sphyraena	barracuda	Great barracuda	Piscivores
Sphyraena	picudilla	Southern sennet	Piscivores
Hippocampus	reidi	Longsnout seahorse	Carnivores
Synodus	intermedius	Sand diver	Piscivores
Canthigaster	rostrata	Sharpnose puffer	Omnivores
Dasyatis	americana	Southern stingray	Benthic Carnivore
Narcine	brasiliensis	Brazilian electric ray	Benthic Carnivore
Manta	birostris	Giant manta ray	Planktivores
Aetobatus	narinari	Spotted eagle ray	Benthic Carnivore

Source: Grenada Ministry of Agriculture Forestry and Fisheries 2010

Appendix 2: MTRA Workshop Sheet 1, What is an MTRA?

Modified Threat Reduction Assessment Workshop
Molinière/Beauséjour Marine Protected Area (MBMPA)
Moderated by Erin Loughney
Central European University

What is a Threat Reduction Assessment (TRA)?
Threat Reduction Assessments, or TRAs, developed based on the idea that, no matter their size or location, a commonality shared by all Protected Areas, marine or terrestrial, is that they all face threats.

Instead of monitoring one specific index, such as the number of grazers found on the reef, TRAs monitor the threats themselves and their changes over time. TRAs rely on the knowledge and expertise of the people who know the MPA the most – the staff who manage it, and the local stakeholders who rely on it.

Protected Area Management has been called a crisis discipline; Managers and Stakeholders must respond and adapt to a very dynamic system with limited time and resources. With so many things to handle at once, it can sometimes be difficult to see the forest for the trees.

We believe that the quantification and systematization of this knowledge through the TRA process can give managers a simple and inexpensive tool to help them conceptualize where the MPA has been, where they are now, and where they would like to go.

TRAs rely on three basic assumptions[1]:

1. ***Threats to biodiversity are caused by humans.***
   a. Threats caused by natural phenomenon are not included (e.g. hurricanes)
   b. Natural threats that have worsened due to human activity may be included (e.g. increased flooding due to certain farming techniques).
4. ***It is possible to name every threat***
   1. MPA staff have the knowledge and potential to define, categorize, and rank all threats that the MPA faces based on their severity, their time sensitivity, and the amount of the MPA that they impact.
5. ***It is possible to measure the reduction or expansion of these threats***
   1. Through qualitative and quantitative means, Managers and Stakeholders can determine how threats have changed over a determined period of time.

The original TRA was pioneered by Salafsky and Margoluis; it had some inherent issues with the scoring of the threats. My thesis advisor, Dr. Brandon Anthony, took the basic TRA and modified it to ameliorate these issues. Thus, the Modified Threat Reduction Assessment, or MTRA.

MTRAs have been performed in Ghana, Lebanon, Mongolia, South Africa, and Ukraine (Anthony 2012). As of yet an MTRA has not been performed in the Americas, nor has one been performed on a Marine Protected Area; these are just two of the reasons that I chose to conduct an MTRA at the Molinière/Beauséjour MPA.

[1] Salafsky and Margoluis 1999, Anthony 2008

MTRA in Steps[2]**:**

1. **Define the area we are discussing, both in regard to:**
   a. **Area** (in this case, the boundaries of the MBMPA)
   b. **Time** (decide upon a target year with which to compare the present condition of the MPA)

2. **List every direct threat that is caused by humans that has occurred in the park, both historically and present day**
   a. In general, threats can be
      i. **Internal Direct Threats** (caused by stakeholders on the MPA)
      ii. **External Direct Threats** (caused by people outside the MPA)
      iii. **Indirect Threats**; we will not be using these, but it may be helpful to discuss them with regards to the direct threats (for example, how the economy may encourage more sustenance fishing

3. **As a group, discuss the threats and create a definition for each**
   a. First, in your own words
   b. Second, using the IUCN Standard Lexicon of Threats

4. **Create a definition for what 100% mitigation of this threat would look like**
   a. We will assume that 100% mitigation of a threat means that the threat does not exact anymore, at all. If this is not the case (if some amount of an activity is fine, but above a certain amount it becomes a threat, such as line fishing), we will define that on the sheets.

5. **Give each threat a rank in each of the following categories**
   a. **Are**a – total habitats impacted by the threat
   b. **Intensity** – how severe the threat is to the MPA
   c. **Urgency** – time sensitivity in dealing with the threat

6. **Add together the scores to calculate each threat's total rank**
   a. We will assume that Area, Intensity, and Urgency each have equal weight

7. **Decide how much (in percent) the threat has been mitigated since the chosen baseline time**
   a. If a threat was present during the baseline year and has improved, the score will be positive (e.g. 75% for anchoring in the MPA)
      i. The top score of an improvement is the 100% mitigation
   b. If a threat was present during the baseline year and has worsened, the score will be negative (e.g. -50% for illegal fishing)
      i. There is no top line for a negative score; if illegal fishing was an issue in the base year, and you believe it is 3 times as bad as it was, then this threat can be given a score of -300%
   c. If a threat was not present during the base year but has since become an issue (e.g. a new invasive species such as lionfish), that threat can be given a score of -100% to represent that it is a new issue

[2] Margoluis and Salafsky 2001, Anthony 2008, Matar and Anthony 2010, Anderson 2012.

8. **Calculate each threat's raw score (total rank multiplied by percent change)**

9. **Calculate the threat reduction index, which accounts for mitigation changes of all the listed threats in the PA**
    a. This is the average of the raw scores, divided by the total rankings, multiplied by 100

10. **Discussion**
    a. Positive actions taken by the park
    b. Effective and ineffective mitigation strategies

Appendix 3: MTRA Workshop Sheet 2, IUCN Threat Lexicon

A Standard Lexicon for Biodiversity Conservation: Unified Classifications of Threats and Actions[3]

By Salafsky, Salzer, et.al. 2008

Structure:
 # - Broad threat
#.# More defined threat
#.#.#. Example

1. **Residential and commercial development:** human settlements or other nonagricultural land uses with a substantial footprint

   1.1. **Housing and urban areas:** human cities, towns, and settlements including nonhousing development typically integrated with housing
      1.1.1. Urban areas, suburbs, villages, vacation homes, shopping areas, offices, schools, hospitals

   1.2. **Commercial and industrial areas**: factories and other commercial centers
      1.2.1. Manufacturing plants, shopping centers, office parks, military bases, power plants, train and ship yards, airports

   1.3. **Tourism and recreation areas**: tourism and recreation sites with a substantial footprint
      1.3.1. Ski areas, golf courses, beach resorts, cricket fields, county parks, campgrounds

2. **Agriculture and aquaculture**: threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture, and aquaculture

   2.1. **Annual and perennial nontimber crops**: crops planted for food, fodder, fiber, fuel, or other uses
      2.1.1. Farms, household swidden plots, plantations, orchards, vineyards, mixed agroforestry systems

   2.2. **Wood and pulp plantations**: stands of trees planted for timber or fiber outside of natural forests, often with non-native species
      2.2.1. Teak or eucalyptus plantations, silviculture, christmas tree farms

---

1. [3]http://www.iucnredlist.org/documents/Salafsky_et_al._2008_Unified_Classifications_of_Threats_and_Actions.pdf

2.3. Livestock farming and ranching: domestic terrestrial animals raised in one location on farmed or nonlocal resources (farming); also domestic or semidomesticated animals allowed to roam in the wild and supported by natural habitats (ranching)

2.3.1. Cattle feed lots, dairy farms, cattle ranching, chicken farms, goat, camel, or yak herding

2.4. Marine and freshwater aquaculture: aquatic animals raised in one location on farmed or nonlocal resources; also hatchery fish allowed to roam in the wild

2.4.1. Shrimp or fin fish aquaculture, fish ponds on farms, hatchery salmon, seeded shellfish beds, artificial algal beds

3. <u>Energy production and mining</u>: threats from production of nonbiological resources

3.1. Oil and gas drilling: exploring for, developing, and producing petroleum and other liquid hydrocarbons

3.1.1. Oil wells, deep sea natural gas drilling

3.2. Mining and quarrying: exploring for, developing, and producing minerals and rocks

3.2.1. Coal mines, alluvial gold panning, gold mines, rock quarries, coral mining, deep sea nodules, guano harvesting

3.3. Renewable energy: exploring, developing, and producing renewable energy

3.3.1. Geothermal power production, solar farms, wind farms (including birds flying into windmills), tidal farms

4. <u>Transportation and service corridors</u>: threats from long, narrow transport corridors and the vehicles that use them including associated wildlife mortality

4.1. Roads and railroads: surface transport on roadways and dedicated tracks

4.1.1. Highways, secondary roads, logging roads, bridges and causeways, road kill, fencing associated with roads, railroads

4.2. Utility and service lines: transport of energy and resources

4.2.1. Electrical and phone wires, aqueducts, oil and gas pipelines, electrocution of wildlife

4.3. Shipping lanes: transport on and in freshwater and ocean waterways

4.3.1. Dredging, canals, shipping lanes, ships running into whales, wakes from *cargo ships*

4.4. Flight paths: air and space transport

4.4.1. Flight paths, jets impacting birds

5. <u>Biological resource use</u>: threats from consumptive use of "wild" biological resources including deliberate and unintentional harvesting effects; also persecution or control of specific species

: threats from consumptive use of "wild" biological resources including deliberate and unintentional harvesting effects; also persecution or control of specific species

5.1. Hunting and collecting terrestrial animals: killing or trapping terrestrial wild animals or animal products for commercial, recreation, subsistence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch

5.1.1. Bushmeat hunting, trophy hunting, fur trapping, insect collecting, honey or bird nest hunting, predator control, pest control, persecution

5.2. Gathering terrestrial plants: harvesting plants, fungi, and other nontimber/nonanimal products for commercial, recreation, subsistence, research or cultural purposes, or for control reasons

5.2.1. Wild mushrooms, forage for stall fed animals, orchids, rattan, control of host plants to combat timber diseases

5.3. Logging and wood harvesting: harvesting trees and other woody vegetation for timber, fiber, or fuel

5.3.1. Clear cutting of hardwoods, selective commercial logging of ironwood, pulp operations, fuel wood collection, charcoal production

5.4. Fishing and harvesting aquatic resources: harvesting aquatic wild animals or plants for commercial, recreation, subsistence, research, or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch

5.4.1. Trawling, blast fishing, spear fishing, shellfish harvesting, whaling, seal hunting, turtle egg collection, live coral collection, seaweed collection

6. <u>Human intrusions and disturbance</u>: threats from human activities that alter, destroy and disturb habitats and species associated with nonconsumptive uses of biological resources

6.1. Recreational activities: people spending time in nature or traveling in vehicles outside of established transport corridors, usually for recreational reasons

6.1.1. Off-road vehicles, motorboats, jet-skis, snowmobiles, ultralight planes, dive boats, whale watching, mountain bikes, hikers, birdwatchers, skiers, pets in rec areas, temporary campsites, caving, rock-climbing

6.2. War, civil unrest and military exercises: actions by formal or paramilitary forces without a permanent footprint

6.2.1. Armed conflict, mine fields, tanks and other military vehicles, training exercises and ranges, defoliation, munitions testing

6.3. Work and other activities: people spending time in or traveling in natural environments for reasons other than recreation or military activities

6.3.1. Law enforcement, drug smugglers, illegal immigrants, species research, vandalism

7. Natural system modifications: threats from actions that convert or degrade habitat in service of "managing" natural or seminatural systems, often to improve human welfare

7.1. Fire and fire suppression: suppression or increase in fire frequency and/or intensity outside of its natural range of variation

7.1.1. Fire suppression to protect homes, inappropriate fire management, escaped agricultural fires, arson, campfires, fires for hunting

7.2. Dams and water management/use: changing water flow patterns from their natural range of variation either deliberately or as a result of other activities

7.2.1. Dam construction, dam operations, sediment control, change in salt regime, wetland filling for mosquito control, levees and dikes, surface water diversion, groundwater pumping, channelization, artificial lakes

7.3. Other ecosystem modifications: other actions that convert or degrade habitat in service of "managing", natural systems to improve human welfare

7.3.1. Land reclamation projects, abandonment of managed lands, rip-rap along shoreline, mowing grass, tree thinning in parks, beach construction, removal of snags from streams

8. Invasive and other problematic species and genes: threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance

8.1. Invasive non-native/alien species: harmful plants, animals, pathogens and other microbes not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities

8.1.1. Feral cattle, household pets, zebra mussels, Dutch elm disease or chestnut blight, Miconia tree, introduction of species for biocontrol, Chytrid fungus affecting amphibians outside of Africa

8.2. Problematic native species: harmful plants, animals, or pathogens and other microbes that are originally found within the ecosystem(s) in question, but have become "out of balance" or "released" directly or indirectly due to human activities

8.2.1. Overabundant native deer, overabundant algae due to loss of native grazing fish, native plants that hybridize with other plants, plague affecting rodents

8.3. Introduced genetic material: human-altered or transported organisms or genes

8.3.1. Pesticide resistant crops, hatchery salmon, restoration projects using nonlocal seed stock, genetically modified insects for biocontrol, genetically modified trees, genetically modified salmon

9. Pollution: threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources

9.1. Household sewage and urban waste water: water-borne sewage and nonpoint runoff from housing and urban areas that include nutrients, toxic chemicals and/or sediments

9.1.1. Discharge from municipal waste treatment plants, leaking septic systems, untreated sewage, outhouses, oil or sediment from roads, fertilizers and pesticides from lawns and golf-courses, road salt

9.2. Industrial and military effluents: water-borne pollutants from industrial and military sources including mining, energy production, and other resource extraction industries that include nutrients, toxic chemicals and/or sediments

9.2.1. Toxic chemicals from factories, illegal dumping of chemicals, mine tailings, arsenic from gold mining, leakage from fuel tanks, PCBs in river sediments

9.3. Agricultural and forestry effluents: water-borne pollutants from agricultural, silivicultural, and aquaculture systems that include nutrients, toxic chemicals and/or sediments including the effects of these pollutants on the site where they are applied

9.3.1. Nutrient loading from fertilizer runoff, herbicide runoff, manure from feedlots, nutrients from aquaculture, soil erosion

9.4. Garbage and solid waste: rubbish and other solid materials including those that entangle wildlife

9.4.1. Municipal waste, litter from cars, flotsam and jetsam from recreational boats, waste that entangles wildlife, construction debris

9.5. Air-borne pollutants: atmospheric pollutants from point and nonpoint sources

9.5.1. Acid rain, smog from vehicle emissions, excess nitrogen deposition, radioactive fallout, wind dispersion of pollutants or sediments, smoke from forest fires or wood stoves

9.6. Excess energy: inputs of heat, sound, or light that disturb wildlife or ecosystems

9.6.1. Noise from highways or airplanes, sonar from submarines that disturbs whales, heated water from power plants, lamps attracting insects, beach lights disorienting turtles, atmospheric radiation from ozone holes

10. Geological events: threats from catastrophic geological events

10.1. Volcanoes: volcanic events

10.1.1. Eruptions, emissions of volcanic gasses

10.2. Earthquakes/tsunamis: earthquakes and associated events

10.2.1. Earthquakes, tsunamis

10.3. Avalanches/landslides: avalanches or landslides

10.3.1. Avalanches, landslides, mudslides

11. Climate change and severe weather: long-term climatic changes that may be linked to global warming and other severe climatic or weather events outside the natural range of variation that could wipe out a vulnerable species or habitat

11.1. Habitat shifting and alteration: major changes in habitat composition and location

11.1.1. Sea-level rise, desertification, tundra thawing, coral bleaching

11.2. Droughts: periods in which rainfall falls below the normal range of variation

11.2.1. Severe lack of rain, loss of surface water sources

11.3. Temperature extremes: periods in which temperatures exceed or go below the normal range of variations

11.3.1. Heat waves, cold spells, oceanic temperature changes, disappearance of glaciers/sea ice

11.4. **Storms and flooding**: extreme precipitation and/or wind events or major shifts in seasonality of storms

11.4.1. Thunderstorms, tropical storms, hurricanes, cyclones, tornados, hailstorms, ice storms or blizzards, dust storms, erosion of beaches during storms

Appendix 4: MTRA Workshop Sheet 3, Threat Names and Descriptions

Final Rank	Threat Name	Threat Description	Definition of 100% Mitigation (if necessary)	% Threat Reduction

Appendix 5: MTRA Workshop Sheet 4, MTRA Index

MTRA Index

#	Threat Name	Corresponding IUCN Threat Number(s)	Rank: Area	Rank: Intensity	Rank: Urgency	Rank: Final	% Threat Reduction	Raw Score
Ex:	*Garbage and other solid waste*	*9.4*	*7*	*8*	*4*	*19*	*70%*	*13.3*
1						0		0
2						0		0
3						0		0
4						0		0
5						0		0
6						0		0
7						0		0
8						0		0
9						0		0
10						0		0
11						0		0

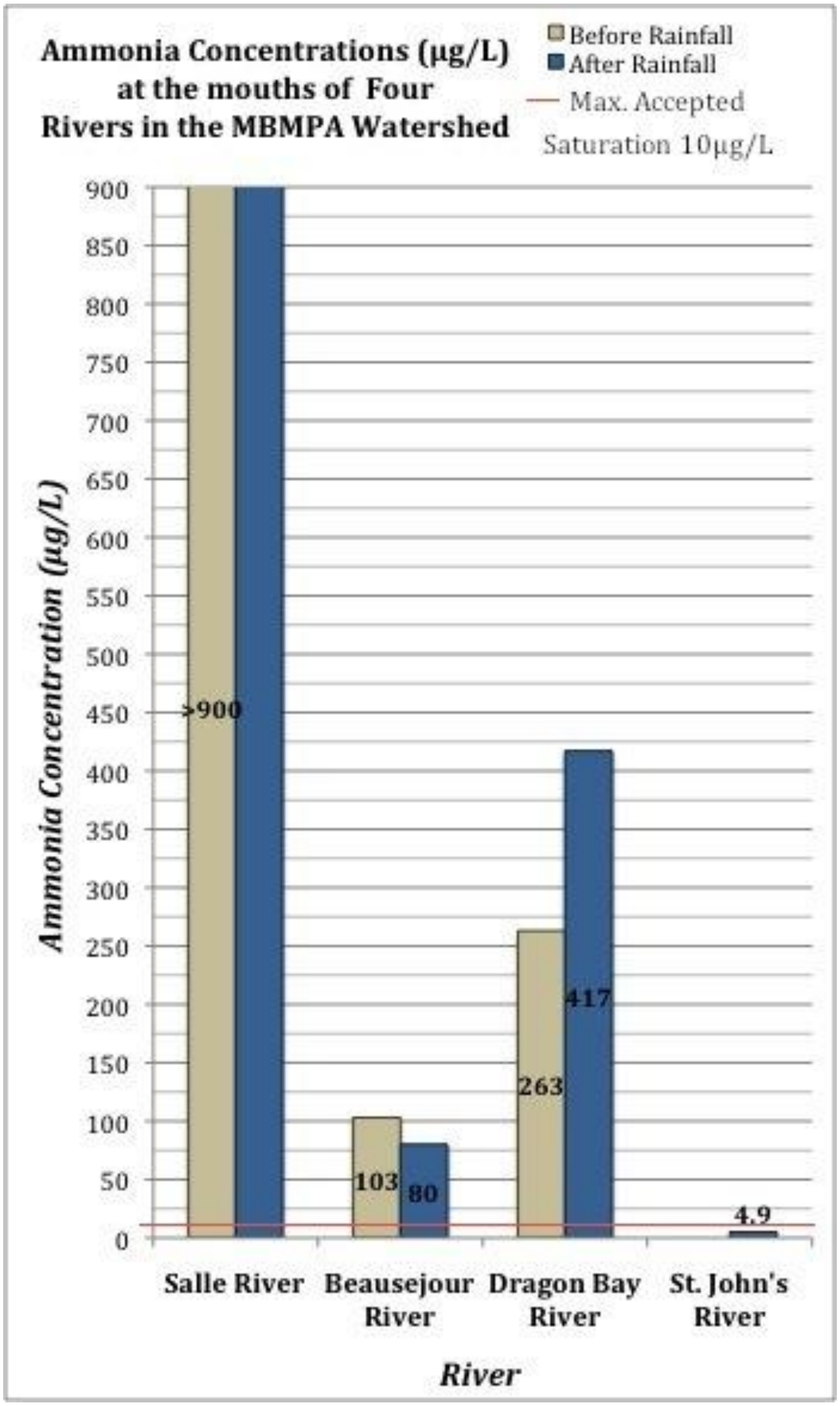
Name: **Date:** / /

MTRA Index

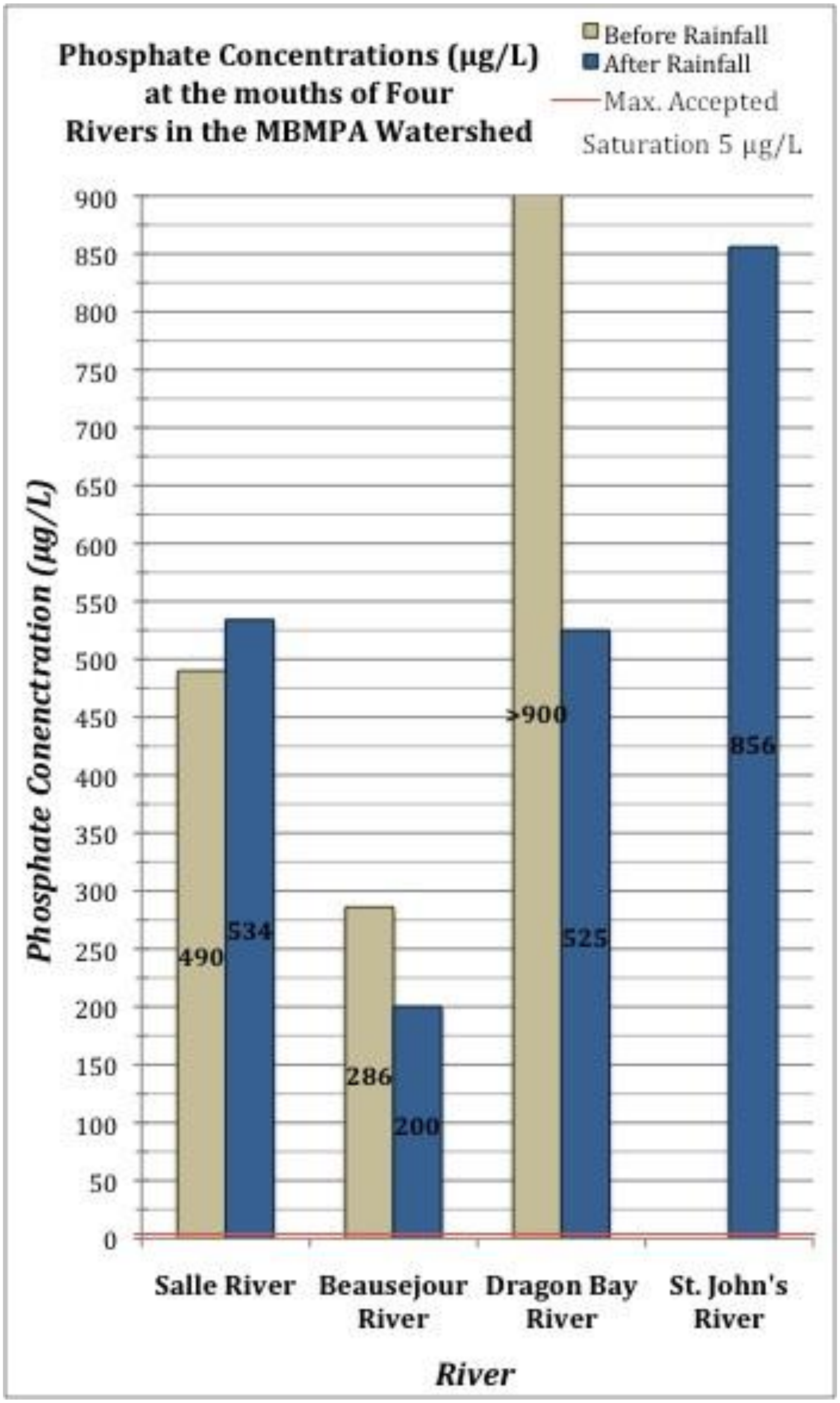
#	Threat Name	Corresponding IUCN Threat Number(s)	Rank: Area	Rank: Intensity	Rank: Urgency	Rank: Final	% Threat Reduction	Raw Score
12						0		0
						0		0
						0		0
						0		0
						0		0
						0		0
						0		0
						0		0
						0		0
						0		0
					Sum Ranks		**Sum Raw Score**	
	Formula:	**Sum Raw Score**	**plus**	**Sum Ranks**	**=**	**x100**	**=**	**TRA Index**
	Numbers:		**plus**		**=**	**x100**	**=**	

Name: **Date:** / /

Appendix 6: Ammonia and Phosphate Concentrations at Four of the MBMPA Rivers

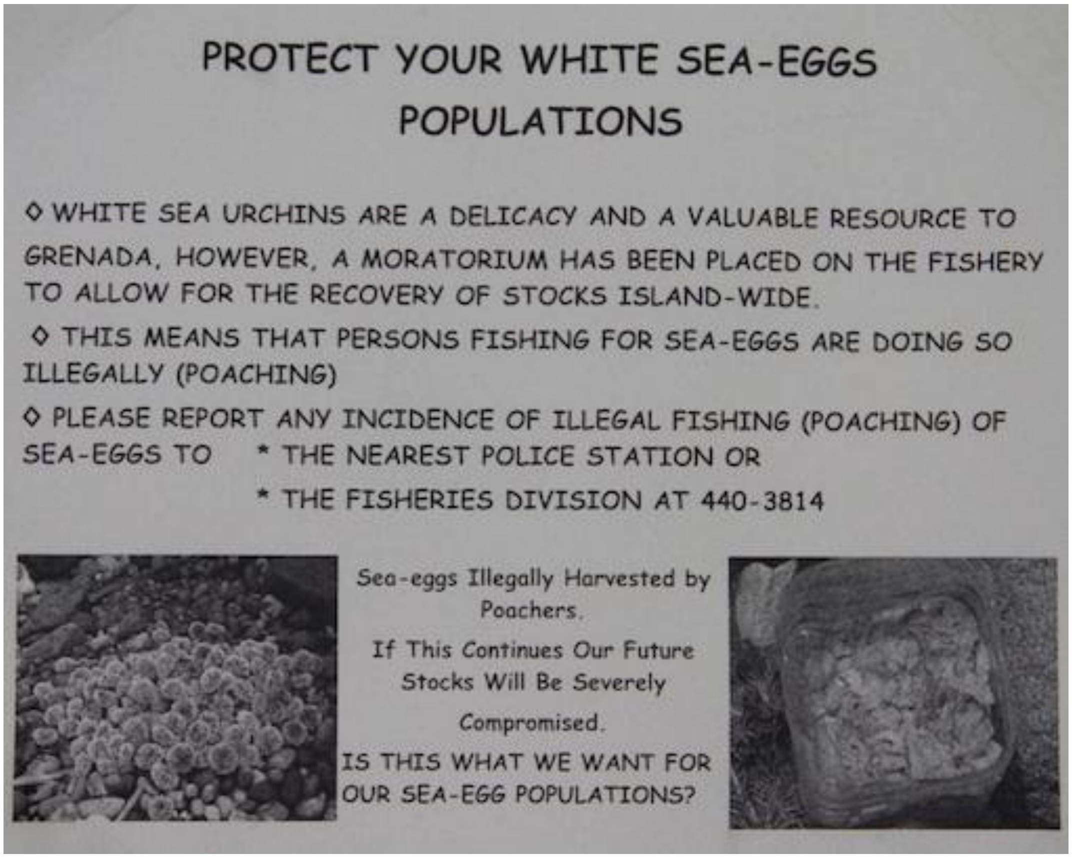


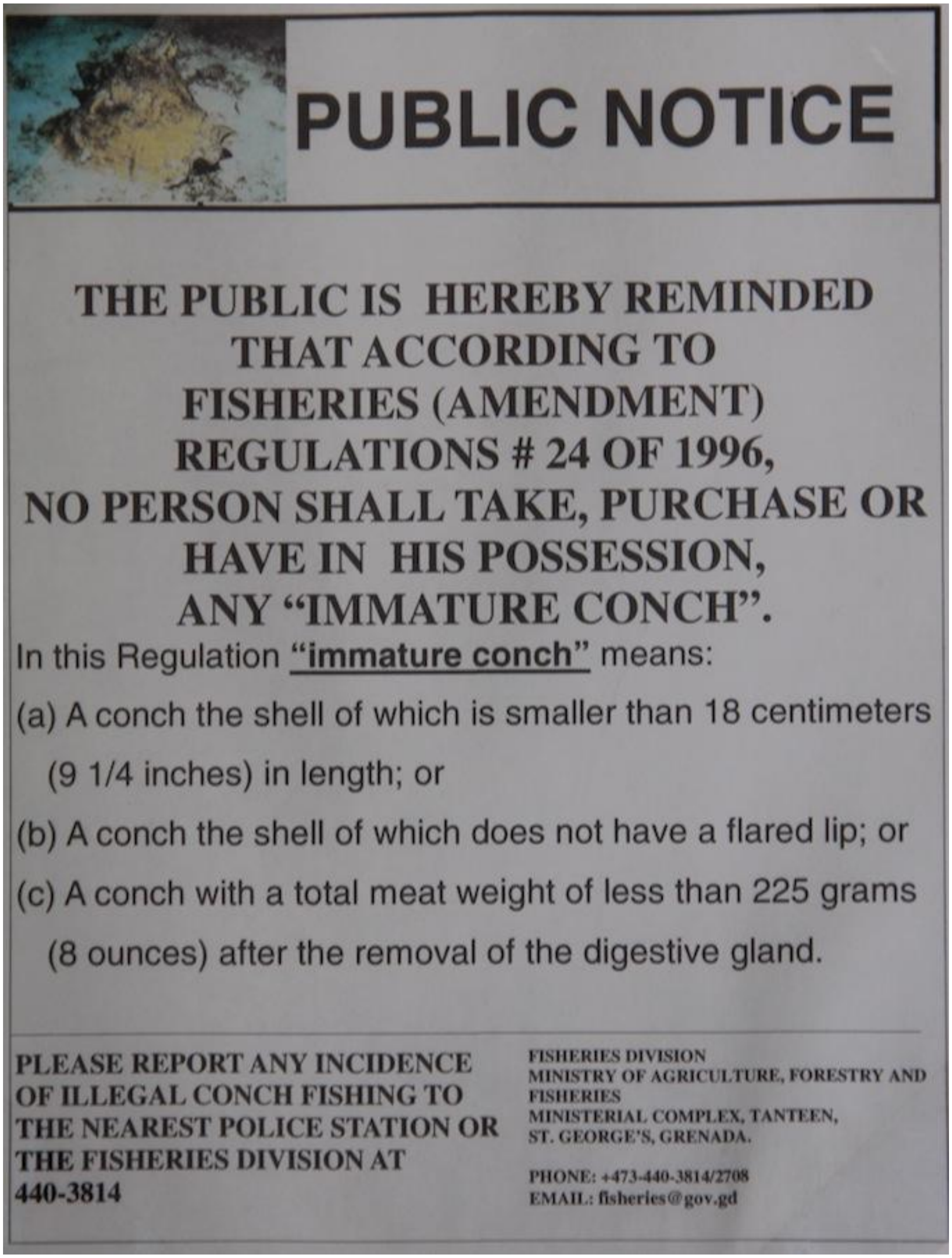
Source: Steven Nimrod 2013



Source: Steven Nimrod 2013

Appendix 7: Educational flyers and signs related to Tripneustes ventricosus (sea eggs), Dermochelys coriacea (leatherback turtles), and strombus gigas (conch) found at the MBMPA Office

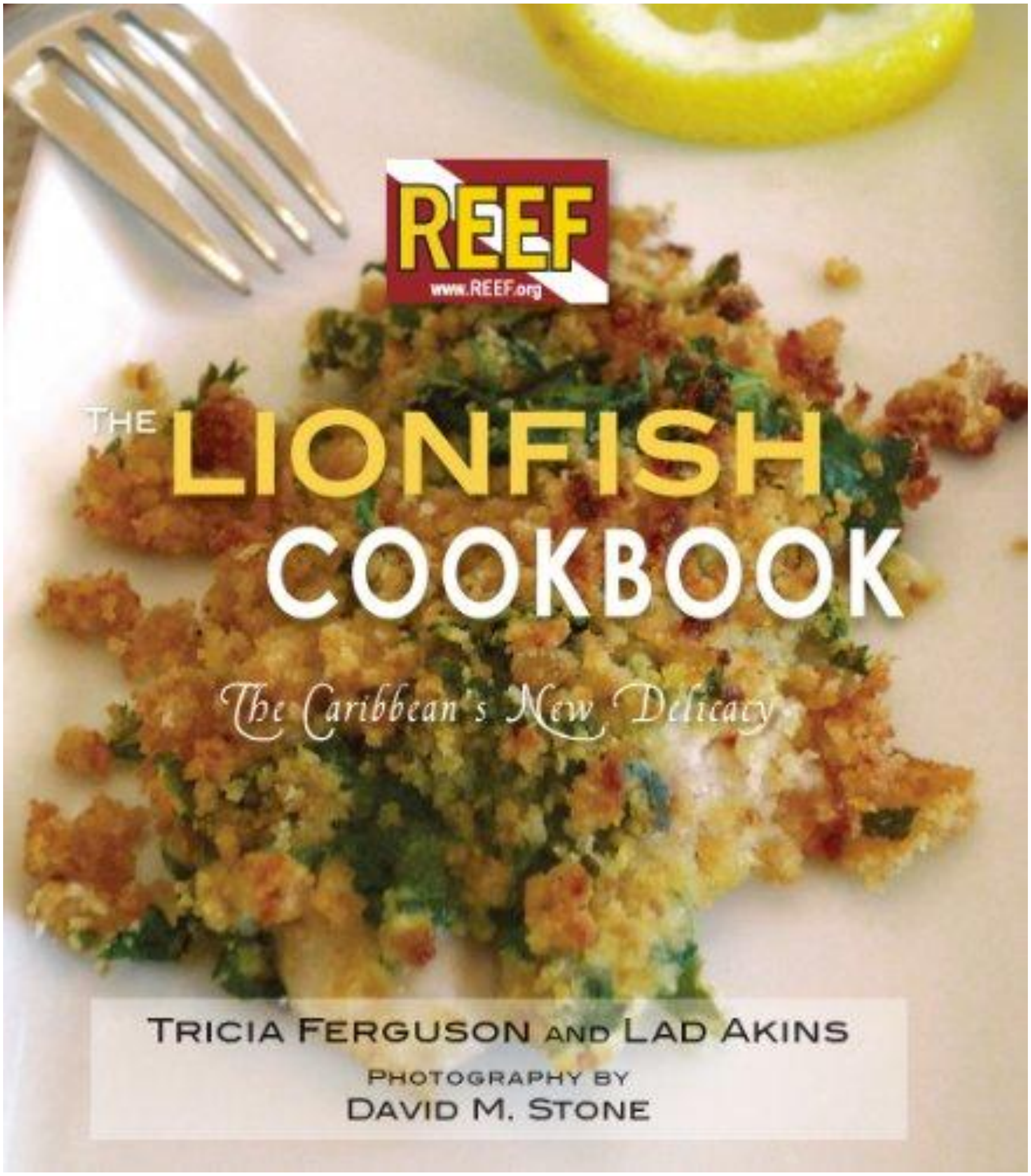




Source: Photographs the author took of a sign in the MBMPA Office

Appendix 8: Lionfish

Source: Photograph the author took of a sign in the MBMPA Office


REEF
www.REEF.org
THE LIONFISH
COOKBOOK
The Caribbean's New Delicacy
TRICIA FERGUSON AND LAD AKINS
PHOTOGRAPHY BY
DAVID M. STONE

Appendix 9: Sculpture Park (Photos by Coddington Jeffrey)


29.03.2013 15:26


29.03.2013 15:29


29.03.2013 15:22