MAPPING SOCIO-ECOLOGICAL VALUES

The use of geospatial tools to make informed decisions on the marine and coastal management areas surrounding Gros Morne National Park, Newfoundland

By © Rebecca D. E. Brushett (Thesis) submitted

to the School of Graduate Studies in partial fulfillment of the

requirements for the degree of

Master of Arts in Environmental Policy

Grenfell Campus

School of Science and the Environment

Memorial University of Newfoundland

May 2018

Corner Brook, Newfoundland and Labrador

Table of Contents

Abstract

Marine and coastal environments are highly complex integrated systems. While it is recognized these aquatic environments offer valuable ecosystem services, there is a paucity of information on how these systems are structured and how they function. Moreover, there are few tools available to assist in the management of these natural resources. Marine and coastal environments are not only important to the stability of the ocean but also to the socio-cultural, ecological and economic well-being of coastal communities. Many important biological areas are vulnerable to “agents of change” which include but are not limited to, commercial fishing, oil and gas activities, tourism and aquatic invasive species (green crab and membranipora specifically) and, climate change. This study will use expert informed GIS (xGIS) as a management tool to highlight the socio-ecological areas of importance and perceived impact in the coastal and marine areas surrounding Gros Morne National Park, western Newfoundland, Canada. This research used a family of decision-making protocols to promote effective stakeholder participation, allowing exploration and evaluation of multiple attributes where cost benefit analysis was inappropriate. The geospatial tool created for this study will serve as a management tool that can help: 1. identify geospatial hotspot areas of importance and impact from various ‘agents of change’ in the coastal and marine management areas surrounding the Gros Morne Region of western, Newfoundland; 2. construct a tool that can be used to aid in the creation of responsible marine plans for Newfoundland and areas bordering the Gulf of St. Lawrence and; 3. identify socio-ecological and justified areas valued for protection under a National Marine Conservation Area around Gros Morne National Park, Newfoundland.

Acknowledgements

Funding for this research was provided by Memorial University of Newfoundland and the School of Graduate Studies as well as the Geological Association of Canada. The invaluable contributions to this study were given in time and space by the experts, coastal community members and stakeholders of western Newfoundland, the town of Norris Point and the Bonne Bay Marine Station.

To my supervisors and steering committee, Dr. Michael Van Zyll de Jong, Mr. Stephen Decker and Dr. Robert Scott, thank you for your guidance and generous time to helping me through this adventure. Your knowledge and vision provided me a map to get through this confidently and I couldn’t have done it without you!

My research would not have been possible with out the aid, expertise and support of Ms. Selina Agbayani, Mr. Myron King and mother-like-figure, Nadia Simmons. Selina, the assistance you gave me for this work will never be forgotten and I look forward to creating amazing tools with you in the future. Myron, thank you for providing your knowledge and time. Nadia, not only did you help me within the program, you also lifted my spirit and cheered me on right to the end; thank you so much for this!

My Family, Friends and Husband Ian, your love and support throughout this long journey was with me literally through thick and thin. When I thought it was impossible, you all gave me the strength to finish this, and I’m so grateful you did.

List of Tables

List of Figures

List of Abbreviations

AIS	Aquatic Invasive Species
CE	Cumulative Effect
CEE	Cumulative Environmental Effect
CI	Circle and Identify
COOP	Cooperative
COP	Conference of Parties
DFO	Department of Fisheries and Oceans
DM	Decision-making
GIS	Geographical Information Systems
GMNP	Gros Morne National Park
HS	Hotspot
ISA	Incremental Spatial Autocorrelation
IUCN	International Union for Conservation and Nature
MAEP	Master of Arts in Environmental Policy
MPA	Marine Protected Area
MRC	Marine Reserve Coalition
MSA	Marine Significant Areas
MSP	Marine Spatial Planning
NGO	Non-Governmental Organization

NL	Newfoundland and Labrador
NMCA	National Marine Conservation Area
NMCAP	National Marine Conservation Area Policy
NRRD	Non-Renewable Resource Development
PM	Prime Minister
RRD	Renewable Resource Development
SDM	Structured Decision Making
SOP	Standard Operating Procedures
SS	Shipping and Sewage
TCC	Tourism and Community Culture
UN	United Nations
UNEP	United Nations Environmental Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
VS	Value Shading
xGIS	Expert Informed Geographical Information Systems

List of Appendices

Section 1.3

General Introduction

The Gulf of St. Lawrence is a large body of water located in the North Atlantic Ocean and is essential for the marine biodiversity that inhabit it year round, migratory species that depend on it for it's rich feeding grounds and nursery areas, as well as thousands of people who depend on it in the coastal communities of eastern, Canada and around the world (see **Fig 1.1**). The high activity of the Gulf of St. Lawrence has made it vulnerable to both internal and external "agents of change". An agent of change in this context refers to natural or man-made activities that may cause a change in the environment. Examples for this study look will look at, inshore and offshore fishing, sewage and shipping, oil and gas exploration and development, tourism, and impacts from aquatic invasive species (green crab and membranipora *sp.* specifically). Degradation of ecosystem functions has highlighted the need for better marine stewardship to allow marine environments to recover from decades of overexploitation and habitat destruction (DFO, 2010b; MRC, 2012). The International Union for Conservation and Nature (IUCN) established a World Conservancy Strategy in 1980. One of the key recommendations stressed the need for cooperative stewardship programs that combine "legislation, assistance and other actions to be developed to concentrate on the global commons (the open oceans as well as regional strategies for international river basins and seas)" (IUCN, 1980). In September of 2015, the UN established17 sustainable development goals. Goal 14 at the UN General Assembly aimed "to conserve and sustainably use the oceans, seas and marine resources for sustainable development" and:

> "By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their

resilience, and take action for their restoration in order to achieve healthy and productive oceans” (U.N. Charter art 14.2, par 1).

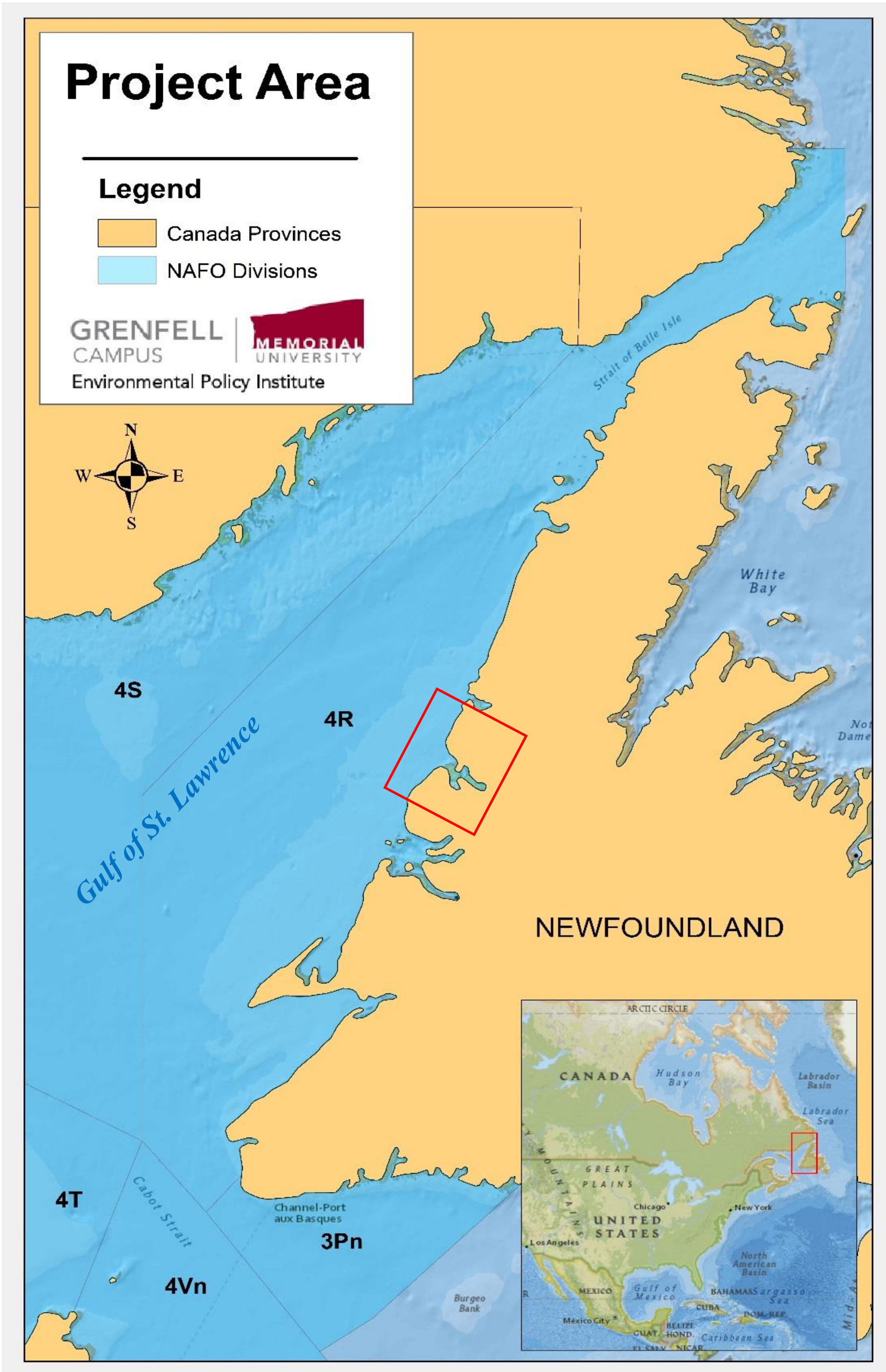


Figure 1.1 The province of Newfoundland highlighting the study area in the red box; Gros Morne National Park.

In support of the UN resolution and with a view to improved stewardship in Canadian coastal environments, DFO (2013), contends that decision makers must ensure continuity of healthy and productive aquatic ecosystems to provide ecosystem goods and services, which our coastal and marine economies depend on, as well as ecological integrity for the future of ocean biodiversity. Decision making can be a very difficult process, especially when the decision is to be applied in a complex situation with many stakeholders with different opinions. The situation becomes even more complicated when you are a policy maker who needs to factor in several contrasting views and opinions in the decision that is to be made. To achieve this, a method has to be devised to incorporate views and create alternatives that successfully eliminate the poles in arguments and, encourage parties to make compromises and trade-offs until a decision or a series of decisions can be reached. This is the very essence of the structured decision-making (SDM) process. According to R. Gregory, L. Failing, M. Harstone, T. McDaniels (2012), SDM can be defined as the collaborative and facilitated application of multiple objective decision making and group deliberation methods to environmental management and public policy problems. They further posited that it employs analytical methods derived from a combination of decision analysis, applied ecology and insights into human judgment, behavior from cognitive psychology, group dynamics and negotiation theory and practice. The process of data gathering for this geospatial tool was done in a manner that agrees with the theoretical framework mentioned in the SDM process above. Through this method, all values from the available experts were incorporated; producing a socio-ecological tool showing importance and perceived impact in a truly unbiased manner.

As Gopnik *et al.*, (2012) explains: human goals cannot be met in the long run with the absence of healthy ecosystems, and environmental goals will never be met in the absence of thriving communities and a vibrant economy. This study will serve as a management tool that will promote common awareness, assessment and action by stakeholders, policy makers and scientists to promote sustainable development and conservation in the marine and coastal environments around Gros Morne National Park (GMNP). Management decisions require an understanding of the locations of marine spaces associated with important social or ecological values (e.g. economic opportunities), and the degree to which those spaces are important. With such an understanding, anticipated impacts could be spatially distributed with the objective of avoiding spaces with the highest social-ecological values (Mahboubi *et al.*, 2015).

GMNP is a UNESCO world heritage site on the west coast of the island of Newfoundland, Canada, (see **Fig. 1**.**1** above, and **1.2** below). The landscape of this National Park includes towering cliffs and dramatic fjord valleys, glacial lakes, coastal bogs and dunes, and highland plateaus (Parks Canada, 2009). GMNP is home to many species including Woodland caribou, Arctic hare, wild Atlantic salmon, hundreds of harbour seals and acres of conifers. This natural playground encompasses 1805 km^2 of mountainous and coastal areas as well as eight “enclave” or residential communities that are scattered throughout the park; making a total population of roughly 3,000 people (Parks Canada, 2009, Census Canada 2016).

Figure 1.2. Marine and Coastal Study Area around Gros Morne National Park, NL.

The waters surrounding GMNP are rich in many marine resources and is one of the main drivers for coastal community settlement. Coastal communities in western Newfoundland were established in the late 1800's primarily because of the abundant marine resources such as ground fish (cod and halibut) and lobster (Kukac, 2009). The decline and the eventual collapse of the cod fishery in 1992 caused many coastal community members to leave the small coastal communities to seek other sources of income. Others remained and found employment with Parks Canada or eco-tourism industries that arose to support a vital economy in the Gros Morne region (Mason, 2002; Kukac, 2009). With the fishing industries still struggling and a global pressure to visit western NL's beautiful coasts, tourism has exploded. This has caused citizens especially the local stakeholders, and government(s) to look to diversify the economy which has lead to development in and around the coastal and marine environments of western Newfoundland. Given the vulnerability of the local economy, the need to develop a marine management plan is pressing. As such, the rationale for this study is based on the need to understand the socio-ecological values of importance and potential impacts from cumulative activities in this area like natural resource development, increased accommodations for tourists, and potential over-fishing to name a few. These values will be gathered by consulting with experts and coastal community stakeholders around the area. To better address the challenges faced by managers and to improve decision-making, this study will use expert informed Geographical Information Systems (xGIS) in a workshop setting to assess the various "agents of change" that may contribute to cumulative environmental effects (CEEs) in the marine and coastal management areas surrounding GMNP. xGIS focuses on the knowledge of local and regional experts, rather than the general public to improve overall accuracy of socio-ecological values which is vital to effective, and legitimate planning (Mahboubi *et al.*, 2015; Gopnik *et al.,* 2012). This process allows decision-making to move forward, even when it involves stakeholders from multi-sectors who have competing objectives (Greene, 2010, Selkoe, *et al.,* 2009). The successful participatory process framework for this study follows a methodology as described by Gopnik *et al*. 2012, and will be centered around active engagement from the beginning to the end. The data gathered will highlight the "agents of change" through various attribute packages and, spatial analysis will be performed to examine the socio-ecological importance and perceived impacts of the marine and coastal management areas surrounding GMNP, NL.

This research was guided by the family of principles set out in the *Oceans Act* (Minister of Justice, 1996) and supports the main ideologies of cumulative effects (CEs). CEs are defined as a change in the environment caused by multiple interactions among human activities and natural processes that accumulate across space and time (Noble, 2014). The theory of CEs is invaluable for this study; the natural fluidity along with abiotic and biotic components of coastal and marine environments create complex interactions and relationships, many of which are little understood. Accordingly, the risks of economic, socio-cultural and environmental damage to such systems is significant and assessment of the ability of an environmental system or coastal community to respond proactively and positively to stressors or opportunities needs to be assessed (Whitney *et al.,* 2017). These characteristics make coastal and marine environments particularly susceptible to potential environmental impacts from both marine and land-based activities whose zones of influence overlap (DFO, 2013). Therefore, the scope of decision making needs to go beyond the reach of a single zone or management project. Given the complexity and uncertainty associated with such decision making, developing a tool to assess or predict CEEs is expected to significantly improve prediction and judgment, two prerequisites for effective decision making. Stronger collaboration between regulatory authorities and stakeholders to integrate and align various objectives and desired outcomes using this xGIS tool will provide a stepping-stone to finding a compromise solution when decision-making needs to exist (DFO, 2013; Greene *et al.*, 2011; Ishizaka *et al.*, 2013).

Co-authorship Statement

Principal Author

Name of Principal Author (Candidate)	Mrs. Rebecca D. E. Brushett		
Contribution to the Paper	Preformed analysis on all samples, interpreted data, wrote manuscript and acted as corresponding author.		
Signature		Date	

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. The candidate's stated contribution to the publication is accurate (see details above);
ii. Permission is granted for the candidate to include the publication in the thesis; and
iii. The sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Dr. Michael Van Zyll de Jong		
Contribution to the Paper	Supervised development of work, helped in data interpretation and manuscript evaluation.		
Signature		Date	

Name of Co-Author	Mr. Stephen Decker		
Contribution to the Paper	Helped to evaluate and edit the manuscript.		
Signature		Date	

Name of Co-Author	Dr. Robert Scott		
Contribution to the Paper	Helped to evaluate and edit manuscript.		
Signature		Date	

Informed Decision-Making: The use of geospatial analysis to identify socio-ecological hotspots in the marine and coastal management areas surrounding Gros Morne National Park, Newfoundland.

2.1 Introduction

Decision-making (DM) in policy or conservation and project development has typically been done through processes that use little or no social-ecological input from stakeholders or experts; deciding the place and role of humans is a secondary point in DM (Blount and Pitchon, 2007). When public consultation is employed, it is usually vague or poorly aligned with public values. This has been documented around the world from Africa, to the UK, the US and even Canada (Blaustein, 2007; Jones, 2009; Blount and Pitchon, 2007, and De Santo, 2013). As Innes and Booher, 2004 stated, "Legally required methods of public participation in government decision making in the U.S. – public hearings, review and comment procedures in particular – do not work. They do not achieve genuine participation in planning or other decisions; they do not satisfy members of the public that they are being heard; they seldom can be said to improve the decisions that agencies and public officials make; and they do not incorporate a broad spectrum of the public." Federal and Provincial legislation recommends, and, if the project may cause severe environmental or social harm, makes it mandatory for public consultation. This process is often done in a manner that either makes the data hard to quantify or is gathered too late in the DM process. The subjectivity that stakeholders bring to the process needs to be valued for its enrichment of debate, even though it may give rise to frustrations and awkward questions for those driving the policy or DM process (Ritchie & Ellis 2010). Any project development that may affect a community's way of life should engage in public consultations earlier, more often, more meaningfully, and through an open and transparent process (Gopnik *et al.,* 2012). This should be the case for any land, coastal, and marine based management regime. The latter is the focus for this study and due to the fluid nature of marine and coastal environments there is another level of difficulty, the uncertainty of unpredicted impacts subject to tidal action.

As the worlds population exceeds 7 billion, pressures are increasing on our marine environments and the natural resources they provide. For this and many other reasons, informed marine and coastal management have never been so important. Social values have been considered in the DM process but are hard to quantify against science and economic values, producing misleading information and decisions that bring resistance from the people that are most at stake. A major challenge facing natural resource managers and environmental decision-makers is to plan for unpredicted impacts while minimizing adverse effects to both human and ecosystem health. Foreseeing resource conflicts and the sense of place through socio-ecological valuation can help bridge the gap between science and the management of coastal communities that depend on those areas most (Mahboubi *et al.,* 2015). Governments need to think broadly about all users' needs, look for synergies, user compatibilities, and dual-use opportunities (Gopnik *et al.,* 2012). Better dialog between different sectors aimed at finding compromises and solving problems need to exist because all parties want to be meaningfully involved in decision making from the earliest stages (Gopnik *et al.,* 2012).

Over the past 10 years many techniques and technologies have been created to aid in a more informed decision-making process. One such technique, when paired with the right consultation process and technologies that has shown success in all areas of sustainability is, marine spatial planning (MSP). MSP is a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that usually have been specified through a political process (Ehler & Douvere, 2009). Whether management decisions are being made for only the coastal areas or the entire ocean, success comes from the process and technologies incorporated into the process to get the best information available. MSP should allow everyone to be heard and to contribute useful knowledge, or data. As such, planners should offer many different approaches to participation, targeted to the needs of different audiences (Gopnik *et al.*, 2011). With the creation of Geographical Information Systems (GIS), information gathered from stakeholders and experts in MSP can be readily incorporated into geospatial software for analysis . Qualitative values can be analyzed and visually displayed through GIS and allow decision makers to use science and economic quantitative data as well as information provided by stakeholders. Incorporating a subjective dimension into understanding well-being helps to better illuminate what individuals value, and choices that they make with respect to marine and coastal resources (Murray *et al.*, 2016). Pomeroy and Douvere (2008) outline nicely the stages within the MSP process in which stakeholders should be involved:

i. The Planning Phase – Stakeholders should contribute to the setting of priorities, objectives, and the purpose of spatial management plans. They can help identify, group, and rank management problems, needs, and opportunities in order of priority;

ii. The Plan Evaluation Phase – Stakeholders should be engaged in the evaluation and choice of plan options;

iii. The Implementation Phase – Stakeholders can be utilized in a community-based approach to enforcement;

iv. The Post Implementation Phase – Stakeholders should be consulted about the overall effectiveness in achieving goals and objectives of the plan.

This study examines the planning and evaluation phase of MSP to create a geospatial tool that highlights the socio-ecological areas of significance and the potential impacts. The tool can be used in combination with scientific and economic data to create future marine plans for the waters surrounding GMNP, NL. GMNP is in western Newfoundland, Canada (**Fig. 2.1.1** and **2.1.2**). The landscape that makes up this National Park includes towering cliffs and dramatic fjords, post-glacial lakes, coastal bogs and dunes, and highland plateau (Parks Canada, 2009). It is a UNESCO world heritage site and home to many species including Woodland caribou and Arctic hare. The park (**Fig. 2.1.2**) encompasses 1805 km^2 of mountainous and coastal areas as well as eight communities that are scattered throughout; making a total population of roughly 3000 people (Parks Canada, 2009; Census Canada, 2016). The waters surrounding GMNP are rich in many marine resources, one of the main drivers for coastal community settlement. The coastal communities settled in the late 1800's in western, Newfoundland for the abundant ground fish and lobster fishery (Kukac, 2009). With the fisheries in decline and the eventual collapse of the cod fishery in 1992, many coastal community members left for other sources of income while others held fast and found a way of life through a variety of marine and land-based tourism industries (Mason, 2002; Kukac, 2009). As the tourism industry grows and other marine based industries continue to look for areas to develop future projects in the marine environment, the pressure to develop a marine management plan has never been so important. Essential to this plan, is understanding the values of importance and impact from experts and stakeholders around the area.

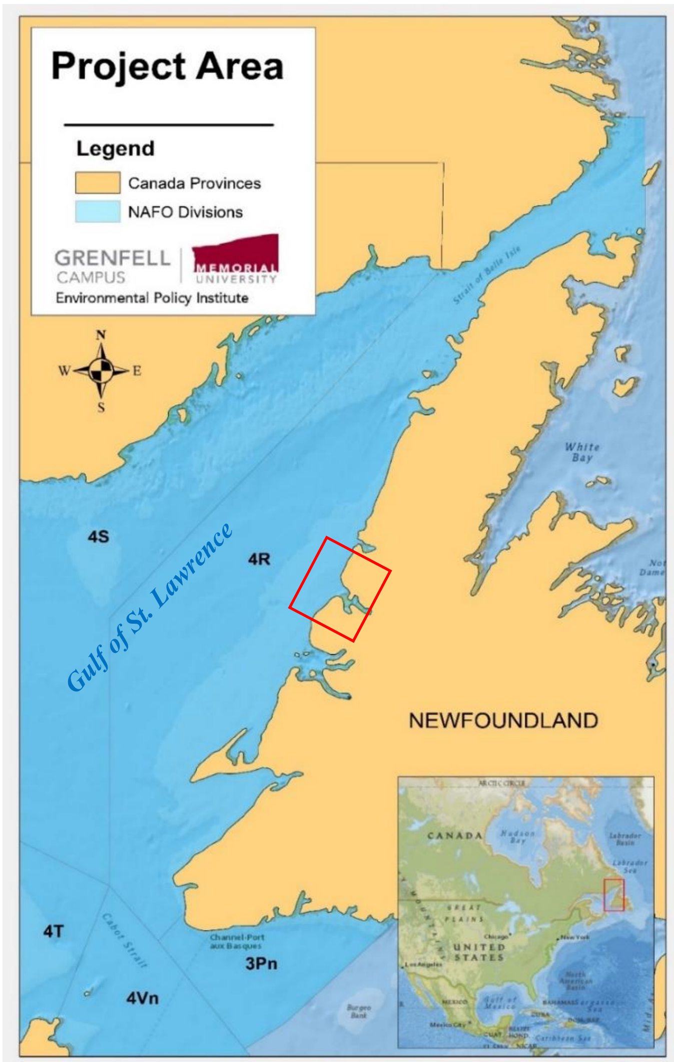


Figure 2.1.1 The province of Newfoundland highlighting the study area in the red box; Gros Morne National Park.

Figure 2.1.2. Marine and Coastal Study Area around Gros Morne National Park.

As the number of users in the coastal and marine region of GMNP increases so do the pressures on the natural marine resources and its environment. Impacts in any system especially the coastal and marine environment occur from cumulative environmental effects (CEEs) from various “agents of change”. The agents of change referred to in this study include activities from recreational and commercial fisheries, coastal and marine based tourism, sewage outflow, shipping, oil and gas exploration as well as natural agents of change from aquatic invasive species. As a first nations participant in Murray *et al.* study stated, “You can’t manage things independent of each other because everything is one big circle”. Data should be drawn from a wide variety of sources, including less traditional non-government sources to solicit a wide range of values (Gopnik *et al.*, 2012; Murray *et al.*, 2016).

There is a danger in only valuing what is (or can be) measured, in the sense of quantifiable ecological and economic data. Characterizing a broad range of values that are relevant in shaping attitudes and conceptions of “what should be” requires holistic thinking and attention to scale, context, relationality, subjectivity and rich detail (Murray *et al.*, 2016). For this reason, this study will use expert informed Geographical Information Systems (xGIS) in a workshop setting to assess the various “agents of change” that may contribute to CEEs in the marine and coastal management areas surrounding GMNP. Expert informed GIS focuses on the knowledge of local experts, rather than the public to improve overall accuracy of socio-ecological hotspot values which is vital to effective, and legitimate planning (Mahboubi *et al.*, 2015; Gopnik *et al.*, 2012). The data gathered will highlight the “agents of change” through various attribute packages and geospatial analysis will be preformed to examine the socio-ecological importance and impact of the marine and coastal management areas surrounding GMNP. The human process of valuing landscapes, coastal and marine areas results in structural and distributional patterns that, although not directly observable, constitute latent patterns of social and psychological complexity that can ultimately be measured and quantified (Brown & Reed, 2012).

2.2 Methods

This study was conducted in two phases to gain a broad view of the issues that may be important or of potential impact to the coastal and marine areas surrounding GMNP:

1. workshops to understand the socio-ecological values from experts in the area and,
2. geospatial analysis of the workshop data to generate mean statistical and hotspot maps of importance and impact.

2.2.1 Pre-workshop preparation

Experts were chosen to participate based on the pillars of sustainability set out by the United Nations Environmental Program (UNEP), economic development, social equity, and environmental protection, to gain unbiased information on all agents of change that use the marine and coastal areas around GMNP (UN, 2015). **Table 2.1** outlines the areas of expertise from the participants in the workshops. For this study, experts were selected from the study area that fit under the three pillars mentioned above. As they were contacted more experts, at times, were identified so they too were contacted to participate. If any identified or recommended people were unfamiliar with the study area, or had only minimal experience in the study areas that this research wanted to assess, then they were not asked to participate. Appendix A. summarizes the selection process of experts and provides tips for a successful public consultation workshop. A survey was emailed to the participants prior to the workshop, (see **Table 2.2),** to assess their level of expertise for each attribute package. From the survey the research was then able to assess the potential participants ability to positively contribute to the workshops, and, They were then only provided a package that fit their specific area of expertise. It should be noted that experts in other areas of expertise, that are not found in **table 2.2,** were approached for this study but were unavailable. Some include experts in the oil and gas industry, wind and tidal energy sector as well as a representative from the NL Department of Environment.

Table 2.1. Categories of Expertise Based on Pillars of Sustainability

Social/ Other	**Environmental/ Science**	**Economic**
Policy Planning Analyst	Government Marine Area Director	Business Development for Coastal Communities
GIS Specialist	Independent Consultant/ Biology	Tourism Business Owner/ Operators
Coastal Community Mayor(s)	Academic Marine Spatial Planner	Commercial Inshore and Offshore Fishermen
Long Time Coastal Community Resident	Academic Petroleum Geologist	Economic Development- Western Region
Marine Tourist	Academic Marine Biologist	Tourism Business Employee
Coastal Community Cooperative	Government Fisheries Development Officer	Coastal Aquarium Employee
Government Fisheries Officer	Terrestrial/ Freshwater/ Coastal NGO	
	Senior Fisheries Specialist NGO	
	Aboriginal Natural Resource Technician	
	Independent Oil and Gas Consultant	
	Government Aquatic Biologist	
	Government Bird Biologist	
	Government Environmental Specialist	

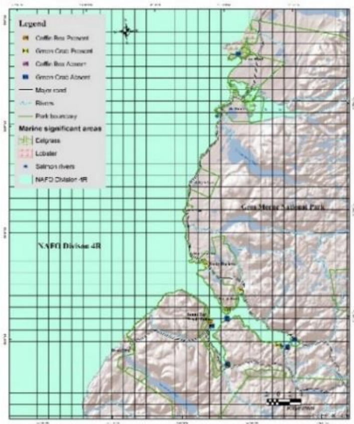
Table 2.2 Participant survey to assess areas and level of expertise	
Questions	**Answer options**
1. How many years have you lived around the coastal and marine environment?	1-5 years
	6-10 years
	11-30 years
	Over 30 years
2. How many years have you studied or worked in or on the marine and coastal environment?	1-5 years
	6-10 years
	11-30 years
	Over 30 years
3. Which subject areas or topics do you feel you would be most knowledgeable in? Check ALL that apply	Environment topics (terrestrial based only)
	Environmental Topics (marine and freshwater based only)
	Environmental Topics (contaminants, sewage, waste)
	Environmental topics (all areas above)
	Economic Topics (transport and shipping)
	Economic Topics (fisheries)
	Economic Topics (tourism)
	Economic Topics (oil and gas)
	Economic Topics (all areas)
	Social Topics (coastal community member)
	Social Topics (tourism)
	Social Topics (fisheries)

2.2.2 Workshop and attribute package design

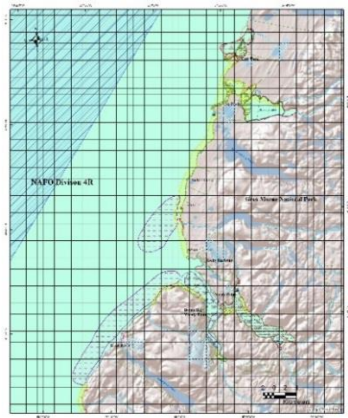
During the workshop participants were given attribute packages based on each "agent of change". In total, there were 5 attribute packages for this study:

1. Aquatic Invasive Species (AIS)
2. Marine Significant Areas (MSA)
3. Non-Renewable Resource Development (NRRD)
4. Shipping and Sewage (SS)
5. Tourism and Community Culture (TCC)

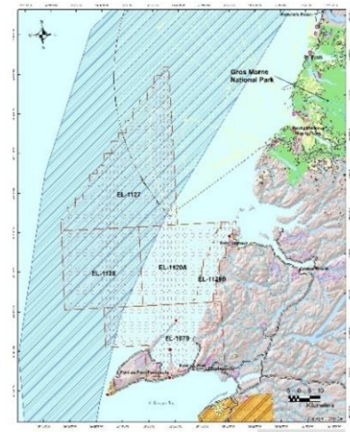
Each attribute package had a map value shading section and the questions for each section can be viewed in Appendix B. Each map was made using GIS software. Map layers were added that would help the experts make more informed decisions (see **Fig. 2.1.3)**. All maps were given a "fishnet" layer that would aid in polygon creation. The participants were given three colored crayons to shade their values on the maps. Green was used for highest *importance*, yellow for medium and red for low importance. Questions on *impact* values were given red for highest impact, yellow for medium and green for low impact. Each participant was asked to shade areas in the coastal, marine and fresh water sections. Some examples include, the marine waters of Bonne Bay, various salt marshes, rivers connected to the marine environment as well as Western Brook Pond; an ogliotrophic, land-locked fjord (Parks Canada, 2009).



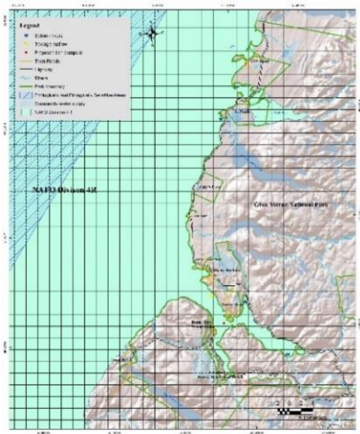
a. AIS Package



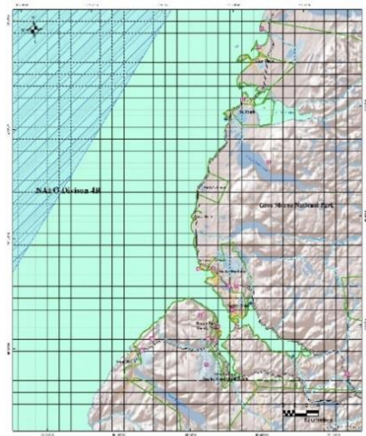
b. MSA Package[1]



c. NRRD Package[2]



d. SS Package



e. TCC Package

Figure 2.1.3 Maps used in the workshops which display the study area and secondary data needed to inform stakeholders prior to their valuation for each attribute package. Map A. displays areas aquatic invasive species (AIS), eelgrass beds, lobster spawning grounds, as well as, major rivers systems that support salmon species. Map B. displays fish and crustacean spawning grounds, the ecologically and biologically sensitive areas (EBSA) identified by DFO as well as, important areas for marine mammals and seabirds. Map C. outlines areas C-NLOPB have been approved for oil and gas exploration, onshore and offshore wells, community water supply sites and river systems, petroleum land tenure, EBSAs and the significant view points from hiking trails within GMNP. Map D. highlights the EBSAs, currently known sewage outflows and a proposed dump site from a local fish processing plant in Woody Point, Newfoundland. Map E displays significant view points, the park boundary, EBSAs off western Newfoundland and salmon rivers in the area.

[1] Some maps without legends had them attached on the side due to the large amount of information for that package.

[2] A different map was used in this package so participants could view where the exploration was taking place; south of the study area near Port Aux Port, Newfoundland.

2.2.3 Analysis of workshop maps

After all the workshops were complete, the hardcopy maps were digitized and georeferenced (see Appendix C. for details). The images shaded by the experts were converted into polygons and given numeric values that correspond to importance in their valuation (see **Table 2.3**). Maps were than repared for spatial analysis using the "MAEP_Toolbox"; a GIS tool created specifically for this project. This GIS tool was created to perform seven steps that are essential for the spatial analysis of this study:

1. standardizing fields
2. deleting unwanted fields
3. converting feature classes to rasters
4. adding rasters by zone
5. adding rasters by map category
6. converting sum rasters to polygons and
7. preforming hotspot analysis

The first two steps in the toolbox involve data preparation. The third through fifth step execute the mean statistical analysis which calculates cumulative importance and impact for each attribute package. The sixth and seventh steps run Incremental Spatial Autocorrelation (ISA) and a Getis-Ord Gi* Hot Spot (HS) analysis on the cumulative importance and cumulative impact feature classes to produce the hotspot maps (refer to **Appendix C**. for specific details on geospatial analysis). The data gathered was used to create mean statistical maps for each attribute package as well as two cumulative hotspot value maps of importance or impact. In total 9 mean statistical maps were generated and 2 hotspot maps were created (see **Table 2.4**).

Table 2.3 Score given to colors used to shade maps

Importance Shading	Green; highest importance	1000
	Yellow; medium importance	100
	Red; lowest importance	10
Impact Shading	Red; highest impact	1000
	Yellow; medium impact	100
	Green; lowest impact	10

Table 2.4 Socio-Ecological Mean Statistical and Hotspot Maps

1.	Cumulative Importance of all attribute packages
2.	Cumulative Importance for Marine Significant Areas (MSA)
3.	Cumulative Importance for Non-renewable Resource Development (NRRD)
4.	Cumulative Importance for Tourism and Community Culture (TCC)
5.	Cumulative Impact from all attribute packages
6.	Cumulative Impact from Aquatic Invasive Species (AIS)
7.	Cumulative Impact from NRRD
8.	Cumulative Impact from Sewage and Shipping (SS)
9.	Cumulative Impact from TCC
10.	Hotspot map of Importance
11.	Hotspot map of Impact

2.3 Results

2.3.1 Participation and sample size

The feedback and participation for this study was very positive. The aim was to get experts in fields that looked at all areas of sustainability, social, scientific or ecological and economic. The candidate list identified 40 experts for this study area, of whom, 32 were available to participate in the workshops. Participants were listed under the expertise they identified in during the initial survey given prior to the workshop (see **Table 2.2** above). Within the same survey found in **Table 2.2**, it was also identified how long the participants either lived or worked near the marine or coastal environment. Eighty-four percent of the participants surveyed, were noted as having worked on the marine and coastal environment for 10 or more years and 94% lived near the marine and coastal environment for 10 or more years (see **Fig. 2.1.4**). Though I initially planned to categorize participants in one of the three areas of sustainability, the results from the survey shown in **Fig. 2.1.5** proved this was not possible**.** Many involved were not just experts in various fields but also, people who were socially invested in this area as coastal community members. This dynamic brought a social aspect that positively contributed to the data gathering process.

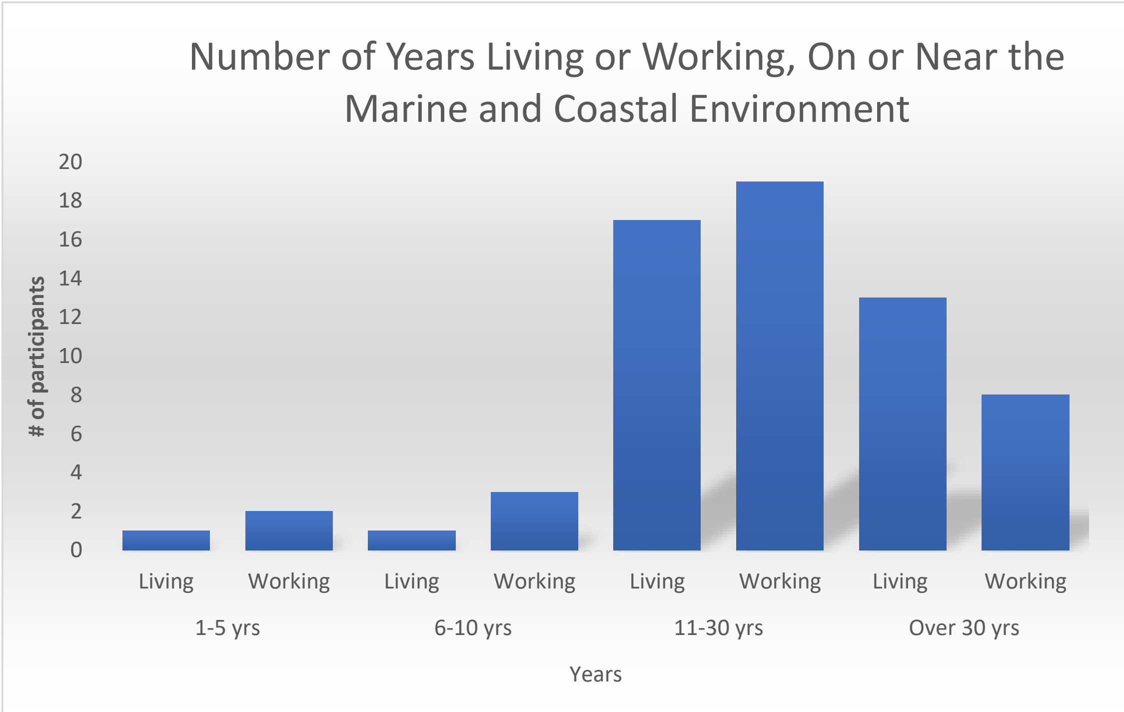


Figure 2.1.4 The number of years each participant lived or worked on or near the marine and coastal environment.

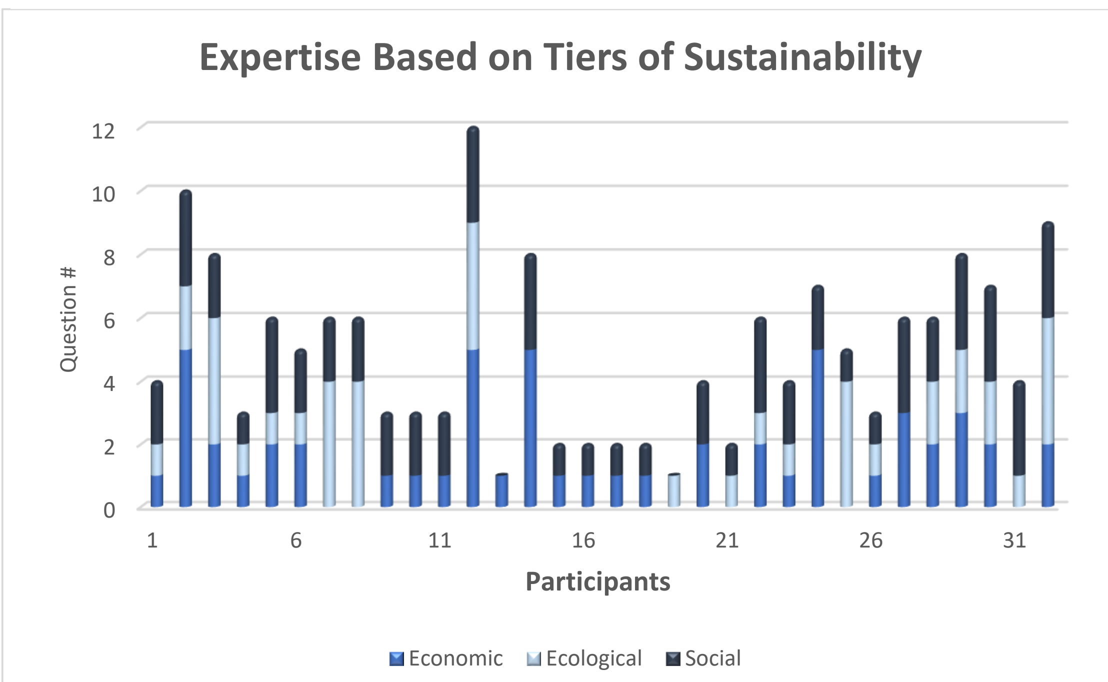


Figure 2.1.5 The outcome of expertise of each participant based on the 12-question survey found in **Table 2.2** above**.**

2.3.2 Workshop data

Each attribute package was completed in an almost unbiased manner due to the diversity of the experts in this study, (see **Fig. 2.1.6**). This diversity of the public consultation workshops enabled positive alignment with the recommendations for an effective structured decision-making approach found in Gregory, *et al.* 2012.

Table 2.5 lists the questions used to create the spatial maps of importance and perceived impact for each attribute package. The participant number varied because each map was completed by participants with knowledge in that area. If a participant was selected to complete the AIS package, for example, and were not confident on what areas were important/ impacted, they were advised to skip that particular question and move on to the next one. The questions were generated to provide an unbiased view of how the experts valued the study area to then produce maps that visually show outcomes in an unbiased manner.

Figure 2.1.6 Number of experts who participated in each attribute package. Attribute packages include: Tourism and Community Culture (TCC), Sewage and Shipping (SS), Non-renewable Resource Development (NRRD), Marine Significant Areas (MSA) and Aquatic Invasive Species (AIS).

Table 2.5 Questions Given to Expert Participants in Each Attribute Package

Map Type	# Participants	Attribute Questions
AIS	12	Areas most environmentally impacted by AIS
AIS	6	Areas most economically/ socially impacted by AIS
MSA	21	Important commercial and recreational fishing areas
MSA	16	Important areas for current and future marine research
MSA*	12	Most important areas for NMCA zones 1-3
TCC	22	Most important coastal and marine areas to the participant
TCC	22	Most important view sheds
TCC	21	Most impacted by motorized marine activities
TCC	22	Most impacted by non-motorized marine activities
TCC	21	Most impacted by recreational activities (hiking, camping, swimming etc.)
TCC	22	Most impacted by locals and tourists for photography
TCC	14	Most impacted by locals and tourists for bird watching
TCC	7	Most impacted by moose hunting
TCC	15	Most impacted by recreational fishing.
TCC*[3]	11	Most important areas for NMCA zones 1-3
NRRD	29	Most impacted from NRRD
NRRD	27	Most impacted from seismic testing for NRRD
NRRD	18	Most important economically from NRRD
SS	19	Areas too important to allow dumping of sewage to occur
SS	18	Areas most impacted around sewage and dump sites

[3] MSA and TCC with an * beside it identifies the two questions that were the same but given to a different group of experts based on their knowledge.

2.3.3 Analysis

2.3.3.1 Data Clustering for Hotspot Analysis

The hotspot analysis for cumulative importance and impact was conducted using Getis-Ord Gi* Hot Spot (HS) analysis in ArcGIS 10.3. To symbolize the hotspots in the feature classes, I used the "Gi_Bin Fixed 6000" field. **Table 2.6** display the values in this field and represent the various levels of confidence. A high z-score and small p-value for a feature indicates a spatial clustering of high values. A low negative z-score and small p-value indicates a spatial clustering of low values. The higher (or lower) the z-score, the more intense the clustering. A z-score near zero indicates no apparent spatial clustering (the white spaces). To read more on this refer to “Workbook Two” found in Appendices B.3. There was not enough data gathered during this study to preform a hoptspot analysis for each attribute level.

The hotspot analysis for cumulative importance and impact was conducted using Getis-Ord Gi* Hot Spot (HS) analysis in ArcGIS 10.3. To symbolize the hotspots in the feature classes, I used the "Gi_Bin Fixed 6000" field. **Table 2.6** display the values in this field and represent the various levels of confidence. A high z-score and small p-value for a feature indicates a spatial clustering of high values. A low negative z-score and small p-value indicates a spatial clustering of low values. The higher (or lower) the z-score, the more intense the clustering. A z-score near zero indicates no apparent spatial clustering (the white spaces). To read more on this please refer to Workbook two found in Appendices B.3. There was not enough data gathered during this study to preform a hotspot analysis for each attribute level.

Table 2.6 Confidence levels and connected hotspot descriptions			
Gi_Bin Fixed 6000	**DESCRIPTION**	**Confidence interval**	**p value**
3	Hot	99%	$p < 0.001$
2	V. Warm	95%	$p < 0.05$
1	Warm	90%	$p < 0.1$
0	Neither hot nor cold	0%	$p > 0.1$
-1	Cool	90%	$p < 0.1$
-2	V. Cool	95%	$p <0.05$
-3	Cold	99%	$p < 0.001$

2.3.3.2 Geospatial Analysis

Prior to the hotspot analysis, mean statistical analysis was completed on each attribute map package to show areas of importance or impact as well as a map to display each of their cumulative outputs. Under areas of importance, 4 individual attribute maps were created as well as a cumulative map of importance (**Fig. 2.1.7** and **Fig. 2.1.8)**. There were 5 impact value maps created including the cumulative map shown in **Fig. 2.1.9** and **Fig 2.2.0**. The areas seen by experts as important covered a large area throughout the entire u-shaped fjord of Bonne Bay, NL and, some coastal areas north and south of Bonne Bay in, Cow Head, St. Pauls and Trout River, NL (see **Fig. 2.1.7-2.1.8**). The impact values, shown in red, were a little more focused and can be seen in **Fig 2.1.9**. The AIS map in **Fig. 2.1.9A,** had highest impacts focused in areas where aquatic invasive species were identified by DFO and provided to this study as secondary data. The NRRD map in **Fig. 2.1.9B**, had highest impact displayed near all the major towns in GMNP but also, covering the entire coastal areas. The SS map shown in **Fig. 2.1.9C**, had its highest impacts shown within Bonne Bay near coasts of Woody Point and Norris Point, NL. **Fig 2.1.9D** displays TCC and the highest impacts can be seen again around Woody Point, Norris Point, at the mouth of a river in the eastern and southern arm of Bonne Bay, Rocky Harbour and the beaches of Cow Head, NL. Overall, in **Fig. 2.2.1**, the highest impacts continue to be focused in the u-shaped fjord of Bonne Bay, especially around Woody Point, Norris Point, and Rocky Harbour, NL.

The mean statistical analysis maps were the basis for the socio-ecological hotspot analysis. There was not enough data in each individual attribute package to produce hotspot maps. However, cumulatively, hotspot analysis was possible for the importance and impact value maps. The importance hotspot maps combined the 3 attribute packages; MSA, NRRD and TCC which can be seen in **Fig. 2.2.1A**. The impact hotspot analysis combined 4 attribute packages: AIS, NRRD, TCC and SS which is shown in **Fig. 2.2.1B.**

These final maps also confirm the areas of importance and impact for the study area are focused in the coastal areas and in the heart of Gros Morne National Park, the u-shaped fjord that makes up Bonne Bay. It is also important to note that rivers connecting the ocean to fresh water sources in the study area were also listed as a high importance and impact by the experts.

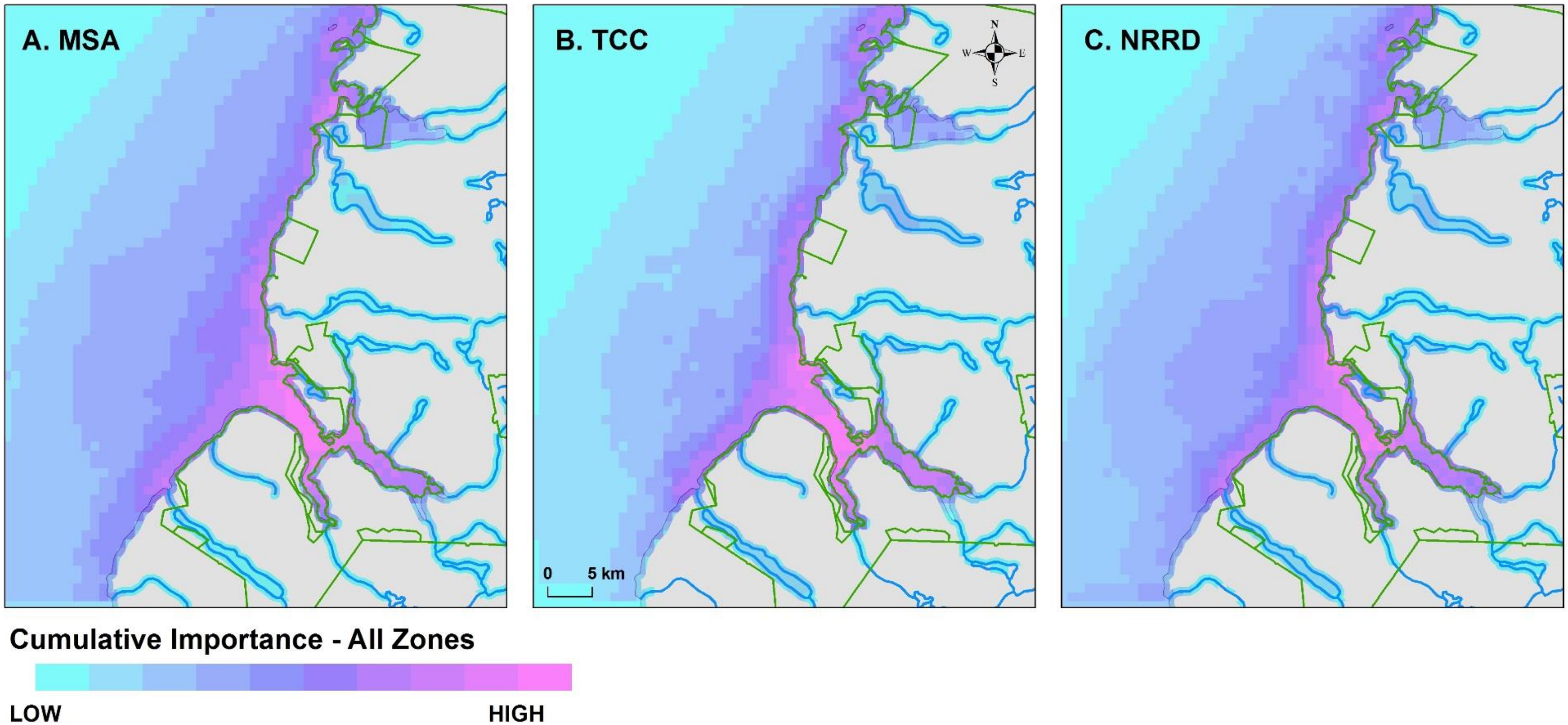


Figure 2.1.7 Mean statistical maps of importance for individual attribute packages. The attribute packages included are MSA, NRRD, TCC. The highest valued areas of importance for the coastal and marine management areas are visually displayed from dark purple to pink.

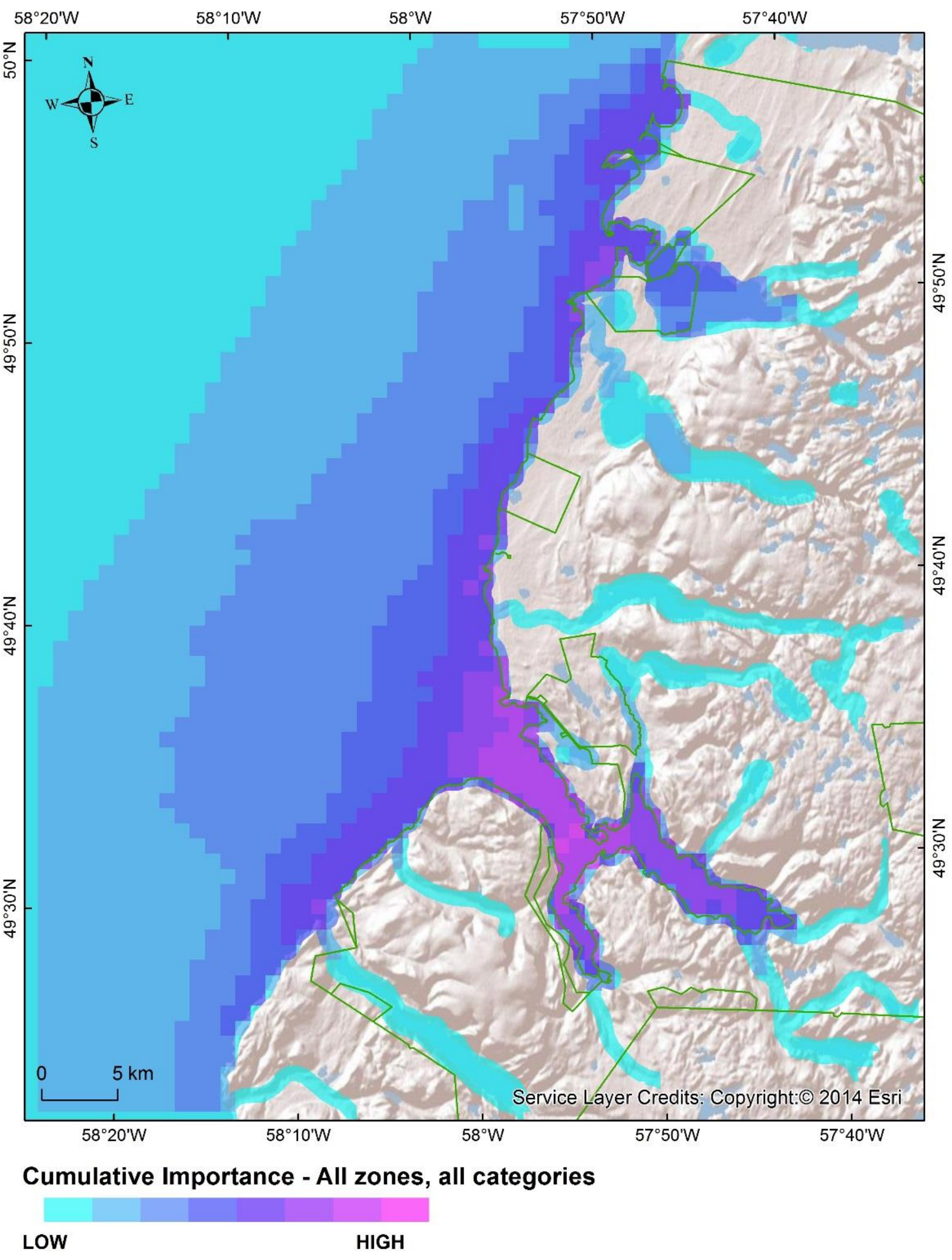


Figure 2.1.8 Mean statistical map of cumulative importance

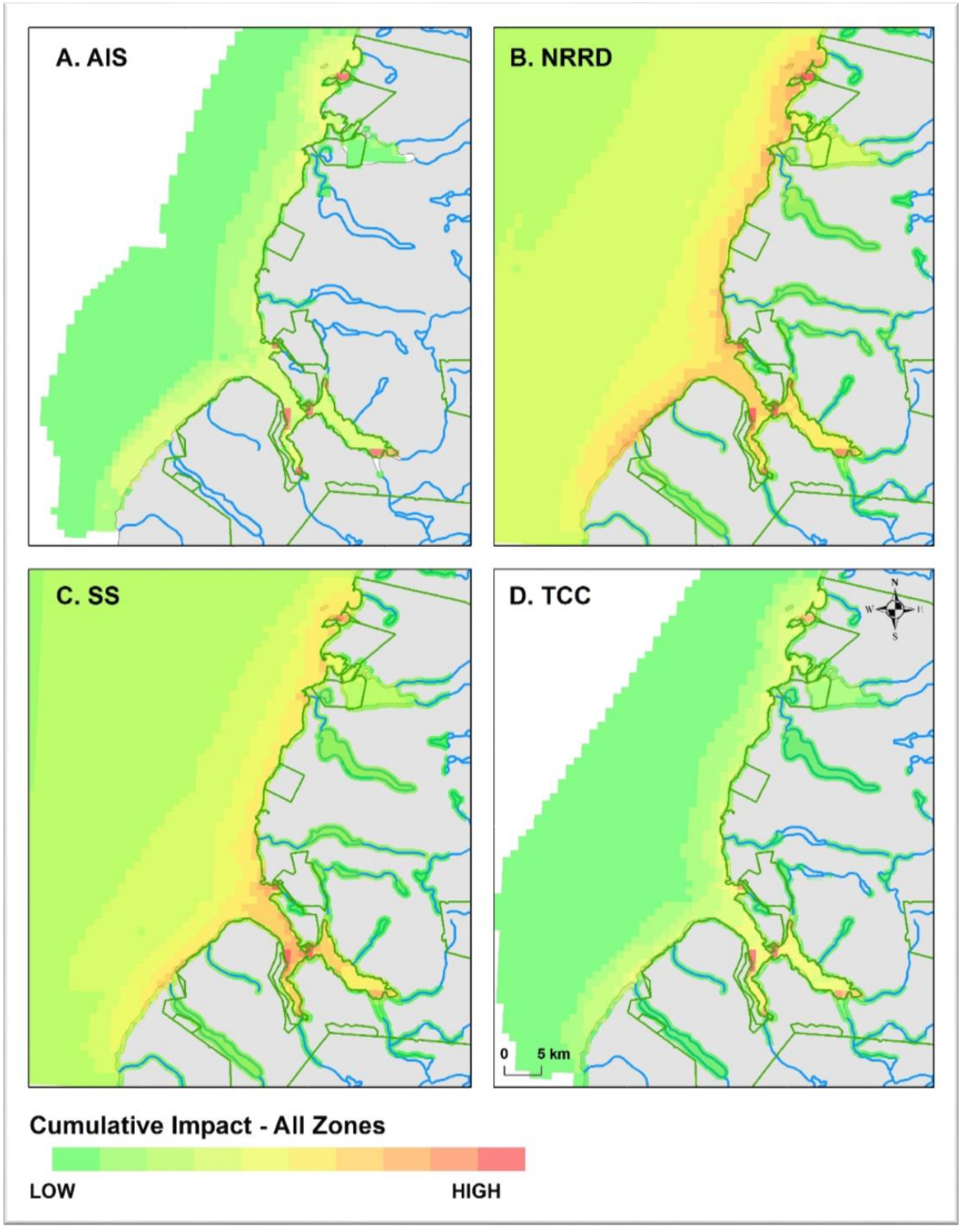


Figure 2.1.9 Mean statistical maps of impact for individual attribute packages. The attribute packages included are AIS, NRRD, TCC, SS and their cumulative output map. The highest valued areas of impact for the coastal and marine management areas are visually displayed from orange to dark red.

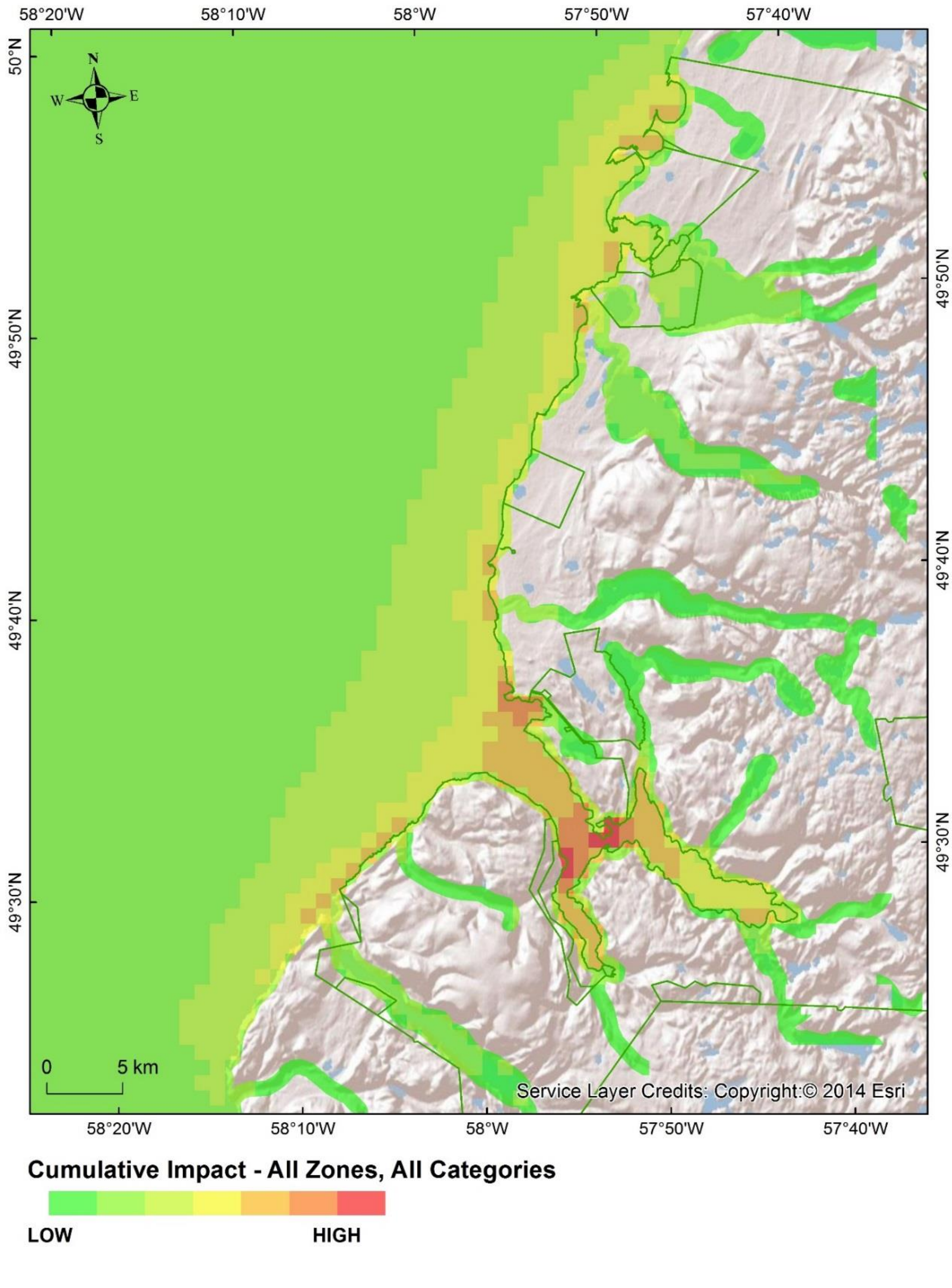


Figure 2.2.0 Mean statistical map of cumulative impact

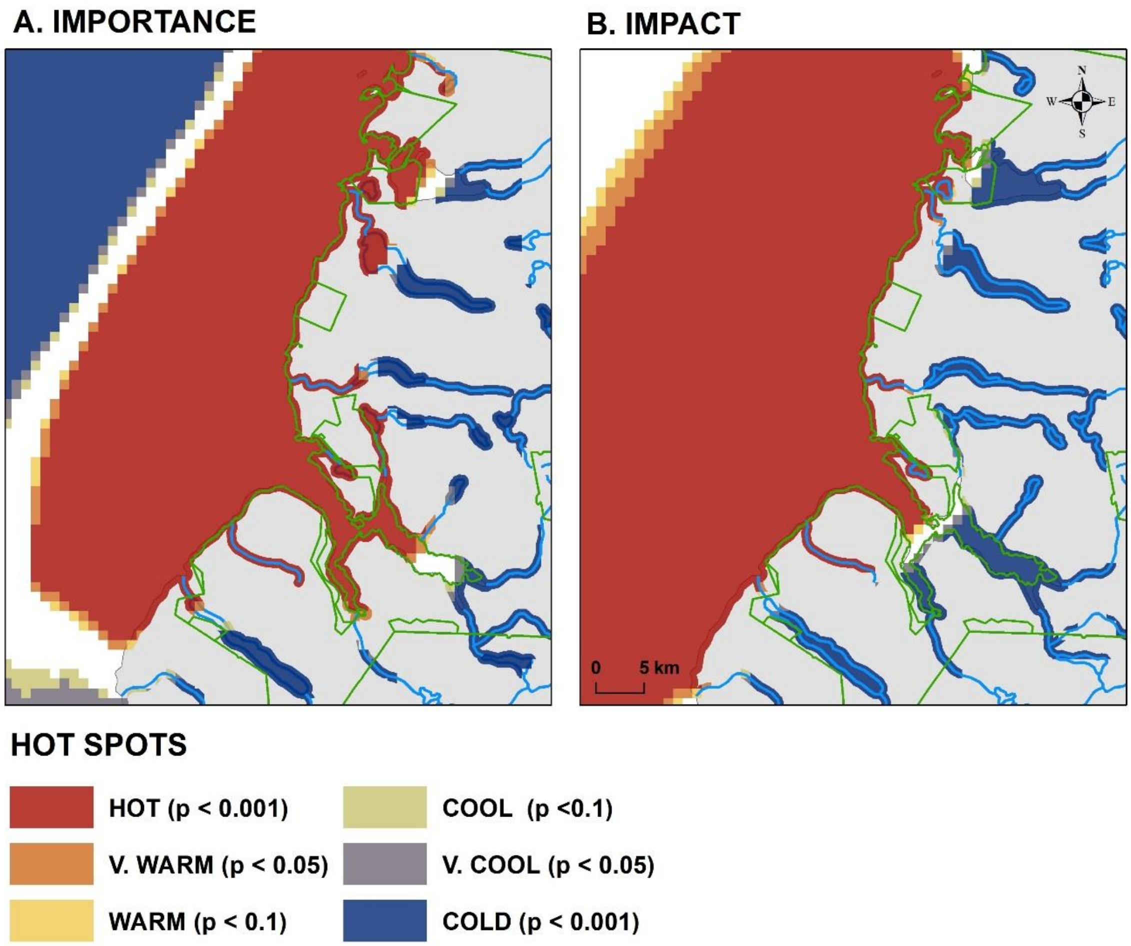


Figure 2.2.1 A comparison of the socio-ecological hotspot maps of impact and importance. Maps were produced using the Getis-Ord Gi* spatial statistic software in ArcGIS 10.3. The red hotspots ($p< 0.001$) and yellow warm spots ($p< 0.1$) are most agreed by experts for their cumulative levels of impact and importance. Major areas of importance and impact are dominated along the coastline and into the u-shaped fjord of Bonne Bay, NL.

2.4 Discussion

2.4.1 Areas of Importance and Impact

Overall the polygons which highlight the areas of importance and impact show many similarities in where they are located. The highest areas of importance (dark purple and pink shaded areas in **Fig 2.1.7** and **Fig. 2.1.8**) seem to be more widespread than those of the orange and red areas of impact shown in **Fig. 2.1.9** and **2.2.1**. This may therefore identify two positive outcomes: 1. The experts believe socio-ecologically, that a large part of this study area is of great importance to multiple sectors, visitors and coastal community members and, 2. The experts believe overall there are specific areas to focus on that may be highly impacted; especially ones close to the enclave communities within GMNP (see **Fig 2.1.2**). Through the maps one can also infer that the participants who were experts and stakeholders from various areas of western NL believe, cumulatively, the largest impacted area, in this study area, is throughout Bonne Bay and the rest of the coastal regions that border GMNP have been impacted to a lower degree (see **Fig. 2.2.1**). This study area is one that is situated in a National Park. Rural Newfoundland communities typically with fewer visitors, would argue, that activities like bird watching and hiking may not be considered an impact. With the coastal community population in this study area ranging on a regular basis of approximately 3000 in the fall and winter to a conservative, 100,000 tourists in the spring and summer, enjoying the minimal impact activities converts to one that is not so insignificant (Parks, 2009; Census, 2016).

Among the agents of change assessed for values of importance, the marine significant area (MSA) seems to highlight the most coastal and offshore marine areas as important (see **Fig. 2.1.7A**). Tourism and Community Culture (TCC), has a focus area of importance more to the coastal regions and inner portions of Bonne Bay (see **Fig. 2.1.7B**). Fishing is a large part of the coastal community's way of life in this region and the MSA map reflects this. Since the 1970s the tourism sector in this region has also been important and although this national park is land based, the marine environment and beauty of the ocean is a large part of our visitor's overall experience in GMNP (Parks, 2009). Many of the experiences created for visitors to GMNP are concentrated near the coast or take you through the boreal forests and up lookout areas that allow the visitor to admire GMNP's coastal and marine vistas for miles.

The Non-Renewable Resource Development (NRRD) map seen in **Fig. 2.1.7C**, was created to show where experts felt NRRD would be important economically. Visually, if this industry were to take place in this area, the experts feel all coastal communities would benefit. But, if you view the maps analyzed for impact you can also see the experts felt, on a higher, more focused level, the whole study area would be impacted (see **Fig. 2.1.9B**). The large concentration of orange and red polygons illustrations there is also a large agreement among experts of where exactly the study area would be impacted by this industry on an exploration level and if drilling were to take place. Overall this and Shipping and Sewage (SS) (**Fig. 2.1.9C)** were the two agents of change experts agreed added to the most potential impact for the area. The overall results show Aquatic Invasive Species (AIS) and Tourism and Community Culture (TCC) were two agents of change that may have the least amount of impact to the area (see **Fig. 2.1.9A** and **Fig. 2.1.9D**). The high concentration of red polygons in AIS does, however, show that experts feel where AIS was identified, they are of high impact. Overall the large amount of green in the TCC map shows the majority believe the impact from tourism is low. It is interesting to note that although Western Brook Pond gets the largest number of visitors for the area, (Parks, 2009), it was only pointed out as a level green or low for impact in the mean statistical maps.

In contrast, the hotspot map of importance and impact found in **Fig. 2.2.1** shows a larger agreement among experts that Western Brook Pond in not only important to the study area but, is also highly impacted at the beginning of the pond, and river where most of the traffic from tourism exists. The ongoing theme from the mean statistical maps to the hotspot maps also validates the importance of the entire coastal and marine region surrounding GMNP (**Fig. 2.2.1A**). Less impact is seen further in the mouth of Bonne Bay and up the river systems that were identified as important but, more impact was identified by experts in the offshore areas (**Fig. 2.2.1B**).

The large areas being identified as both highly important and impacted should send a loud message to decision makers that review of the areas being used most by various “agents of change” should be assessed to ensure sustainable efforts are made for the health of the oceans and the community.

2.4.2 The workshop and experts

The dynamic of the workshops proved to be very successful. From the inception of recruiting experts for this study to the framework that set the stage for the workshop, everyone was well informed prior to their valuation of the maps and, everyone felt included no matter what their background of expertise was. Having everyone answer their questions on an individual basis and, emphasizing their work would be anonymous, allowed the experts to relax and complete the map valuations to their best ability without worrying about pressures from other experts outside their sector. As Daniels *et al.*, 2001 noted, by giving ocean users time to learn about marine spatial planning and explore their individual and collective concerns in a confidential setting, subsequent interactions with environmental groups, ocean managers, and policy-makers can occur on a more even footing.

Hosting a workshop for people that had a lower reading ability was also a successful component of this study. A large portion of the small-scale fishing industry as well as other coastal community members still have literacy challenges. Holding at least one workshop where the researcher read through the questions to all, not just a few, allowed those with literacy issues to blend in with the crowd and complete their maps in a confident manner; adding again to the richness of local knowledge you might miss without this available setup.

2.4.3 Combining SDM and Geospatial Tools

Ensuring there was a balance of experts in all areas of sustainability produced results that a decision maker could use in an effective manner. Future management in this area using a SDM and the maps produced with the MAEP tool can be combined and, if used properly, have little opposition in the socio-ecological sector. The geospatial tool that has been created in this study would fit well in an SDM framework. The addition of this tool in a SDM process can be applied in complex situations as it makes allowances for uncertainties and helps in the creation of a series of alternatives within which stakeholders can negotiate and trade-off until they find a common ground (Gregory *et al.*, 2012).

2.4.4 Uncertainties with Socio-Ecological Data

Although public consultation and collaboration is ongoing between various experts and stakeholders in natural resource management it is still not ideal. Many government agencies have workloads and deadlines that leave them no time to do effective public consultations. When it does take place, it is rushed and done in a manner that is hard to evaluate in a way that can be used for actual decision making against science and economic advice. Christie *et al.*, 2003, states that many marine spatial planning (MSP) events underline the lack of broad participations in management, little or no sharing of economic benefits, the absence of conflict resolution mechanisms and tension between different sectors. MSP using tools, like the one created in this study, should be conducted in an open, transparent, and participatory fashion that ensures all stakeholders, including representatives from existing and emerging ocean industries, have an active role during all processes (Cantral, 2009).

The process of acquiring and using socio-ecological data can be messy and at times, hard to use against values numerically set out in science and economics. That does not take away from its importance in the DM process. Decision-makers should not wait for perfect data before moving forward; they need to make sure all parties are meaningfully involved and their conclusions should be drawn from a wide variety of sources, including the less traditional non-governmental sources (Gopnik *et al.*, 2012). Converting socio-ecological data into a geospatial tool, like what has been done in this study, allows the decision maker to have a visual display of information that in the past was hard to value against quantitative data. By translating social values into something more visually tangible this tool was able to show how advice can be communicated to decision-makers, increasing the likelihood that government will integrate the information within its DM process (Hutchings & Stenseth, 2016).

2.5 Conclusion

From the inception of the tool and decision to study GMNP to the final results created with the aid of available experts, this study has established an innovative way to use socio-ecological data to make more informed decisions for the marine and coastal management areas off western, Newfoundland. The analysis of the maps valued by these experts demonstrates the importance of this area on multiple levels and highlights the participants perceived impacts from various agents of change throughout the study area which should not be ignored. The experts chosen for this study were from all areas of sustainability and for that reason, allowed this study to produce spatial data that can be used along with science and economic data to push a more integrated approach to decision-making. Pressures on the marine environment to produce resources for the globe have never been more dominant. These pressures are ones that should drive the municipal, provincial and federal governments to create sustainable marine plans for the present and future generations that will depend on them most. This tool was made with all industries, NGOs, and municipalities in mind. Its goal was to create a way to efficiently and effectively plan from beginning to end with all stakeholders at the decision-making table. If used correctly, in a structured decision-making approach, this tool will allow sustainable projects to exist in harmony with healthy oceans and coastal communities for many generations to come.

2.6 References

Blaustein, R.J., 2007. Protected areas and equity concerns. Bioscience 57 (3), 216-221.

Blount, B.G. & Pitchon, A, 2007. An Anthropological Research Protocol for Martine Protected Areas: Creating a Niche in a Multidisciplinary Cultural Hierarchy. Human Organization; Summer. 66 (2), pp.103-111

Brown, G., Reed, P., 2012. Social landscape metrics: measures for understanding place values from public participation geographic information systems (PPGIS). Landsc. Res. 37, 73e90.

Cantral, L., et al. 2009. Principles for Marine Spatial Planning: Outcomes of the Ocean Industries MSP Policy Labs. Policy Brief from the Nicholas Institute for Environmental Policy Solutions, Duke University.

Census Stats Canada 2016 http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E&TABID=1

Christie, P., McCay, B.J., Miller, M.I., Lowe, C., White, A.T., Stoffle, R., Fluharty, D.L., McManus, L.T., Chuenpagdee, R., Pomeroy, C., Cuman, D.O., Blount, B.G., Huppert, D., Villahermosa Eisma, R.-L., Ocacion, E., Lowry, K., Pollanac, R.B., 2003. Toward developing a complete understanding: a social science research agenda for marine protected areas. Fisheries 28 (12). 22-26.

Daniels, S.E., Walker, G.B. 2001. Working through Environmental Conflict: The Collaborative Learning Approach. Praeger Publishers.

De Santo, E.M., 2013. Missing marine protected area (MPA) targets: how to push for quanity over quality undermines sustainability and social justice. Journal of Environmental Management 124, 137-146.

Ehler, C., Douvere, F., 2009. Marine spatial planning: a step-by-step approach toward ecosystem-based management. Intergovernmental Oceanographic Commission (IOC) Manual and Guides; No.53, ICAM Dossier No.6. http://unesdoc.unesco.org/images/0018/001865/186559e.pdf

Gregory, R., Failing, L., Harstone, M., Long, G., McDaniels, T., & Ohlson, D.,. (2012). *Structured decision making: A practical guide to environmental management* (First ed.). West Sussex: Wiley-Blackwell.

Gopnik, M., et al. 2011. Stakeholder Participation in Coastal and Marine Spatial Planning. Policy Brief from the Nicholas Institute for Environmental Policy Solutions, Duke University.

Gopnik, M., Fieseler, C., Cantral, L., McClellan, K., Pendleton, L., Crowder, L. 2012. Coming to the table: Early stakeholder engagement in marine spatial planning. Marine Policy. 36, 1139-1149

Hutchings, J., Stenseth, N.C. 2016. Communication of science advice to government. Trends in Ecology & Evolution. 31 (1) 7-11.

Innes JE, Booher DE. 2004. Reframing public participation: strategies for the 21st century. Planning Theory Pract.; 5(4):419–36.

Jones, P.J.S., 2009. Equity, justice and power issues raised by no-take marine protected area proposals. Marine Policy 33, 759-765.

Kukac, J. 2009. Capturing the importance of natural resources and future activities in St. Paul's, Newfoundland. Thesis fulfillment for the Masters of Arts (Geography). Pp 1-148. Memorial University of Newfoundland.

Mahboubi, P., Parkes, M., Stephen, C., Chan, H.M. 2015. Using expert informed GIS to locate important marine social-ecological hotspots. Journal of Envir. Manag. 160; 342-352.

Murry, G., D'Anna, L., MacDonald, P. 2016. Measuring what we value: The utility of mixed methods approaches for incorporating values into marine social-ecological system management. Marine Policy. 73, 61-68.

Parks Canada. 2009. Gros Morne National Park of Canada-Management Plan. (2009, October). Retrieved October 16, 2014, from http://publications.gc.ca/collections/collection_2014/pc/R64-105-67-2006-eng.pdf

Pomeroy, R., Douvere, F. 2008. The engagement of stakeholders in the marine spatial planning process. Marine Policy; 32(5): 816–22.

Ritchie, H., Ellis, G. 2010. A system that works for the sea? Exploring stakeholder engagement in marine spatial planning J. Environ. Plan. Manage. 53:701–23.

United Nations. *Transforming our world: The 2030 agenda for sustainable development.* A/RES/70/1, 21 October, 2015, available from https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

Whitney, C. K., Bennett, N. J., Ban, N. C., Allison, E. H., Armitage, D., Blythe J. L., Burt, J. M., Cheung, W., Finkbeiner, E. M., Kaplan-Hallam, M., Perry, I., Turner, N. J., and Yumagulova, L. 2017. Adaptive capacity: from assessment to action in coastal social-ecological systems. Ecology and Society 22(2):22. https://doi.org/10.5751/ES-09325-220222.

The link between successful marine conservation areas and social justice: Using social-ecological hotspots to determine the suitability for a National Marine Conservation Area surrounding Gros Morne National Park, Newfoundland.

3.1 Introduction

3.1.1 Marine Protected Areas and Social Justice

In 2010, the Conference of Parties (COP) set one of their target goals to protect 10 percent of coastal and marine areas especially areas of importance for biodiversity and ecosystem services (COP 10 decision; target 11). The hope was that the target would be done through effective and equitable management of well-connected systems. This target has not been met and in Canada alone, the United Nations Environmental Program (UNEP) stated in their 2012 review of global Marine Protected Area (MPA) establishment that, on a federal level there is a low percentage of Canadian oceans that are being protected and managed (~0.56%) (UNEP-WCMC, 2008). Throughout the world many proposals have been written for the establishment of different MPAs whether they are large no-take MPAs, “micro” MPAs, or marine reserve style MPAs. Historically there has been challenges implementing proposed. Many governments are proposing large scale MPAs and, one challenge, is the need for effective monitoring and enforcement tools that are ignored by advocates, and the use of local human networks as the stewards (De Santo, 2013).

Many factors affect the establishment of MPAs. When developed, government and managers often pay little attention to social justice. Social justice, in the context of MPAs, considers the fair allocation of adequate access to the coastal waters and its resources amongst fishers and other members that rely on the land for their economic sustainability prior to MPA's designation (De Santo, 2013; Jones, 2009). Some studies suggest when a large target for MPAs are made, governance looks beyond the stakeholders and instead, makes decisions that are more "politically fit"; this has caused many social injustices globally (Blaustein, 2007; Jones, 2009; Chuenpagdee *et al.* 2012; De Santo, 2013; Blount and Pitchon, 2007). In Gopnik *et al.,* 2012, fishing interests (both commercial and recreational), whose efforts are widely distributed rather than tied to a specific location, felt under siege from the growing number of claims for ocean space, including the establishment of MPAs. Some users also felt misunderstood and vilified by environmental advocates who seemed to disregard the value of economic activity; all reasons for resistance and unsuccessful MPAs (Gopnik *et al.,* 2012).

In areas where communities and MPAs are either co-existing or are trying to co-exist one can observe many issues related to social justice. Those issues are far more prevalent in areas close to shore with a long history of fishing. To ensure protection of marine life and its habitat, biological and ecological factors are the primary concern of MPAs. Deciding the place and role of humans is a secondary point for decision making. This is where the injustice surfaces; especially when the creation of MPAs principally was to manage human behaviour and overexploitation of fish stocks (Blount & Pitchon 2007). Many MPAs in place are declaring to be entirely no-take which phases out human activity. Although this may be ecologically sound, it risks alienating stakeholders and removes the potential for monitoring by humans (De Santo, 2013). Managers need to negotiate with all who have a stake in the resource, to ensure conflicting interests are balanced. This allows some harmony of involvement throughout the decision-making process; “a divided community is not a good breeding ground for success” (Chuenpagdee *et al.*, 2012).

Incorporating environmental values from society in a meaningful way is essential for the success of marine conservation development. Environmental goods must be counted as primary goods alongside all other goods relevant to society like opportunity, income and wealth for them to be significant and vice versa (Miller, 1999). The use of equity is important when looking at the needs for conservation and currently it is not playing a dominant role in Canada (Brechin, 2003). If society feels the resources they depended on as ‘a way of life’ or primary goods are denied to them then social justice is denied. The policies created to protect our oceans deal with a fundamental challenge in environmental and social justice; our way of thinking that human society and the natural environment are mutually exclusive (Peterson *et al*., 2007).

In Miller, (1999) social justice is stated as the distribution of rights, opportunities and resources among human beings and has principles to regulate the legal system, the structure of the economy, welfare and so to allow fair distribution of benefits and burdens to society. Social justice can also tie in with another term, socioeconomics, and many believe socioeconomic considerations are fundamental in the success of MPA establishment (Blount & Pitchon 2007). The main stakeholders affected when MPAs or where marine reserves are established, are the fisher people and local users who depend on the ocean for economic gain or way of life. The fisher ‘way of life’ can, and often does, trump ‘rational economic actors’ (Blount & Pitchon 2007). The presence or absence of cooperation and support from such dependents of the marine environment will be influential as they will be the ones concerned with notions of ‘fairness’ and ‘equity’, a concept that requires cultural elaboration (Blount & Pitchon 2007). When marine conservation areas are tailored to meet the local needs, understanding conditions and attitudes of those most affected, then success will be observed. Socioeconomics can therefore be the pivotal set of variables for MPA success (Robert & Hawkins, 2000). MPA success is reliant on the connection to social justice and the human dimension. It is intimately involved in the resolution of conflicts and will thus influence the effectiveness and outcomes of governance solutions (Chuenpagdee *et al*., 2012). The ten human dimensions that connect most to successful MPAs mentioned by, Charles and Wilson, 2009 are: (i) objectives and attitudes, (ii) people-orientated “entry points”, (iii) attachment to place, (iv) make participation meaningful, (v) knowledge has a “people side”, (vi) effective governance is critical, (vii) get the rights right, (viii) costs, benefits, and distribution, (ix) deal with displacement, and (x) see MPAs in the bigger picture.

3.1.2 Study Area

Gros Morne National Park (GMNP) is in western Newfoundland, Canada (**Fig. 3.1** and **Fig. 3.2).** The landscape that makes up this National Park includes towering cliffs and dramatic fjord valleys, glacial lakes, coastal bogs and dunes, and highland plateau (Parks Canada, 2009a). It is a UNESCO world heritage site and home to many species including Woodland caribou and Arctic hare. The park encompasses 1805 km^2 of mountainous and coastal areas as well as eight communities that are scattered throughout; making a total population of roughly 3000 people (Parks Canada, 2009a; Census Canada 2016).

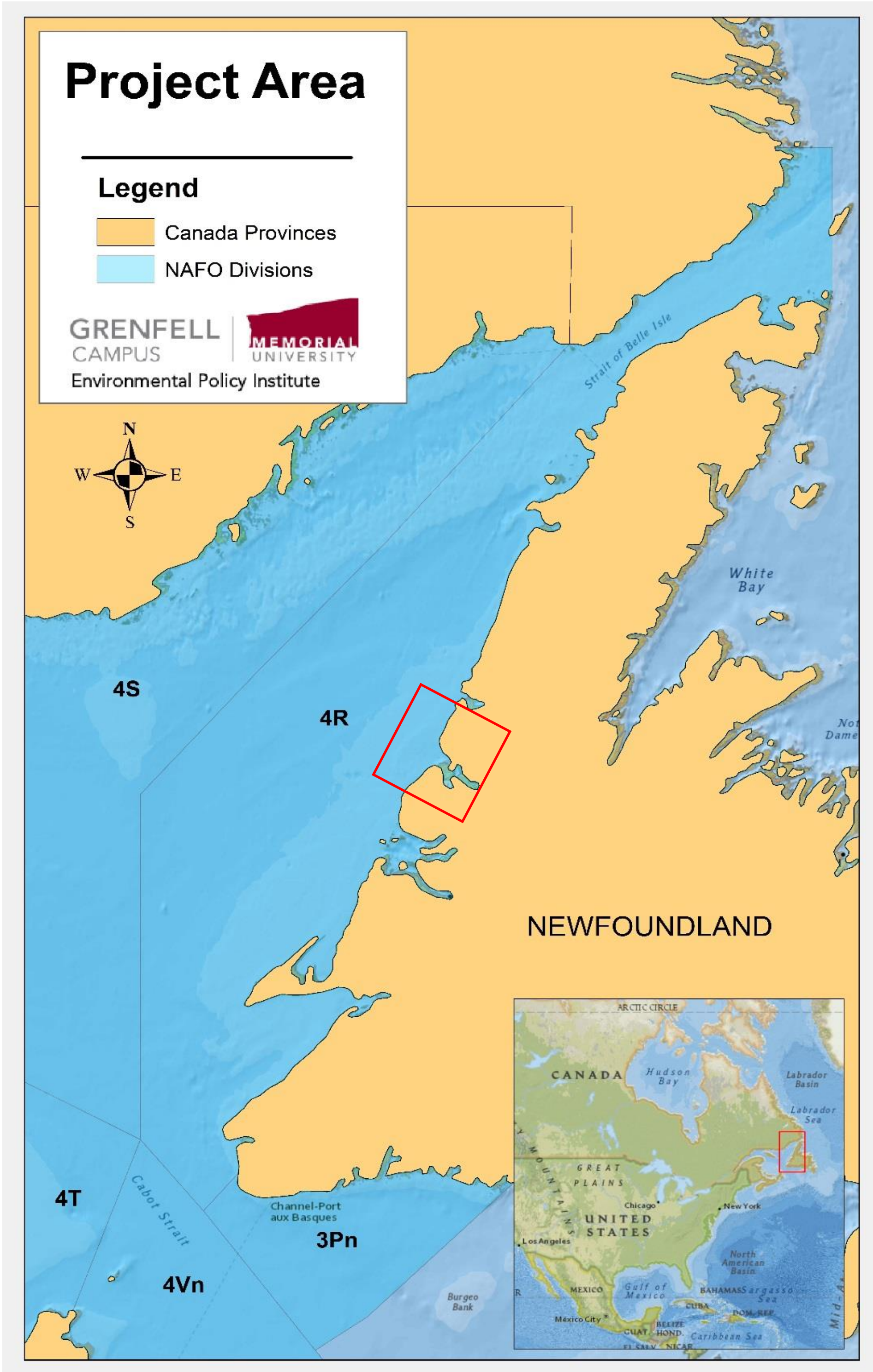


Figure 3.1 The province of Newfoundland highlighting the study area in the red box; Gros Morne National Park.

Figure 3.2 Marine and Coastal Study Area around Gros Morne National Park.

The waters surrounding GMNP are rich in many marine resources; one of the main drivers for coastal community settlement. The coastal communities settled in the late 1800's in western, Newfoundland for the abundant ground fish and lobster fishery (Kukac, 2009). With the fisheries in decline and the eventual collapse of the cod fishery in 1992, many coastal community members left for other sources of income while others, held fast and found a way of life through a variety of marine and land-based tourism industries (Mason, 2002; Kukac, 2009). As the tourism industry grows with an annual visitation of over 100,000 people to the Park (Parks, 2009a) and, as marine based industries continue to look for areas to develop in the marine environment of western, Newfoundland, the pressure to develop a marine management plan and highlight recommended areas for conservation has never been so important. Like mountain areas, fragile coastal lands are also put at risk by active tourist industries; wetland drainage, littering careless waste disposal and inadequate planning are contributing to environmental damage of these regions (Mueller & McChesney, 1996).

3.1.3 Is a National Marine Conservation Area the right MPA?

To aid in the National Marine Conservation Areas Policy (NMCAP) formulation, Parks Canada with the help of DFO developed a biogeographical classification to aid in the selection of a truly representative system of MPAs (DFO, 2011). Parks Canada recognized that success was based on, "the need for a high level of cooperation between the public and all levels of government to properly manage areas in a sustainable manner that meets the needs of present and future generations without compromising the structure and function of the ecosystems, including the submerged lands, water column, with which they are associated" (Parks Canada, 2009b).

An essential feature to this formulation was that NMCA had to be large and have multiple "zones". Physically, they would be separated but functionally, they are connected due to the nature and fluidity of water; see the ecoregions in **Fig. 3.3** (De Santo, 2013; Parks Canada, 2009b). **Fig. 3.4** shows a simple diagram of how the zones are created within an NMCA area. The core area: Zone I, would have a significantly vulnerable ecosystem or high cultural value and would be set for preservation. Zone II; the natural environment zones, would be a buffer zone to enhance protection of Zone I and used for ecological research and monitoring. The outer Zone III, referred to as the conservation zone, would allow renewable resources and aquaculture industry to exist in it. It would also have high potential for non-consumptive recreational use and public education (Parks Canada, 2009b). With the same agency governing the land and coastal areas of GMNP it seems the transition to create a NMCA surrounding GMNP would be ideal.

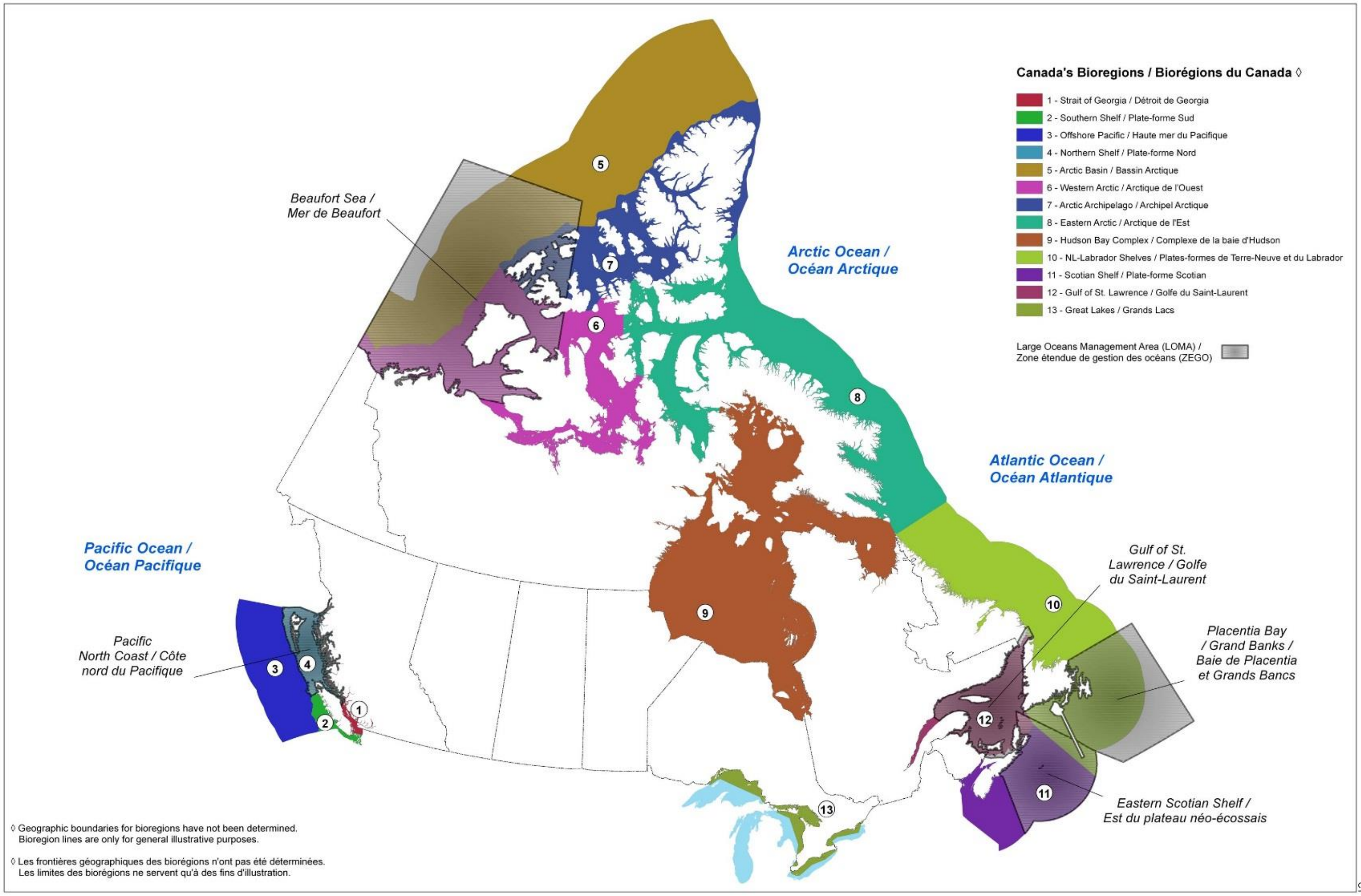


Figure 3.3 Large Ocean Management Areas and Bioregions for Canada's National Network of Marine Protected Areas (DFO, 2011).

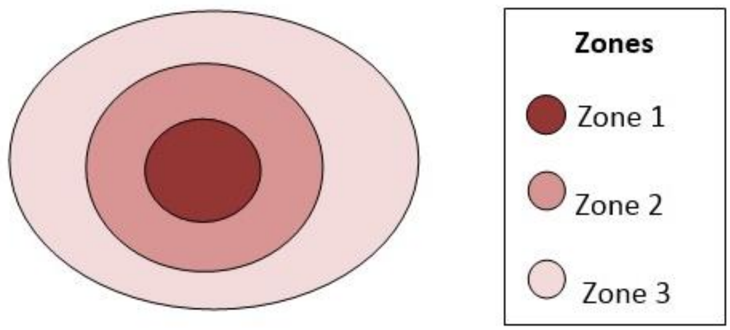


Figure 3.4 Diagram representing the zones for a National Marine Conservation Area.

This study used a socio-ecological, geospatial tool to assess the potential for a MPA surrounding GMNP. Because a similar zoning system exists by Parks Canada for the land based management (LBM) of GMNP this study has chosen the NMCA framework for the potential MPA design. This study aims to use the geospatial tool referred to as, "MAEP tool", to assess the social values of importance and impact from experts and coastal community members most at stake. This data will offer recommendations that decision makers could use along with scientific and economic data to decide the best areas for effective zoning of a possible MPA around GMNP. It is recognized that some potential stumbling blocks can occur when implementing any type of MPA or conservation zone that has historically allocated most of its marine space to commercial and recreational fishery management (Sanchirico *et al*., 2013). With the inclusion of those with most at stake this study will avoid the failure to consider human activities outside MPA boundaries, ultimately achieving the overall MPA goals with the inclusion of social justice (Havard *et al.*, 2015).

3.2 Methods

This case study was generated from a larger study that looked at the areas socio-ecologically most important and impacted in the marine and coastal management areas surrounding GMNP (see Ch2: Informed Decision-Making: The use of geospatial analysis to identify socio-ecological hotspots in the marine and coastal management areas surrounding Gros Morne National Park, Newfoundland). To gain the essential information for this case study multiple workshops were held to ask experts in various fields what they thought of an MPA for this area; specifically, an NMCA. Prior to this question the researcher gave the experts and stakeholders an information package explaining what a National Marine Conservation Area was and how its zoning was broken down (see **Fig 3.5**). After reading this package, the participants were asked if the coastal and marine areas were suitable for an NMCA around GMNP. If they answered yes, they were given a map to shade the areas they believed were appropriate for each zone (see **Fig. 3.6**).

1. Zone 1 was represented with a red shade
2. Zone 2 was represented with a yellow shade
3. Zone 3 was represented with a green shade

National Marine Conservation Area (NMCA) Valuation

Background Information on NMCA; did you know…

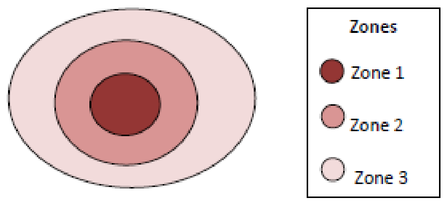


Fig 2. Diagram representing the zones for a National Marine Conservation Area.

A NMCA has to be large and have multiple "zones". Physically, they would be separated but functionally, they are connected due to the nature and fluidity of water (4,5)*. "The Core Area";* ***Zone I****, would have a significantly vulnerable ecosystem or high cultural value and would be set for complete preservation.* ***Zone II****; "The Natural Environment Zones", would be a buffer zone to enhance protection of zone I and used for ecological research and monitoring. "The Outer Area";* ***Zone III****, referred to as the conservation zone, would allow renewable resources and aquaculture industry to exist. It would have high potential for non-consumptive recreational use and public education.*

1. After reading the information above, do you think the study area in this workshop would be a good fit for a NMCA?
   A. Yes
   B. No

2. Identify areas that you feel would be best suited for the three different zones of a NMCA. If you ***did not*** *think there was anywhere appropriate for a NMCA on either map then* ***skip this map valuation.***

Zone I = RED   ZONE II = YELLOW   Zone III = GREEN

Figure 3.5 Information Package and Question on NMCA Suitability for GMNP

[4] De Santo, E.M. 2013. Missing marine protected area (MPA) targets: how to push for quantity over quality undermines sustainability and social justice. Journal of Environmental Management 124, 137-146.

[5] Parks Canada-Activity Policies: National Marine Conservation Areas Policy. (2009b, April 15). Retrieved October 16, 2014, from http://www.pc.gc.ca/eng/docs/pc/poli/princip/sec2/part2b.aspx

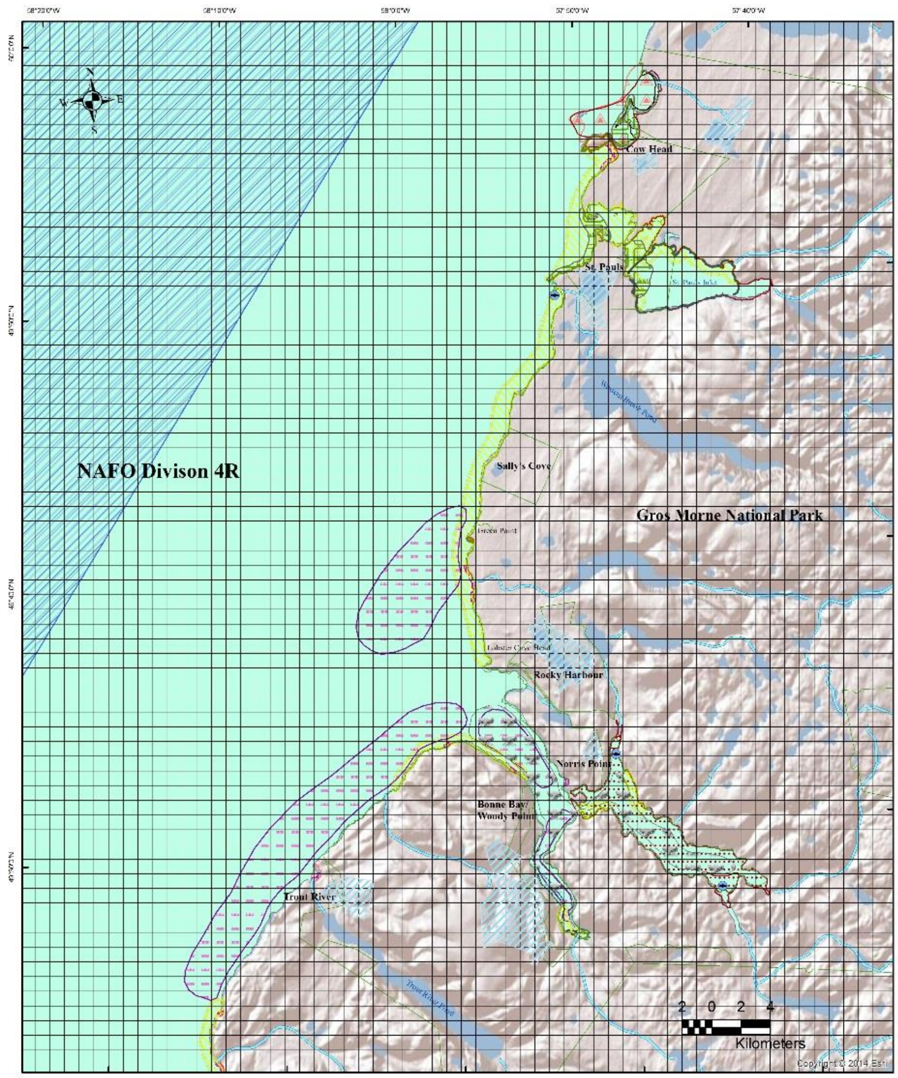


Figure 3.6 Study area map given to participants to shade during workshop.

The MAEP Toolbox created for **Chapter 2** was used to generate mean statistical maps and an overall hotspot map that displayed socio-ecological values of importance for each NMCA zone. Once shading was complete geospatial analysis was conducted and a number value was given to each color shade: red = 1000, yellow = 100 and, green = 10. To understand the process of this analysis please refer to **Appendix C**.

The shaded, hard copy maps were digitized then georeferenced (refer to **Appendix C**.). After this was completed, the maps were prepared for spatial analysis using the MAEP Toolbox. This GIS tool was created to preform the following 7 steps essential for the spatial analysis of this study:

1. standardizing fields
2. deleting unwanted fields
3. converting feature classes to rasters
4. adding rasters by zone
5. adding rasters by map category
6. converting sum rasters to polygons and,
7. preforming hotspot analysis

The first two steps in the toolbox involve data preparation and cleaning. The third through fifth steps will run the actual analysis, calculating the mean statistical outputs for zone 1, 2 and 3 as well as 1 cumulative map displaying overall preferred protection for the area. The sixth and seventh steps were conducted to run Incremental Spatial Autocorrelation (ISA) and a Getis-Ord Gi* Hot Spot (HS) analysis on the cumulative preferred protection for the marine and coastal management areas surrounding GMNP (See **Appendix C** for specific analysis details).

Maps that were created to show the hotspots for socio-ecological importance and impact in the marine and coastal areas around GMNP in **Chapter 2** were also used to compare with the hotspot map of protection. These maps were necessary to give the researcher a better base to make decisions for effective conservation zoning in the study area. To learn more about the process to gain those values please review **Appendix A**, Steps for a Successful Public Consultation Workshop for Natural Resource Management.

3.3 Results

3.3.1 Participation and sample size

As mentioned in the methods, the participation for this study came from a preliminary? first? workshop to identify the overall socio-ecological importance and impact values of the marine and coastal management areas surrounding the Gros Morne, Newfoundland region[6]. Of the 32 experts that participated in that study, 27 completed the MPA survey. The question for this research was found in the Tourism and Community Culture (TCC) attribute package as well as, the Marine Significant Areas (MSA) package; listed as "National Marine Conservation Area (NMCA) Valuation", seen in **Fig. 3.5**.

Feedback and participation for this study was all very positive. One hundred percent of the experts surveyed checked, YES, agreeing that the coastal and marine management areas needed protection around GMNP and thought it would be a good fit for a NMCA. The experts were sourced from all areas of expertise and a balance of backgrounds based on the tiers of sustainability was key to ensuring the outcomes were unbiased; producing maps suitable for informed decision making. Participants were listed under the expertise they identified in during the initial survey given prior to the workshop (see **Table 3.1**). From these data, it was observed that many experts could not be labelled in solely one tier of sustainability or the other (see **Fig. 3.7**). Because this study was

[6] For more information on this study please refer to **Chapter 2**.

concentrated on expertise and not just coastal community input, many people who were socially invested in this area were also an expert in another tier of sustainability; aiding to the confidence of information they submitted during the workshops.

The initial survey for the overall workshop also identified how long the participants either lived or worked near the marine or coastal environment (see **Table 3.1**). The results from this survey indicated that 84% of the participants have worked on the marine and coastal environment for 10 or more years and 94% have lived near the marine and coastal environment for 10 or more years (see **Fig. 3.8**).

3.3.2 Analysis

3.3.2.1 Data Clustering for Hotspot Analysis

The hotspot analysis for cumulative importance and impact was done using Getis-Ord Gi* Hot Spot (HS) analysis in ArcGIS 10.3. To symbolize the hotspots in the feature classes, use the "Gi_Bin Fixed 6000" field. **Table 3.2** display the values in this field and represent the various levels of confidence.

Table 3.1 Participant survey to assess areas and level of expertise	
Questions	**Answer options**
1. How many years have you lived around the coastal and marine environment?	1-5 years
	6-10 years
	11-30 years
	Over 30 years
2. How many years have you studied or worked in or on the marine and coastal environment?	1-5 years
	6-10 years
	11-30 years
	Over 30 years
3. Which subject areas or topics do you feel you would be most knowledgeable in? Check ALL that apply	Environment topics (terrestrial based only)
	Environmental Topics (marine and freshwater based only)
	Environmental Topics (contaminants, sewage, waste)
	Environmental topics (all areas above)
	Economic Topics (transport and shipping)
	Economic Topics (fisheries)
	Economic Topics (tourism)
	Economic Topics (oil and gas)
	Economic Topics (all areas)
	Social Topics (coastal community member)
	Social Topics (tourism)
	Social Topics (fisheries)

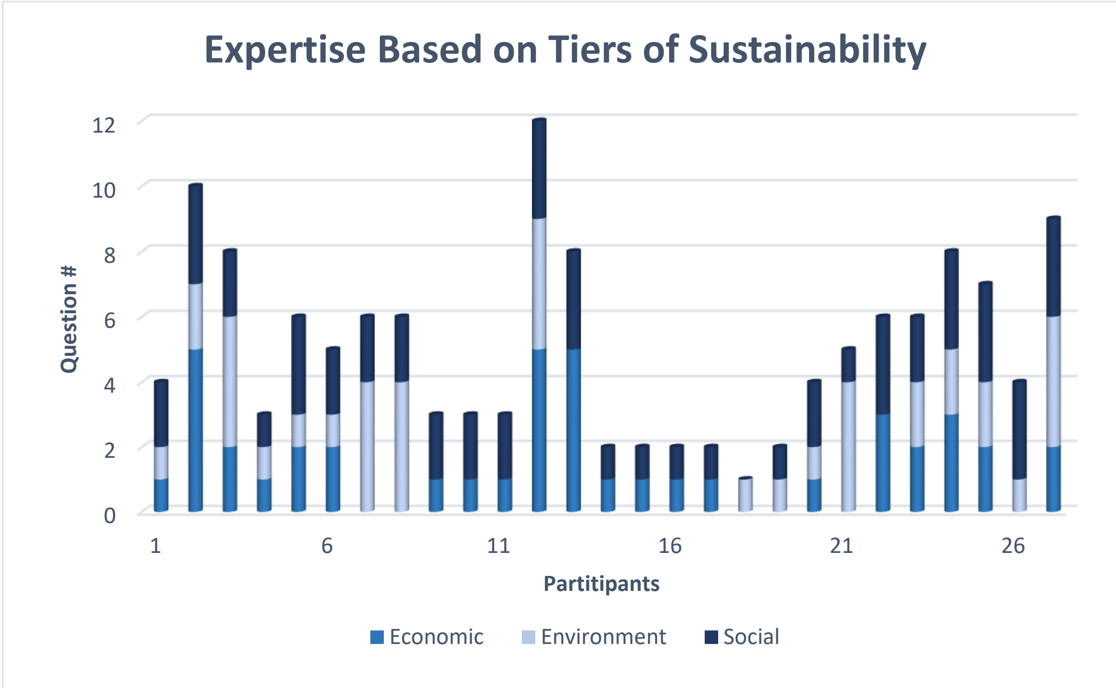


Figure 3.7 The outcome of expertise for each participant based on the 12-question survey found in Table 3.1.

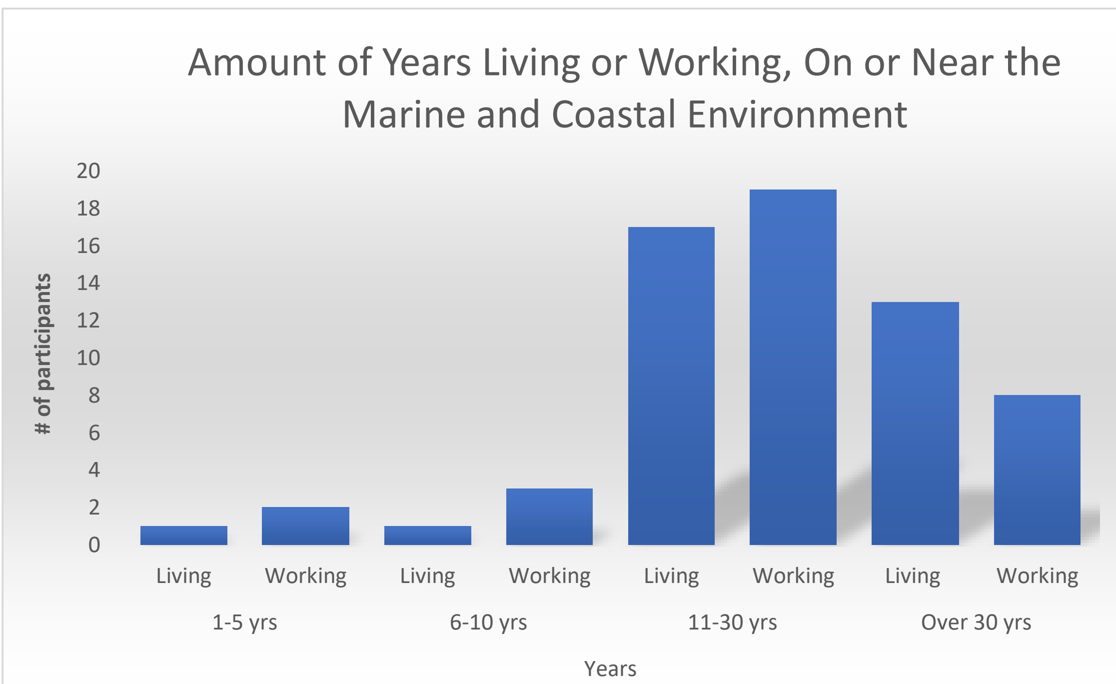
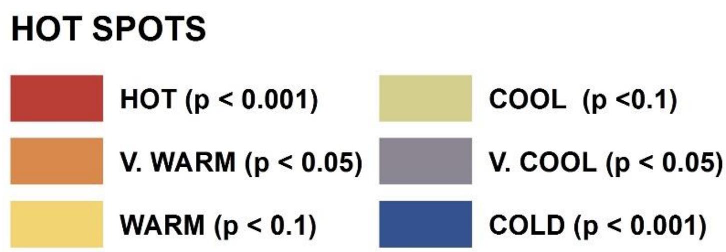


Figure 3.8 The amount of years each participant lived or worked on or near the marine and coastal environment.

Table 3.2 Confidence levels and connected hotspot descriptions			
Gi_Bin Fixed 6000	**DESCRIPTION**	**Confidence interval**	**p value**
3	Hot	99%	p < 0.001
2	V. Warm	95%	p < 0.05
1	Warm	90%	p < 0.1
0	Neither hot nor cold	0%	p > 0.1
-1	Cool	90%	p < 0.1
-2	V. Cool	95%	p <0.05
-3	Cold	99%	p < 0.001



A high z-score and small p-value for a feature indicates a spatial clustering of high values. A low negative z-score and small p-value indicates a spatial clustering of low values. The higher (or lower) the z-score, the more intense the clustering. A z-score near zero indicates no apparent spatial clustering (the white spaces). To read more on this please refer to Workbook 2 in, **Appendix C**.

3.3.2.2 Most preferred areas for protection

Mean statistical analysis was completed as the basis for the hotspot analysis. The statistical maps allowed this study to have another output to visually display the participants, most preferred areas for NMCA zones 1, 2 and 3 as well as the overall areas they preferred to be protected on all levels (see **Fig. 3.9** and **Fig. 4.0**). Although there was an overall agreement that all the coastal and marine areas that border Gros Morne

National Park (areas shaded from blue to pink), there were some differences in the areas to concentrate each zone. These differences are shown in **Fig. 3.9 A-C**.

Zone 1 or full protection found in **Fig. 3.9A** shows the majority chose the central area and two arms of Bonne Bay, shaded in dark pink. The second most preferred areas shown in dark purple for Zone 1 protection can been seen at the mouth of Trout River, Bonne Bay, the coast boarding Sally's Cove and throughout St. Pauls Inlet, NL. Zone 2 protection, which would essentially buffer Zone 1 in an NMCA, is shown in **Fig.3.9B.** This map, without overlaying it on the Zone 1 map found in **Fig. 3.9A**, displays a generated coastal border of pink throughout the u-shaped fjord of Bonne Bay as well as around the mouth of St. Pauls Inlet. Zone 3 protection which would serve as a conservation zone but also, allows renewable resource and aquaculture industries to exist is found in **Fig. 3.9C.** Although the dark purple can be seen through Bonne Bay and boarding the coasts north and south of it, the highest selected area for Zone 3 protection is found in pink at the mouth of Bonne Bay and just offshore in the marine areas parallel to the coastal zones throughout the study area. The pink areas are close to the town of Woody Point and Norris Point, areas very busy in the seasonal tourism industry.

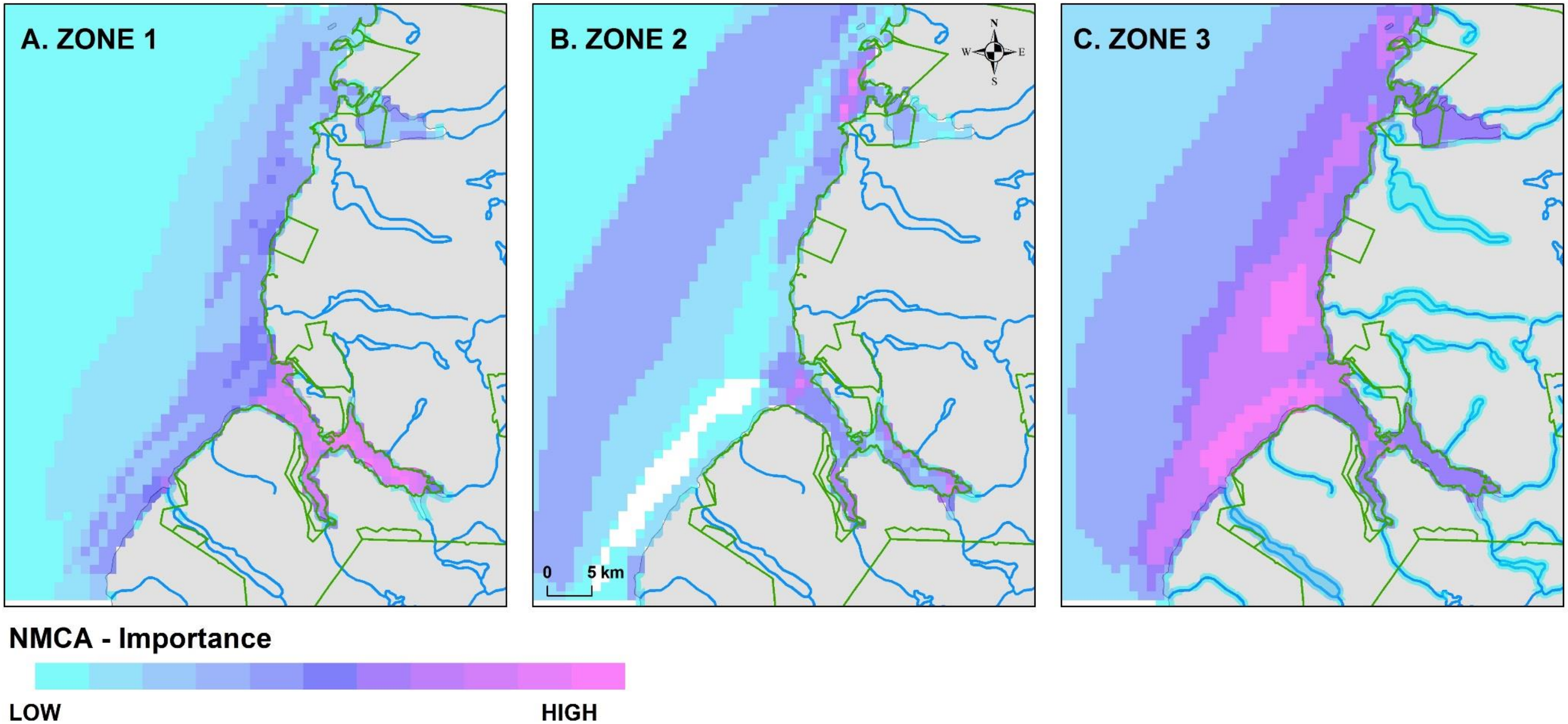


Figure 3.9 Mean statistical outputs of most favored areas for zones 1 (A), 2 (B) and 3(C) under an NMCA. The highest valued areas are visually displayed from dark purple to pink.

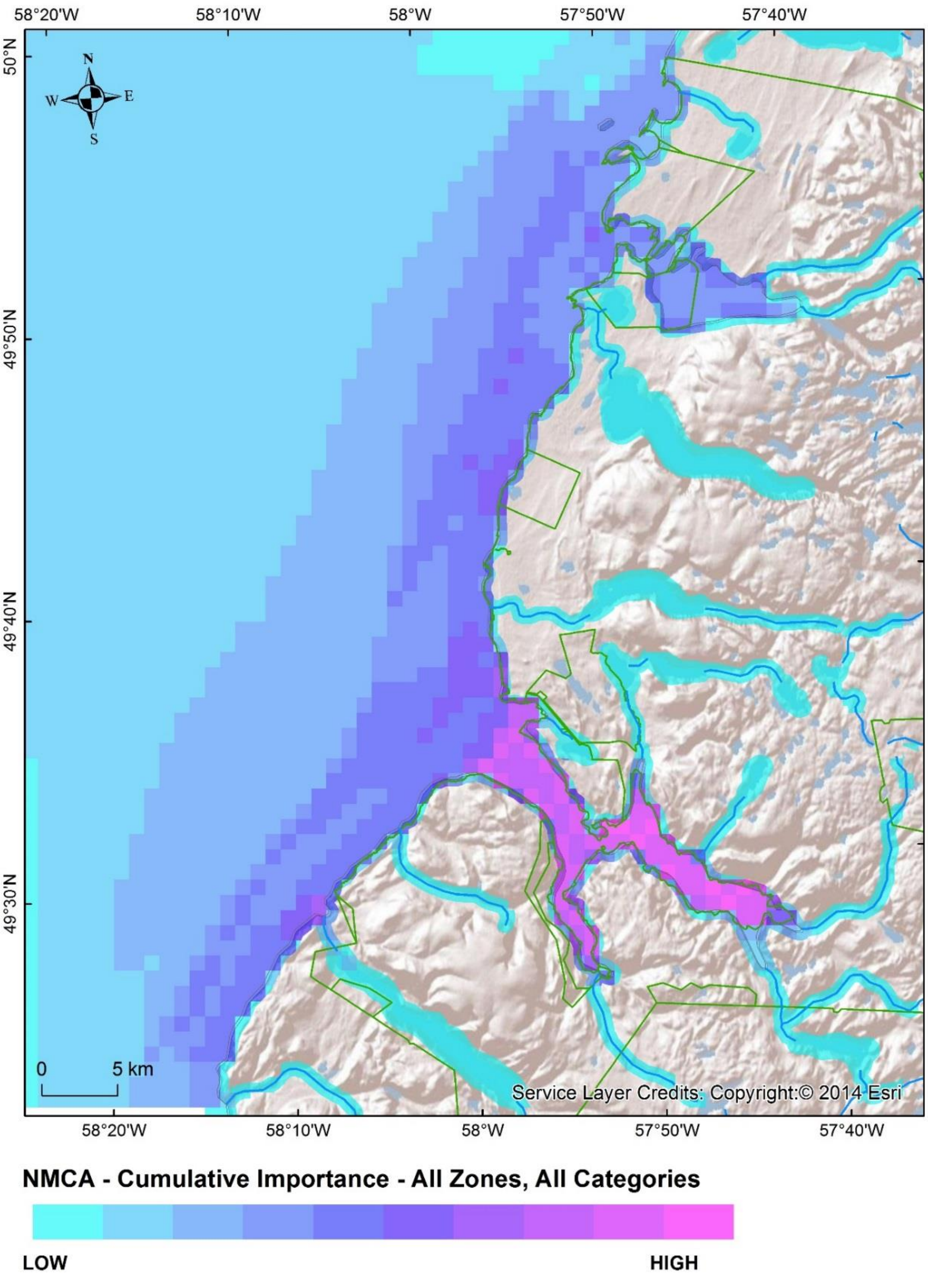


Figure 4.0. Mean statistical values for overall NMCA protection. The highest valued areas are visually displayed from dark purple to pink.

There was not enough data in each zone of protection for an NMCA to produce hotspot analysis. However, cumulative hotspot analysis was possible to assess the overall area the experts wanted marine protection for this study area. This map was then compared with the hotspot map of importance and impact generated in Chapter 2 and is shown in **Fig. 4.1**. The impact and importance hotspot maps looked at 5 attribute packages to generate its results: Aquatic Invasive Species (AIS) including Green Crab and Membranoporia *sp.*, Marine Significant Areas (MSA), Non-Renewable Resource Development (NRRD), Tourism and Community Culture (TCC) and, Sewage and Shipping (SS).

The map of importance (**Fig. 4.1A**) and impact (**Fig. 4.1B**) show the darkest red (hotspot) in the coastal areas and in the heart of Gros Morne National Park; the u-shaped fjord of Bonne Bay, NL. It is also important to note that rivers connecting the ocean to fresh water sources in the study area were also listed as a high importance and impact. **Figure 4.1C**, displays the hotspot for preferred marine and coastal protection which resembles the hotspot map of importance.

3.4 Discussion

3.4.1 Best Fit Zoning for an NMCA

Overall, the entire coastal, marine and even freshwater and rivers systems have been selected for protection. For a rural fishing community in Newfoundland whose historical way of life was fishing, this is very rare and shows the shift in values for all. Of the 27 experts who

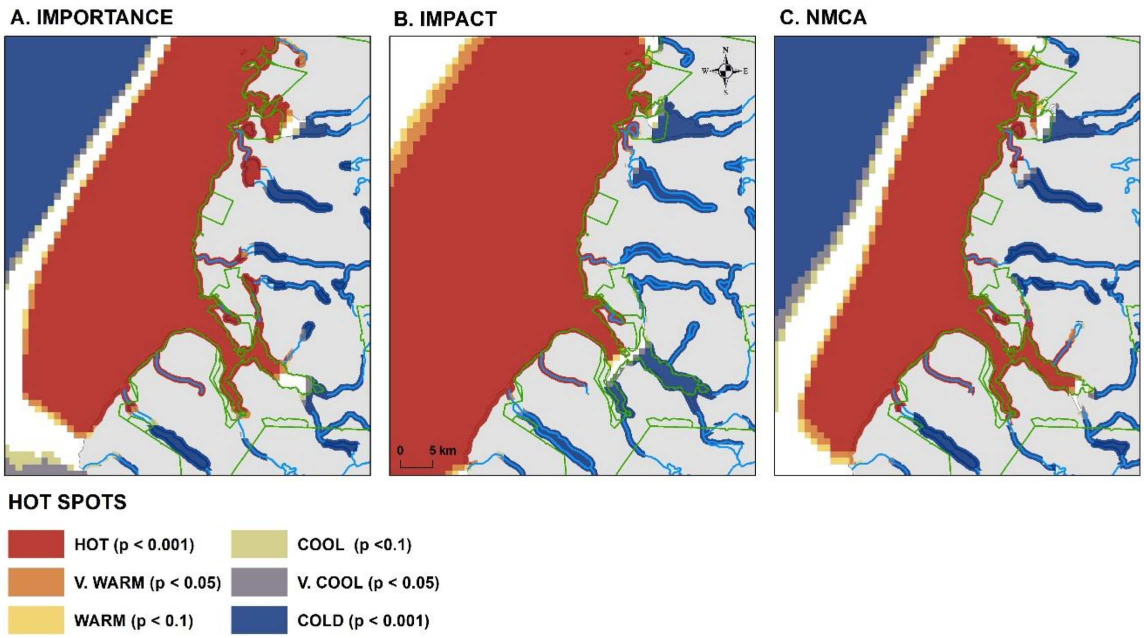


Figure 4.1 A comparison of the socio-ecological hotspot maps of impact and importance against areas most preferred for a NMCA in the marine and coastal management areas surrounding Gros Morne National Park, Newfoundland. Maps were produced using the Getis-Ord Gi* spatial statistic software in ArcGIS 10.3. The red hotspots ($p < 0.001$) and yellow warm spots ($p < 0.1$) are most agreed by experts for their cumulative levels of importance (A), impact (B) and, highest preferred level of protection (C).

participated in this survey, 100% said yes, this area would be ideal for an NMCA. The concentration of dark purple and pink polygons in each map not only outlines where the participants prefer each zone but, the focus of these points, highlights the understanding each expert had about the zone's protection and the agreement of where these zones should be.

Zone 1 protection found in **Fig. 3.9A** displays the highest concentration in pink then moves to dark purple. This map confirms the preferred protection is strongest in the eastern arm of Bonne Bay, moves out to the southern arm and then towards the mouth into Rocky Harbour, NL (see **Fig. 3.2**). The next area with a hint of pink and dark purple is at the mouth of Trout River, NL and the coast that borders Sally's Cove and St. Pauls Inlet. Zone 2, which would essentially act as a buffer zone for Zone 1 is displayed in **Fig. 3.9B** and mimics how a buffer zone should look in comparison to the area the experts outlined as their preferred Zone 1. The main concentration is located on the coastal regions throughout all of Bonne Bay and the other highest concentration is at the mouth of St. Pauls Inlet, near Stearin Island off Cow Head, NL and the mouth of Western Brook Pond. The area highlighted near St. Pauls is significant because it is a highly productive saltmarsh and, the dark purple north of St. Pauls is already protected by Parks Canada for its diverse seabird and Eider Duck population (Kukac, 2009; Parks Canada, 2009a). **Fig. 3.9C** illustrates the agreement that coastal and marine offshore areas surrounding GMNP should have a Zone 3 protection, allowing the commercial and recreational fishing industries to exist. It is also worth noting the dark purple within St. Pauls Inlet; an area that was historically overfished/ and depleted of its herring population. In the 1940s, fishers from outside of St. Pauls began to seine for herring. The people of St. Pauls began to question the sustainability of the inlet, and in 1977 they formed a Herring Protection Committee to prevent overfishing (Kukac, 2009). To their disappointment, the committee was created too late and seining eventually wiped out the once vibrant herring stock. With the loss of the herring population in the 70's and then the decline of the cod population that led to the closure in 1992, it is easy to understand why the coastal communities in this study area are opting for protection of this marine and coastal management area (see **Fig. 4.0**).

The NMCA hotspot map in **Fig. 4.1C**, shows the cumulative agreement of areas that should be protected. Although it shows similar values to **Fig. 4.1A** and **4.1B, there is** a higher agreement for protection throughout both the eastern and southern arms of Bonne Bay. As the global market demands more from the marine resources, the people that live and depend on them seem ready to protect it. Several commercial fisheries have exceeded maximum sustainable levels and fishermen's perceptions of environmental baselines are rapidly evolving (Havard *et al.,* 2015).

3.4.2 Workshop and expert dynamics

From the inception of recruiting experts for this study to the framework that set the stage for the workshop, the dynamic of the workshops proved to be very successful. Everyone was well informed prior to their valuation of the maps and, everyone felt included no matter what their background of expertise was. All participants were instructed to answer their questions on an individual basis and emphasizing their work would be anonymous. This allowed them to relax and complete the map valuations to their best ability; without worrying about pressures from other experts outside their sector. As Daniels *et al.*, (2001) put it, by giving ocean users time to learn about marine spatial planning and explore their individual and collective concerns in a confidential setting, subsequent interactions with environmental groups, ocean managers, and policy-makers can occur on a more even footing. It is also worth noting that many were unaware of what an NMCA was and, once it was defined to them, all participants were at ease and confident on where they would shade the protection for each zone.

Hosting a workshop for people that had a lower reading ability was also a successful move for this study. A large portion of the small-scale fishing industry as well as other coastal community members still have literacy challenges. Holding at least one workshop where the researcher read all the questions to everyone, not just a few, allowed those with literacy issues to blend in with the crowd and complete their maps in a confident manner; adding again to the richness of local knowledge missed without this available setup.

3.4.3 Uncertainties with Socio-Ecological Data

Although public consultation and collaboration is ongoing between government, various experts and stakeholders during efforts to create effective MPAs, it is still not ideal. Many government agencies have workloads and deadlines that leave them no time to do effective public consultations. When it does take place, it is rushed and done in a manner that is hard to evaluate against science and economic data. Christie *et al.,* (2003) states, that many marine spatial planning (MSP) events underline the lack of broad participations in management, little or no sharing of economic benefits, the absence of conflict resolution mechanisms and tension between different sectors. The MAEP tool created asked specific question for future marine protection around GMNP and has shown socio-ecological data can be used along side scientific and economic data. Areas specific to zones in an NMCA have been clearly identified and if used properly, with science and economic advice, could aid in the correct designation of an MPA around GMNP. MSP using tools like the one created should be conducted in an open, transparent, and participatory fashion that guarantees all stakeholders, including representatives from existing and emerging ocean industries, have an active role during all processes (Cantral, 2009).

The process of acquiring and using socio-ecological data can be messy and at times, hard to use against values numerically set out in science and economics but, that does not take away from its importance in the DM process. One, ongoing challenge for policy makers has been to find the right balance between the exploitation of marine resources, whether living or nonliving, and the conservation of those resources and protection of the marine environment (Sanchirico *et al.,* 2013). Decision makers should not wait for perfect data before moving forward; they need to make sure all parties are meaningfully involved and their conclusions should be drawn from a wide variety of sources, including the less traditional non-governmental sources (Gopnik *et al.,* 2012). This tool displays how advice can be communicated to decision-makers translating social values into something more tangible, affecting? influencing? the likelihood that government will integrate the information within its decision-making process to create effective marine and coastal protection. Without explicit consideration of these issues, it is unclear whether MSP will better conserve ocean resources than the status quo (Hutchings & Stenseth, 2016; Sanchirico *et al.,* 2013).

3.4.4 Policy Importance

When establishing different forms of policy, a more holistic approach needs to be taken when dealing with areas that may affect society's welfare. MPAs were developed originally by the United Nations (UN) in 1992, to "pursue the protection and sustainable development of the marine and coastal environment and its resources". The marine areas are to some, their way of economic survival. The very nature of sustainable development is one that meets the need of the present without compromising the ability of future generations (De Santo, 2013). If MPA policies do not change in a way to include the present generations then no development will take place. They ignore any framework for future generations which creates social and environmental justice issues (Jones, 2009). Strengthening MPA governance will ensure we meet our target set by COP of 10% to protect our oceans by 2020. Strengthening the linkages between all stakeholders is the key to meet this target. Promoting different incentives in areas that incorporate biological conservation, economics, knowledge, participation, legal and interpretation will provide a more resilient, equitable and effective approach that incorporates social justice in MPA governance (Jones *et al.*, 2011).

3.5 Conclusion

The paradigm of conservation and protection for our oceans is constantly evolving and at present is one that is finally awake. Prior to this study there was a belief that Newfoundlanders, especially the ones that directly depended on the oceans for their economic way of life, would resist marine protection. Not only did the outcomes surpass the vision of this research and old Newfoundland beliefs, it suggests coastal community stakeholders and all experts connected to this ocean are 100% ready to protect the marine and coastal management areas that surround GMNP. The socio-ecological data produced in this study demonstrates that the experts involved not only want protection, they understand the zoning breakdown of a NMCA and know exactly how much protection is needed. The federal government has been quick to layout protection for the 3 oceans that surround Canada to meet the Prime Minister’s mandate to protect 10% of the oceans by 2020 (Prime Minister of Canada, 2016). The pressure to have this organized and implemented by 2020 has created a plethora of work for federal scientists and economists with little to no help from the coastal members that depend on ocean resources. . With the use of this tool to display mean statistical and overall hotspot points of importance for protection with all stakeholders at the decision-making table, this structured decision-making approach ensures social justice is kept at the forefront with science and the economy. If this data is used with scientific and economic data, it will produce an MPA that is accepted by the region, and one that will be successfully enforced and monitored by stakeholders for generations to come. It will be one that welcomes sustainable industries, healthy oceans and happy coastal communities.

3.6 References

Blount, B.G. & Pitchon, A, (2007). An Anthropological Research Protocol for Martine Protected Areas: Creating a Niche in a Multidisciplinary Cultural Hierarchy. Human Organization; Summer. 66 (2), pp.103-111

Blaustein, R.J., 2007. Protected areas and equity concerns. Bioscience 57 (3), 216-221.

Brechin, S.R., Wilshusen, P.R., Fort Wangler, C.L., West, P.C., (2003). Contested Nature: Promoting International Biodiversity with Social Justice in the Twenty-first Century. State University of New York Press, Albany

Cantral, L., et al. 2009. Principles for Marine Spatial Planning: Outcomes of the Ocean Industries MSP Policy Labs. Policy Brief from the Nicholas Institute for Environmental Policy Solutions, Duke University.CBD COP Decision X/2 Strategic Plan for Biodiversity 2011-2020, available online: http://www.cbd.int/decision/cop/?id=12268

Census Stats Canada 2016 http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E&TABID=1

Charles, A. & Wilson, L., (2009). Human dimensions of Marine Protected Areas. ICES Journal of Marine Science. 66 (1), pp.6-15.

Christie, P., McCay, B.J., Miller, M.I., Lowe, C., White, A.T., Stoffle, R., Fluharty, D.L., McManus, L.T., Chuenpagdee, R., Pomeroy, C., Cuman, D.O., Blount, B.G., Huppert, D., Villahermosa Eisma, R.-L., Ocacion, E., Lowry, K., Pollanac, R.B.,

2003. Toward developing a complete understanding: a social science research agenda for marine protected areas. Fisheries 28 (12). 22-26.

Chuenpagdee, R., Pascual-Fernandez, J.J., Szelianszky, E., Alegrer, J.l., Fraga, J. & Jentoft, S.2012. Marine protected areas: Re-thinking their inception. Marine Policy 39, 234-240.

Convention on Biological Diversity. Conference of Parties (COP): Background and Status. [ONLINE] Available at: http://www.cbd.int/cop/. [Last Accessed 01, December, 2014].

Daniels, S.E., Walker, G.B. 2001. Working through Environmental Conflict: The Collaborative Learning Approach. Praeger Publishers

De Santo, E.M. 2013. Missing marine protected area (MPA) targets: how to push for quanity over quality undermines sustainability and social justice. Journal of Environmental Management 124, 137-146

DFO-Government of Canada. 2010. Spotlight on Marine Protected Areas in Canada. Fisheries and Oceans Canada. Ottawa. 24 pp. http://www.dfo-mpo.gc.ca/oceans/marineareas-zonesmarines/mpa-zpm/spotlight-pleinsfeux/index-eng.htm

DFO-Government of Canada. 2011. *National Framework for Canada's Network of Marine Protected Areas.* Fisheries and Oceans Canada, Ottawa. 31 pp. http://waves-vagues.dfo-mpo.gc.ca/Library/345207.pdfhttp://www.dfo-mpo.gc.ca/oceans/publications/dmpaf-eczpm/docs/framework-cadre2011-eng.pdf

Dunsmuir, M. (2002, June 13). Bill C-10: An Act Respecting the National Marine Conservations Areas of Canada. Retrieved October 18, 2014, from http://www.parl.gc.ca/About/Parliament/LegislativeSummaries/bills_ls.asp?lang=E&ls=C10&Parl=37&Ses=1&source=Bills_House_Government–A

Gopnik, M., Fieseler, C., Cantral, L., McClellan, K., Pendleton, L., Crowder, L. 2012. Coming to the table: Early stakeholder engagement in marine spatial planning. Marine Policy. 36, 1139-1149

Havard, L., Brigand, L., Carino, M. 2015. Stakeholder participation in decision-making processes for marine and coastal protected areas: case studies of the south-western Gulf of California, Mexico. Ocean Coast. Manag. 116, 116-131.

Hutchings, J., Stenseth, N.C. 2016. Communication of science advice to government. Trends in Ecology & Evolution. 31 (1) 7-11.

International Action: Law and assistance. 1980. *World Conservancy Strategy* (pp. 52-53). IUCN-UNEP-WWF.https://portals.iucn.org/library/efiles/documents/WCS-004.pdf

Jones, P.J.S., 2009. Equity, justice and power issues raised by no-take marine protected area proposals. Marine Policy 33, 759-765.

Jones, P. J. S., Qiu W., De Santo, E. M. (2011). Governing marine protected areas—getting the balance right. Technical Report. United Nations Environment Programme. ISBN 978-92-807-3159-0.

Kukac, J. 2009. Capturing the importance of natural resources and future activities in St. Paul's, Newfoundland. Thesis fulfillment for the Masters of Arts (Geography). Pp 1-148. Memorial University of Newfoundland.

Mason, F. 2002. The Newfoundland Cod Stock Collapse: A review and Analysis of Social Factors. Electronic Green Journal, 1(17).

Miller, D., (1999). 'Social Justice and Environmental Goods'. In: Dobson, A.P. (ed), Fairness and Futurity: Essays on Environmental Sustainability and Social Justice. 1st ed. UK: Oxford University Press. pp.151-172.

Minister of Justice –Canada National Marine Conservation Areas Act. (2002). Updated September 29, 2014. http://laws-lois.justice.gc.ca/PDF/C-7.3.pdf

Mueller, T., McChesney, A. 1996. Nature-based tourism: shaping new laws for the environment. Ecodecision, English ed. 20: 16.

Parks Canada. 2009a. Gros Morne National Park of Canada-Management Plan. (2009, October). Retrieved October 16, 2014, from http://publications.gc.ca/collections/collection_2014/pc/R64-105-67-2006-eng.pdf

Parks Canada. 2009b. Activity Policies: National Marine Conservation Areas Policy. (2009, April 15). Retrieved October 16, 2014, from http://www.pc.gc.ca/eng/docs/pc/poli/princip/sec2/part2b.aspx

Peterson, M.N., Peterson, M.J., Peterson, T.R., (2007). 'Moving toward Sustainability: Integrating Social Practice and Material Process'. In: Sandler, R. and Pezzullo, Phaedra, C. (ed), Environmental Justice and Environmentalism: The Social Justice Challenge to the Environmental Movement. 1st ed. Cambridge, MA, USA: MIT Press. pp.189-221.

Prime Minister of Canada, 2016. Minister of Fisheries, Oceans and the Canadian Coast Guard Mandate Letter. Justin Trudeau. (2016, August 9). Retrieved December, 2017, from https://pm.gc.ca/eng/minister-fisheries-oceans-and-canadian-coast-guard-mandate-letter

Roberts, C. M., and Hawkins, J.P., (2000). Fully-Protected Marine Reserves: A Guide. Washington, D.C.: WWF Endangered Seas Campaign.

Sanchirico, J.N., Lew, D.K., Haynie, A.C., Kling, D.M., Layton, D.F. 2013. Conservation values in marine ecosystem-based management. Marine Policy. 38, 523-530.

UNEP-WCMC, (2008). National and Regulation Networks of marine Protected Areas: A Review in Progress. UNEP WCMC, Cambridge

United Nations- Conference on the Environment and Development (1992, June 3-14). Protection of the Oceans, all kinds of seas, including enclosed and semi-enclosed seas and coastal areas and the protection, rational use and development of their living resources. Ch17. http://www.un.org/depts/los/consultative_process/documents/A21-Ch17.htm

Overall Summary

4.1 Motivation

As the IUCN continues to raise the bar and challenge the world to ensure that any use of natural resources is equitable and ecologically sustainable, it is our responsibility as individuals and as a country, to follow at a productive pace. The global population has exceeded 7 billion so great care needs to be taken to conserve habitat and ensure the integrity and diversity of nature. Canada is connected to three oceans and every decision made to protect or develop on the land or in its waters will in some way affect Canada and the well-being if its citizens. Moreover, Canada has a responsibility to be a world leader in sustainability. Being prosperous while also remaining sustainable economically, environmentally and socially requires decision makers to ensure continuity of a healthy and productive aquatic ecosystem that will provide not only ecosystem goods and services which our coastal and marine economies depend on but also, to keep our ecological integrity for the future of our ocean's biodiversity.

In 2010 COP set out a target to protect 10% of coastal and marine areas of importance for biodiversity and ecosystem services. This was initiated with the hopes that effective and equitable management would implemented to create or continue the management of well-connected systems. Canada became a signatory to this target aiming by 2020 to protect 10% of the oceans we manage. Although positive, this target has left decision-makers in the Federal Government with an enormous challenge ahead of them and vey little time to address it. The time lines created cause rushed MPA designation that lack effective public consultation that is needed to create effective marine protected areas.

Where decisions are made to protect or develop marine resources, there is frequently too little time and space for effective consultation. Accordingly, stakeholders often lose trust in the process or in the decision makers themselves. Nevertheless, it has been observed and documented time and time again, that given the right tools and time, and working in concert with stakeholders, that depend on the marine and coastal management areas, effective decision-making and management can occur. My findings confirm that public consultation can heighten planning and improve the success implementation. Moreover, new tools and methods of engagement will allow trust, foster development and allow conservation efforts to happen seamlessly. If the right tools do not exist then it is our responsibility to develop them. The decision-making tool to assess the socio-ecological values of importance and impact was created during this study. Placing this tool into geospatial software allows individuals to visually and conceptually understand spatial relationships. Specifically, the use of hotspot maps and analysis will enable resource managers to now more effectively compare social data to science and economical data.

4.2 The Right Tool for the Job

Creating questions on a study area that were not specific to any biased objective allowed the researcher to look at the whole picture and visualize places of importance as determined by experts. Further, the study identified areas being most impacted in the coastal and marine environment. The database created from this tool was formed to enable decision makers from all industries, NGOs and areas of government to look at the socio-ecological values more constructively and use it to augment information from the science and economic sectors. Using this data allows social and environmental information to be incorporated in the decision-making process creating synergies in the communities for development and conservation that is socially just. This style of structured decision-making can allow trust to build between coastal community members, stakeholders and government. Such trust can assist in successful project implementation and create community stewards for marine and coastal environment around them. In the end, the inclusion of socio-ecological data to DM can contribute to a more effective monitoring process where everyone is accountable for the health of our oceans and communities that depend on them most.

In the end, this study developed a tool that effectively assessed the important socio-ecological hotspots in the marine environment in western Newfoundland, specifically surrounding Gros Morne National Park. Through the creation of unbiased questions in the fisheries, tourism, oil and gas, shipping and sewage, and coastal community cultural sectors, this research created a database useable by all. Not only were the questions directed to all fields they relied on the marine and coastal environment, but the experts recruited for this research were also from all sectors of sustainability. The researcher focused on a group that was balanced, with expertise in areas ranging from science, culture, business, oil and gas and, tourism. The diversity of knowledge added to the richness of the results and produced valuable data that encompassed all key areas of potential development in the marine and coastal sectors. The creation of the two workbooks was a necessary step in this study to ensure future work could be done using this tool in other areas of marine or land based management. The workshops were also created to educate any person working in a decision-making role that, with the right tool and steps, it is always possible to have meaningful public consultations and gather information that is useable against science and economic values.

The geospatial analysis conducted with this MAEP tool produced mean statistical and hotspot maps. These maps displayed cumulative importance and impact as well as mean statistical maps for each attribute measured in the workshop. The importance maps displayed high agreement that the coastal and marine management areas are significant to all stakeholders. This importance may be somewhat reflected or is a product of the importance the National Park is on land which surrounds the study area. The impact value maps identified major overlap with areas of importance which would be something natural resource managers should take into consideration when making future plans in development and conservation. The high values of importance and overlap with impact show coastal communities may be more reactive to future development in the areas they value most. The impact values do however show an increased amount of focus in specific zones which favors overall agreement from experts of where specific impacts may be taking place. These higher focused areas could be a first start for management when it comes to creating strategies to reduce environment effects in the area.

The ability to pull one question out of the larger MSA attribute package also allowed this research to question if this area would be accepted on a socio-ecological scale for an MPA. In doing this, the study demonstrated the benefits of using this tool and how common assumptions of what society desires can be incorrect. For decades decision-makers have used the coastal community members as their scapegoat in the fight against increased protection of our oceans. It took minimal time in this study to educate and question the experts on MPAs and zoning options of NMCAs. But, this time was invaluable once analysis was complete, presenting information that would never be expected by any decision maker managing projects or campaigning for conservation in the coastal areas of rural Newfoundland. The 100% agreement that GMNP would be an ideal area for an NMCA, and the highly focused zoning areas displayed on the maps, suggest that a paradigm shift occurred in the way participants view marine protection for this area! It can be further suggested that the data gathering process of this study allowed for increased social justice.. The experts imagined an NMCA and then designated their preferred areas for each zone. This allowed them to allocate adequate access to the coastal waters and its resources for all responsible members who may rely on them for economic sustainability prior to any MPA's designation.

4.3 Data Gaps and Future Recommendations for Research

While this study intended to examine all "agents of change" in the marine and coastal areas surrounding Gros Morne National Park, there were several agents not considered in the research. Areas in the health sector as well as the arts represent two other keys areas this study that could be included to assess importance and impact. The culture of Newfoundland is rich in stories, music and song so the beauty of this area and remoteness is one many artists come to for inspiration. With multiple activities taking place in the marine environment it would also be interesting to see what health impacts may be happening, not only to the coastal community members and tourists, but also to ocean biodiversity. Much of the ocean's health can be measured scientifically but what impact does that have on a socio-ecological level? The topic of energy generation in the renewable resource sector was another issue discussed in the workshops. Unfortunately, not enough data was collected in that field to make significant analysis or conclusion towards its importance or impact for the area.

The data gathering process was well thought out throughout this study, but for future work with this tool, a more structured value system should be applied when asking what is most important and impacted for the area. More questions were generated in certain attribute packages like those in MSA and TCC due to the relative nature of their importance to the area. Future studies using this tool should set a number of questions for each package and try to simulate equal amounts of importance questions to impact questions; something which may not be probable but worth exploring. In addition to the map valuation questions asked in this study, two other sections were conducted and are shown in Workbook 1; multiple choice and circle and identify. Although this information is important to the overall outcomes for decision making, this study did not have the capacity or time to analyze it fully. Future work with this database could include this data to give the decision maker even more information to support their decisions for the marine and coastal management areas.

The geospatial, MAEP tool, created for this study can be used for any style of natural resource management to assess socio-ecological values. It is a tool that could be used in combination with science and economics to create marine or land use plans for the rest of western Newfoundland, throughout the Province or elsewhere, where decision makers need to include sound socio-ecological data in their decision-making process. When used at the planning stages for any project, whether it be for future development or protected areas, it can allow effective involvement by experts and stakeholders that depend on the resources most. Importantly, this tool can give a voice back to society and be applied to any SDM approach, thereby providing a balance between human uses and conservation objectives - the core for sustainable development.

References

Blount, B.G. & Pitchon, A, (2007). An Anthropological Research Protocol for Martine Protected Areas: Creating a Niche in a Multidisciplinary Cultural Hierarchy. Human Organization; Summer. 66 (2), pp.103-111

Census Stats Canada 2016 http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E&TABID=1

DFO-Government of Canada. (2010). Spotlight on Marine Protected Areas in Canada. Fisheries and Oceans Canada. Ottawa. 24 pp. http://www.dfo-mpo.gc.ca/oceans/marineareas-zonesmarines/mpa-zpm/spotlight-pleinsfeux/index-eng.htm

DFO. 2013. Gulf of St. Lawrence Integrated Management Plan. Ocean Management Division, Fisheries and Oceans Canada: Quebec, Gulf and Newfoundland and Labrador Regions. Pp 1-36.

Gopnik, M., Fieseler, C., Cantral, L., McClellan, K., Pendleton, L., Crowder, L. 2012. Coming to the table: Early stakeholder engagement in marine spatial planning. Marine Policy. 36, 1139-1149

Green, R., 2010. Addressing Accessibility Challenges of GIS-based Multiple-Criteria Decision Analysis for Integrated Land Management: Case study in the Humber region of Newfoundland and Labrador, Canada. Masters Thesis, Memorial University of Newfoundland.

Greene, R., Devillers, R., Luther J.E., Eddy, B.G. (2011). GIS-Based Multiple Criteria Decision Analysis. Geography Compass 5/6: 412-432

Gregory, R., Failing, L., Harstone, M., Long, G., McDaniels, T., & Ohlson, D.,. (2012). Structured decision making: A practical guide to environmental management (First ed.). West Sussex: Wiley-Blackwell.

International Action: Law and assistance. (1980). *World Conservancy Strateg*y (pp. 52-53). IUCN-UNEP-WWF.https://portals.iucn.org/library/efiles/documents/WCS-004.pdf

Ishizaka, Alessio, and Nemery, Philippe (2013). Multi-criteria Decision Analysis: Methods and Software. Somerset, NJ, USA: John Wiley & Sons, 2013. ProQuest ebrary. Web. 12 March 2015

Kukac, J. 2009. Capturing the importance of natural resources and future activities in St. Paul's, Newfoundland. Thesis fulfillment for the Masters of Arts (Geography). Pp 1-148. Memorial University of Newfoundland.

Mahboubi, P., Parkes, M., Stephen, C., Chan, H.M. 2015. Using expert informed GIS to locate important marine social-ecological hotspots. Journal of Envir. Manag. 160; 342-352.

Mason, F. 2002. The Newfoundland Cod Stock Collapse: A review and Analysis of Social Factors. Electronic Green Journal, 1(17).

Marine Reserve Coalition (MRC). (2012, May). Manifesto for Marine Reserves. http://www.marinereservescoalition.org/files/2012/07/MRC-Manifesto-for-Marine-Reserves-FINAL.pdf

Noble, B.F. (2014). Cumulative Environmental Effects Assessment. In Third Ed., Introduction to Environmental Impact Assessment (pp242-269). Ontario, Canada: Oxford University Press.

Minister of Justice. 1996. Amended (2015, December,11). Oceans Act. Retrieved October 16, 2014 from http://laws-lois.justice.gc.ca/PDF/O-2.4.pdf

Parks Canada. 2009 a. Gros Morne National Park of Canada-Management Plan. (2009, October). Retrieved October 16, 2014, from http://publications.gc.ca/collections/collection_2014/pc/R64-105-67-2006-eng.pdf

Selkoe, K.A., Halpern, B.S., Ebert, C.M., Franklin, E.C., Selig, E.R., Casey, K.S., Bruno, J., Toonen, R.J., 2009. A map of human impacts to a "pristine" coral reef ecosystem, the Papahanaumokuakea Marine National Monument. Coral Reefs, 28: 635-650.

United Nations-General Assembly (2015, September 25). Transforming our world: the 2030 Agenda for Sustainable Development. Pages 1-35. https://undocs.org/A/RES/70/1

Appendix A

Workbook 1: Steps for a successful public consultation workshop for natural resource management.

Two main components are needed to generate useful socio-ecological information for natural resource management:selection of expert participants and workshop format. If the workshop host would like to assess the information from the workshop in a geospatial tool, refer to workbook 2: The MAEP_TOOLBOX; Methods for socio-ecological spatial analysis.

1. Selecting Participants

Experts were chosen to participate based on the pillars of sustainability set out by the United Nations Environmental Program (UNEP), economic development, social equity, and environmental protection. This selection process was used to gain unbiased information on all agents of change. A scan of the region for experts was done through outreach to multiple levels of government, aboriginal groups, eNGOs, academic agencies and recommendations from experts who were originally approached. The experts available to participate were sent a survey prior to the workshop to assess their level of expertise in each attribute package being valued in the study. The attribute packages for coastal and marine management consist of questions in the following areas:

a. Fisheries (recreational and commercial)
b. Sewage
c. Shipping
d. Tourism and community culture
e. Oil and gas exploration and drilling

f. Aquatic invasive species.

The participants' level of expertise was assessed based on the following criteria:

1. How many years the participant lived around the coastal and marine environment.
2. How many years they have worked or studied the marine or coastal environment
3. Which subject areas or topics they felt most knowledgeable in.

Once surveys were submitted, the researcher put them under the pillar of sustainability that best reflected the participant's expertise. The goal of this study was to make sure an equal number of experts were represented from each pillar; resulting in unbiased data. If the participant had 10-30 or 30 plus years of experience in their field they were considered to have a high level of knowledge; making them an ideal participant for this study.

2. Workshop Design

This workshop was designed to include all areas of expertise and levels of education. Some experts gain their knowledge from years of work and from traditional knowledge passed down through generations. A prime example for this study was the expertise from fishermen. Sometimes people is this industry have very low literacy levels and would not participate in regular public consultations where reading was required. The data needed for natural resource management needs to be given from all knowledge areas to ensure all at stake continue to have a voice regardless of their literacy level or confidence to speak in a workshop setting. The overall success of the workshops during this study came from the following features the researcher kept in mind during the design:

a. anonymity for the participant
b. comfortable workshops for all
c. informative session prior to surveys
d. streamlined surveys to fit areas of expertise
e. token of thanks.

2.1 Anonymity of Participant

Participants in this research were given a participation number and work they conducted in the workshops was done independently or with help from the facilitator. The workshop was setup like this to reduce pressures or fears of voicing your values in front of others at stake from other sectors. Without group participation, this workshop gave participants anonymity, allowed them to speak freely and, it eliminated individuals who may dominate the discussion during the data gathering process.

2.2 Inclusive Workshops

Many in various fields specifically, the fishing industry, have weak literacy skills and some may not even have a computer. To ensure successful outcomes for this study, the researcher read each package to all and went through each question to increase understanding. If the participants seemed comfortable reading and writing independently, then reading by the facilitator ceased. Supervision of participants was constant to ensure everyone was comfortable with the questions being asked. Some potential participants prior to the main workshop had stated they were uncomfortable attending a session where competing stakeholders would be present. For this study fishermen were the ones not comfortable so a fishermen only workshop was created. This added workshop was a positive move for the overall study and increased number of fishermen participants. Another workshop was also created like this for a local government agency of participants. The latter was done due to availability conflicts; allowing them to still participate. In total 5 workshops were created:

1. One in St. John's, NL for all who could not attend in western, NL.
2. Two open workshops in western, NL to open more spots and time for interested participants.
3. One private workshops for experts with local traditional knowledge. This workshop was created for participants who may not be comfortable completing surveys on their own or have literacy issues.[7]
4. One workshop for local agencies that cannot attend open workshops due to time conflicts.

2.3 Informative pre-survey presentation

Before the actual survey was taken by the participants, a short presentation was given to outline the study area, the purpose of the workshop, explain any terms that may be questionable by the public, what each attribute package survey will cover regarding topic areas and, how the surveys were designed. The presentation outlined how to complete each section of the survey, how the data would be analyzed during geospatial analysis

[7] Anyone in a traditional knowledge sector like fishing was also welcomed to all other open workshops. This workshop was created for those who were not comfortable due to personal reasons.

and, there was time for the group to ask any questions at the end. This information was also included in the ethics letter of consent which the participants signed if they still wanted to participate.

2.4 The right survey for the right participant

Surveys the participants completed were divided into seven attribute packages. To complete all seven packages, it would take almost 1 full work day (6 hours). The researcher streamlined the workshop so the participants only received a survey from attributes they previously expressed knowledge in. The questions asked in the initial survey to potential participants were used to decide what surveys each expert received (see **Table 3.1**).

2.5 Show your gratitude

Participants in a workshop for academic study or government consultations are not to be paid for ethical reasons. A small token of gratitude is still allowed. Once the participants completed the workshop, a thank you card was given to them with some university swag; not worth a lot but, valued by the participant for the recognition of their help.

Workshop survey format for geospatial analysis

1. Design of packages and mapping with experts.

The packages designed for this workshop were based on the 7 agents of change the researcher assessed. The agents of change used were; Aquatic Invasive Species (AIS), Marine Significant Areas (MSA), Non-Renewable and Renewable Resource

Development (NRRD and RRD)[8], Shipping and Sewage (SS) and Tourism and Community Culture (TCC). Each attribute survey package was broken down into three sections and asked questions to aid with the analysis of the areas of importance and perceived impact in the marine and coastal managements areas around Gros Morne National Park, Newfoundland. The three sections include:

a. multiple choice and fill in section
b. circle and identify section
c. map value shading section.

Once the participants were done the multiple-choice questions they moved on to the circle and identify section (CI) and then the final section, the map value shading (VS)[9]. Each map was made through GIS software and based on the attribute package. **Figure 2.1.3,** gives you a sample of the maps used. All maps were given a "fishnet" layer that would later aid in the polygon creation used for the hotspot analysis of importance and perceived impact from experts surveyed. The maps were printed on 11x17 pieces of paper and given to participants to shade independently during the workshops. Using a WACOM tablet that displays a digital map for participants to "shade" is also another option if you prefer a paperless study. See Mahboubi, *et al.*, (2015) for more details on this software option.

In the VS section, the participants were given a shading scale and colored crayons to apply to their maps. Questions on importance values were given, green for highest importance, yellow for medium and red for low importance. Questions on percieved

[8] This thesis did not use RRD due to low amounts of data received.
[9] This thesis focused on the analysis of section "C" but, the three sections above are recommended for real workshop analysis to get a better overview of expert values for NRM.

impact values were given red for highest impact, yellow for medium and green for low impact. Every question asked in the VS section was given a new map. For example, in the TCC Package there were 10 questions asked in the VS section. So, there were 10 TCC maps, one for each question. Each participant was asked to only shade the areas in the coastal, marine and fresh water sections. Areas that would indirectly impact or benefit the coastal and marine environments in this study included, salt marshes, rivers connected to the marine areas as well as western brook pond, an ogliotrophic, land-locked fjord.

2. Preparing data for geospatial analysis (optional)

Once workshops are complete, if your maps are not already digital then they have to be digitized and georeferenced; see **Appendix C** for details on this process to create socio-ecological hotspot maps.

References

Mahboubi, P., Parkes, M., Stephen, C., Chan, H.M. 2015. Using expert informed GIS to locate important marine social-ecological hotspots. Journal of Envir. Manag. 160; 342-352

Appendix B

Workshop questions for map valuation

Attribute Package	Questions
AIS Package	1. On MAP 1, shade the areas AIS would negatively impact the study areas ENVIRONMENTALLY. High Impact = RED Medium = Yellow Low impact = GREEN[10]
	2. On MAP 2, shade areas AIS would negatively impact the study area ECONOMICALLY & SOCIALLY (make sure to refer to Map 1 if you added eelgrass and lobster areas that are not displayed on the map). High Impact = RED Medium = Yellow Low impact = GREEN
MSA Package	1. Identify the areas that are most important for the commercial and recreational fishery High Importance= GREEN Medium = YELLOW Lowest = RED
	2. Identify areas most important for current and future research of aquatic, coastal and marine species and their habitats. High Importance = GREEN Medium = YELLOW Least = RED
	3. Due to size question four is shown in **Appendix D.**
NRRD Package	1. Shade the marine and coastal areas you feel would be most **negatively** impacted if non-renewable resource development were to take place. High = RED Medium = YELLOW Low = GREEN
	2. Identify areas most **negatively** impacted by seismic testing for non-renewable resource development or areas that would be most negatively impacted if seismic activity were to take place. High = RED Medium = YELLOW Low = GREEN
	3. Shade the marine and coastal areas most **positively** impacted if non-renewable resource development were to take place. Highest = GREEN Medium = YELLOW Minimal = RED
SS Package	1. Identify areas that would be most **negatively** impacted in and around the sewage and proposed dump site. Highest = RED Medium = YELLOW Lowest = GREEN
	2. Please identify any coastal or marine areas with high traffic **motorized** vehicles. Highest = RED Medium = YELLOW Lowest = GREEN
TCC Package	1. Based on the questions above shade the areas that are most valuable overall to you. Highest = GREEN Medium = YELLOW[11]
	2. Due to size, question is found in **Appendix E.**

[10] If there was NO impact then participants we asked NOT to shade those areas.

[11] Not necessary to put a low rating because it is place that have been identified in circle and identify question #1 in TCC package as important.

	3. Identify areas used most for motorized marine activities (boats, sea-doo, etc.). Highest = RED Medium = YELLOW Least = GREEN
	4. Identify areas used most for NON-motorized marine activities (paddle board, kayak, canoe, etc.) Highest = RED Medium = YELLOW Least = GREEN
	5. Identify areas in the marine or coastal areas and along the coast used most for hiking, camping, swimming, tide pool walks, etc. Highest = RED Medium = YELLOW Least = GREEN
	6. Identify areas along the coast used most for photography. Highest = RED Medium = YELLOW Least = GREEN
	7. Identify areas along the coast used most for bird watching. Highest = RED Medium = YELLOW Least = GREEN
	8. Identify areas along the coast used most for gaining access to prime hunting areas. Highest = RED Medium = YELLOW Least = GREEN
	9. Identify the marine and coastal areas used most for recreational fishing. Highest = RED Medium = YELLOW Least = GREEN
	10. Same question give in MSA Package (see **Table 5).**

Appendix C

Workbook 2: The MAEP Toolbox; Methods for Socio-Ecological Spatial Analysis

This workbook outlines two major sections that are needed to create geospatial, mean-statistical and hotspot maps of importance and perceived impacts for Gros Morne National Park, Newfoundland.

Section 1: Standard operating procedures for georeferencing an image file (scanned map from workshops) and creating shapefiles for geospatial analysis.

Section 2: GIS methods for spatial analysis using the “MAEP Tool”

If you wish to use this workbook in your research please contact Rebecca Brushett; rbrushett@grenfell.mun.ca.

PART 1: STANDARD OPERATING PROCEDURES FOR GEOREFERENCING AN IMAGE FILE AND CREATING SHAPEFILES FOR SPATIAL ANALYSIS

This section will go through a set of standard operating procedures (SOPs) that can be used to create the ground control points for georeferencing a spatially unknown image file. All layers need to be georeferenced before targeted analysis can be performed. This means that you need to tell ArcGIS where on the surface of the Earth the image/layer/feature class/etc. is located.

STEP 1. SCAN AND GEOREFERNCE MAP

Scan in paper map as a JPEG, GIF, etc. In this study 300 dots per inch (DPI), high resolution, color scan was used. Once all your maps are scanned onto your computer, open ArcMap and choose the correct projection for the data frame, the coordinate system used for this analysis was NAD 1983 UTM Zone 20 N.

To know where your scanned map is on the surface of the Earth you must georeference it. Drag and drop your maps from Catalog or use the “Add Data” button. Turn on Georeferencing toolbar and add image files to ArcMap; Do not double-click on image. Zoom to the georeferenced layer.

Ensure that image file is selected in the Georeferencing toolbar then left click the georeferencing drop-down menu “Fit to Display”. The georeferenced layer will be on top of the image file. Go into the properties of the georeferenced layer & turn on transparency to easily distinguish between the image and the layer.

The image will not be in the right location geographically. To georeference the image, select “Ground Control Points” (i.e. points from the georeferenced file that we can use to spatially locate places on the image). Click the “Add Control Points” button in the Georeferencing toolbar. Click on the common point in the **image file**, then click on the common point in the **georeferenced layer**. It is important that you do this step in this order; image file then georeferenced layer. Click on the “View Link Table” to see the points that you have collected. Use this table to delete if you have made an error during collection (click on the link you wish to delete in the “Link Table” & hit the delete key on your keyboard) or can use the “Delete Link” button. If you make an error in collection, do **not** hit undo because you will delete all your links. “Snap” to objects was used when doing ground control points. You need at least four ground control points. These points should be distributed evenly around the image as much as possible and “Auto Adjust” needs to be selected to see the residuals in the “Link Table”. In this study, the residuals were all less than 50 before they were rectified as the georeferenced layer.

When the digitized map lies seamlessly under the georeferenced layer then its spatially correct. Hit “Rectify” in the Georeferencing drop-down and save links as a text file to use later for analysis.

STEP 2. CONVERTING SHADED VALUES INTO SHAPEFILES

On each map, the participants were given three colors to add values to their maps; green, yellow and red. During the georeferencing process each color per map was given a shapefile. The feature type for this analysis was a polygon. Ensure that both the georeferenced image and new shapefile are open in ArcMap. In the editor toolbar click “Create New Feature” and select the layer that you wish to edit in the “Create Features” window. Under “Construction Tools” at the bottom of the “Create Features” window select polygon. Once the polygon is outlined double click to finish and it should then appear in the attribute table.

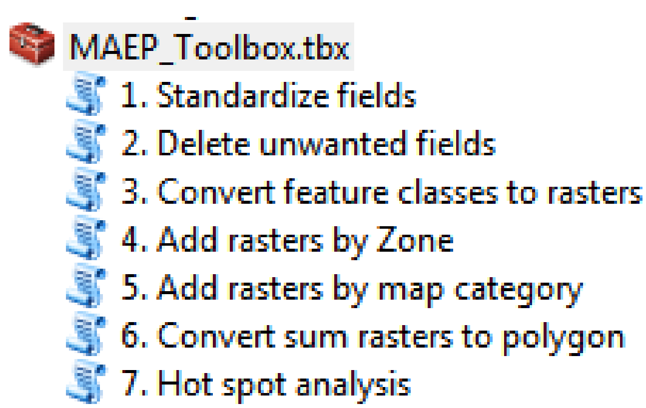
Information Needed in Attribute Table for Spatial Analysis.

In the workshops, the name used on each map to signify the details were: Attribute package_Question#_Participant#. So, for example, if participant 2 was completing the MSA package and adding values for question 1A the file name would read, "MSA_1A_2". This file name was also used for polygon creation. Once the base name for the polygon was create, it was finished with a value id name of high, medium or low. This id outlined how the participant valued that polygon and is needed for the statistical analysis. For example, if the file above was used and participant 2 had shaded areas of high importance, then the polygon created would read, "MSA_1A_2_high". Conversely, if on that same map the participant had also shaded a low importance area then, a new shapefile would be added and the name on that file would read, "MSA_1A_2_low".

To ensure each polygon is analyzed in the correct manner, values need to be input into the attribute table. Once a polygon was created for a value shaded area the attribute table was opened. Fields were then created to add all data needed. The following fields created were,"Category", "Map_No", "Survey_No", "Question", "Zone" and "Score". Under “Category”, the acronym name of the attribute package was given (aquatic invasive species = AIS for category name). Map_No is the Question answered (e.g. 1A/4A), the 3rd part is Survey_No which refers to the participants id number. “Question” refers to whether the question was related to values of impact or importance, “Zone” was created to identify if the polygon in the attribute table was high medium or low importance. Finally, the “Score” field highlighted the value given to the shapefiles created. High values were given a score of 1000, medium was 100 and, low values were given a score of 10.

GIS METHODS FOR SPATIAL ANALYSIS USING THE MAEP TOOL

The MAEP Spatial Analysis can be run using the MAEP_Toolobox.tbx.



It is important to ensure that all the input and output geodatabases are located in the same directory as the Toolbox. This main directory must also contain three other folders:

- "MXDs" contains the ArcMap working files that will generate the Results Maps.
- "Results_maps" contains the Maps that have been exported as 300 dpi JPEG files.
- "isa_reports" contains the .pdf outputs from the Incremental Spatial Autocorrelation step that will run in Step 7 (the Hot Spot Analysis). Please note that the PDF files will not be visible in ArcCatalog – please view them via Windows Explorer.

The first two steps in the toolbox involve data prep and cleaning. The third through seventh steps will run the actual MAEP analysis, calculating cumulative importance or impact, and then running Incremental Spatial Autocorrelation (ISA) and a Getis-Ord Gi* Hot Spot (HS) analysis on the cumulative importance or cumulative impact feature classes.

STEP 1. STANDARDIZE FIELDS

This step takes raw feature class data and standardizes the fields so that the feature classes will be compatible with tools in the later steps of the analysis.

Please ensure that your feature classes are named using this naming convention: "MSA_1A_2_high". The first part is the main topic (MSA/TCC), the second part is the Question answered (e.g. 1A/4A), the 3rd part is the Participant No, and the last part is the category of importance / impact (i.e. high/med/low).

This tool is designed to read the filenames of features classes within the input geodatabase, and populate fields required for the analysis.

Parameter	Explanation	Data Type
Input_Workspace	Please enter the path to the workspace or geodatabase containing the input feature classes. **Default value**: "\Features_Importance.gdb" The default input value can be changed by the user in the tool interface.	Workspace

2. DELETE UNWANTED FIELDS

To remove extra fields from the data collected, a part of the designed toolbox was designed to delete any extra fields in the input feature classes, that are not required for the analysis. The following fields will be kept: "Id", "OBJECTID", "Shape", "Shape_Length", "Shape_Area", "Category", "Map_No", "Survey_No", "Question", "Zone", "Score"

Parameter	Explanation	Data Type
Input_Workspace	Please enter the path to the workspace or geodatabase containing the input feature classes. **Default value**: “\Features_Importance.gdb” The default input value can be changed by the user in the tool interface.	Workspace

3. CONVERT FEATURE CLASSES TO RASTERS

This tool is designed to loop through all the feature classes within the input workspace/geodatabase and convert each one into a raster stored in an output geodatabase.

Please ensure that your input feature classes are named using this naming convention: "MSA_1A_2_high". The first part is the main topic or category (MSA/TCC), the second part is the Question answered (e.g. 1A/4A), the 3rd part is the Participant No, and the last part is the category of importance / impact (i.e. high/med/low).

The cell size and extent of the output rasters will be the same as the inputs for base raster and extent feature class respectively.

Parameter	Explanation	Data Type
Input_Workspace	Please enter the path to the workspace or geodatabase containing the input feature classes. **Default value**: “\Features_Importance.gdb” The default input value can be changed by the user in the tool interface.	Workspace
Output_Workspace	Please enter the path to the workspace or geodatabase that will contain the output raster datasets. **Default value**: “\Importance_rasters.gdb” The default input value can be changed by the user in the tool interface.	Workspace
Base_raster	Please enter the path to a base raster. The tool will use this raster to "snap" the output rasters to, as well as determine the cell size of the output raster. **Default value**: “BaseData.gdb\polygrid_raster_0”	Raster Dataset

	The default input value can be changed by the user in the tool interface.	
Extent_feature_class	Please enter the path to the feature class delineating the extent of your study site. **Default value**: “BaseData.gdb\grosmorne_extent” The default input value can be changed by the user in the tool interface.	Feature class

4. CALCULATE RASTER AVERAGE BY ZONE

This tool is designed to loop through all the raster datasets within the input geodatabase and add them together by Zone (High / Medium / Low). Please ensure that your feature classes are named using this naming convention: "MSA_1A_2_high". The first part is the main topic or category (MSA/TCC), the second part is the Question answered (e.g. 1A/4A), the 3rd part is the Participant No, and the last part is the category of importance / impact (i.e. high/med/low).

The output rasters labeled ALL represent all the rasters for each zone added together, and averaged depending on the number of rasters there are per zone (ALL_high, ALL_med, ALL_low). Similarly, the output rasters labeled with a category and a zone (e.g. MSA_high, MSA_med and MSA_low will represent the average area identified by experts for that zone). The output rasters labeled "combined zones" are the sum of the averages high, med and low rasters (i.e. ALL_combined_zones = ALL_high + ALL_med + ALL_low).

Parameter	Explanation	Data Type
Input_Workspace	Please enter the path to the workspace or geodatabase containing the input rasters. **Default value**: “\Importance_rasters.gdb” The default input value can be changed by the user in the tool interface.	Workspace
Output_Workspace	Please enter the path to the workspace or geodatabase that will contain the output rasters. **Default value**: “\Importance_rasters_results.gdb” The default input value can be changed by the user in the tool interface.	Workspace
Base_raster	Please enter the path to a base raster. The tool will use this raster determine the cell size and coordinate system of the output raster. The output rasters will also be snapped to the base raster. **Default value**: “BaseData.gdb\polygrid_raster_0”	Raster Dataset

	The default input value can be changed by the user in the tool interface.	
Extent_feature_class	Please enter the path to the feature class delineating the extent of your study site. **Default value**: "BaseData.gdb\ grosmorne_extent" The default input value can be changed by the user in the tool interface.	Feature Class

5. CALCULATE RASTER AVERAGE BY MAP CATEGORY

This tool is designed to loop through all the raster datasets within the input geodatabase and add them together by Zone (High / Medium / Low) and Map Type or Category. Please ensure that your feature classes are named using this naming convention: "MSA_1A_2_high". The first part is the main topic or category (MSA/TCC), the second part is the Question answered (e.g. 1A/4A), the 3rd part is the Participant No, and the last part is the category of importance / impact (i.e. high/med/low).

The output rasters labeled with a category (e.g. MSA) represent all the rasters for each zone added together, and averaged depending on the number of rasters there are per zone in that caetgory (e.g. MSA_high, MSA_med and MSA_low will represent the average area identified by experts for that zone). The output rasters labeled "combined zones" are the sum of the averages high, med and low rasters (i.e. MSA_combined_zones = MSA_high + MSA_med + MSA_low).

Parameter	Explanation	Data Type
Input_Workspace	Please enter the path to the workspace or geodatabase containing the input rasters. **Default value**: "\Importance_rasters.gdb" The default input value can be changed by the user in the tool interface.	Workspace
Output_Workspace	**Default value**: "\Importance_rasters_results.gdb" The default input value can be changed by the user in the tool interface.	Workspace
Base_raster	Please enter the path to a base raster. The tool will use this raster determine the cell size and coordinate system of the output raster. The output rasters will also be snapped to the base raster. **Default value**: "BaseData.gdb\polygrid_raster_0" The default input value can be changed by the user in the tool interface.	Raster Dataset
Extent_feature_class	Please enter the path to the feature class delineating the extent of your study site.	Feature Class

	Default value: “BaseData.gdb\ grosmorne_extent” The default input value can be changed by the user in the tool interface.

6. CONVERT AVERAGE RASTERS TO POLYGON

This tool will convert the output sum rasters from the previous step into polygons, and intersect them with a vector grid (feature class).

The output values will be named with a suffix “_polygrid”. These were generated so that the inputs for the hot spot analysis will be represented as grid cells.

Parameter	Explanation	Data Type
Input_Workspace	Please enter the path to the workspace or geodatabase containing the input rasters. **Default value**: “\Importance_rasters_results.gdb” The default input value can be changed by the user in the tool interface.	Workspace
Polygon_reference_grid	Please enter the path to the vector version of the base raster. The polygon outputs of the prior analysis step will be intersected with this feature class. **Default value**: “BaseData.gdb\polygrid_grosmorne” The default input value can be changed by the user in the tool interface.	Feature Class

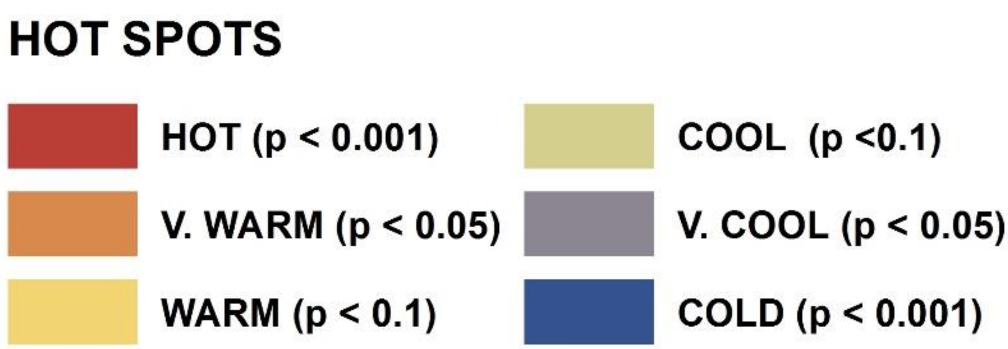
7. HOT SPOT ANALYSIS

This tool is used to run Incremental Spatial Autocorrelation (ISA) and a Getis-Ord Gi* Hot Spot (HS) analysis on the cumulative importance or cumulative impact feature classes. The outputs of the incremental spatial autocorrelation determine the distance bands input for the hot spot analysis.

The output files for the hotspot analysis will have a filename ending in "_hs". These feature classes will contain three relevant fields (e.g. "GiZScore Fixed 6000", "GiPValue Fixed 6000" and "Gi_Bin Fixed 6000"). "Fixed" refers to the conceptualization of spatial relationships used to calculate the hot spots - in this case, it means "fixed distance band". The number that follows is the distance used in meters, and is the distance at which the highest level of spatial autocorrelation was detected by the incremental spatial autocorrelation tool (identified by the highest z value); in this example, 6000m. These values differ with each input - details will be saved in the ISA Reports Workspace.

To symbolize the hotspots in the "_hs" feature classes, use the "Gi_Bin Fixed 6000" field. The values in this field represent the following:

Gi_Bin Fixed 600	DESCRIPTION	Confidence interval	p value
3	Hot	99%	p < 0.001
2	V. Warm	95%	p < 0.05
1	Warm	90%	p < 0.1
0	Neither hot nor cold	0%	p > 0.1
-1	Cool	90%	p < 0.1
-2	V. Cool	95%	p <0.05
-3	Cold	99%	p < 0.001



Parameter	Explanation	Data Type
Input_workspace	Please enter the path to the workspace or geodatabase containing the input rasters. **Default value**: “\Importance_rasters_results.gdb” The default input value can be changed by the user in the tool interface.	Workspace
Incremental_Spatial_Autocorrelation_Reports_Workspace	Please enter the path to a (preferably empty) folder where outputs from the Incremental Spatial Autocorrelation can be saved. **Default value**: “\isa_reports\”	Workspace
Waterbodies	Please enter feature classes for rivers and lakes within your study region. The tool will clip the hot spot analysis results to areas associated with the ocean and inland waterbodies (including rivers) within a specified buffer distance.	
Buffer distance	The tool will clip the hot spot analysis results to areas associated with the ocean and inland waterbodies (including rivers) within a specified buffer distance. Please enter the buffer distance (in metres) around the water bodies here.	
Basedata Workspace	The tool will combine the waterbodies features classes into one feature class (union). Please identify a suitable workspace where this new dataset can be saved (recommended: BaseData.gdb).	
Extent feature class	Please select a feature class that represents the full extent of your study area. The tool will clip the results of the hot spot analysis to this extent.	

Appendix D.

Question number four in the value shading section for the MSA Package

National Marine Conservation Area (NMCA) Valuation

Background Information on NMCA; did you know…

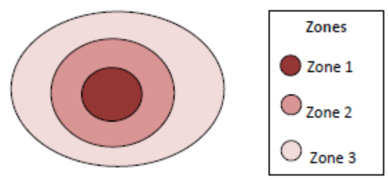


Fig 2. Diagram representing the zones for a National Marine Conservation Area.

A NMCA must be large and have multiple "zones". Physically, they would be separated but functionally, they are connected due to the nature and fluidity of water [12,13]. "The Core Area"; ***Zone I****, would have a significantly vulnerable ecosystem or, high cultural value and would be set for complete preservation.* ***Zone II****; "The Natural Environment Zones", would be a buffer zone to enhance protection of zone I and used for ecological research and monitoring. "The Outer Area";* ***Zone III****, referred to as the conservation zone, would allow renewable resources and aquaculture industry to exist. It would have high potential for non-consumptive recreational use and public education.*

1. After reading the information above, do you think the study area in this workshop would be a good fit for a NMCA?
   C. Yes
   D. No

2. Identify areas that you feel would be best suited for the three different zones of a NMCA. If you ***did not*** *think there was anywhere appropriate for a NMCA on either map, then* ***skip this map valuation.***

Zone I = RED **ZONE II = YELLOW** **Zone III = GREEN**

[12] De Santo, E.M. 2013. Missing marine protected area (MPA) targets: how to push for quantity over quality undermines sustainability and social justice. Journal of Environmental Management 124, 137-146.

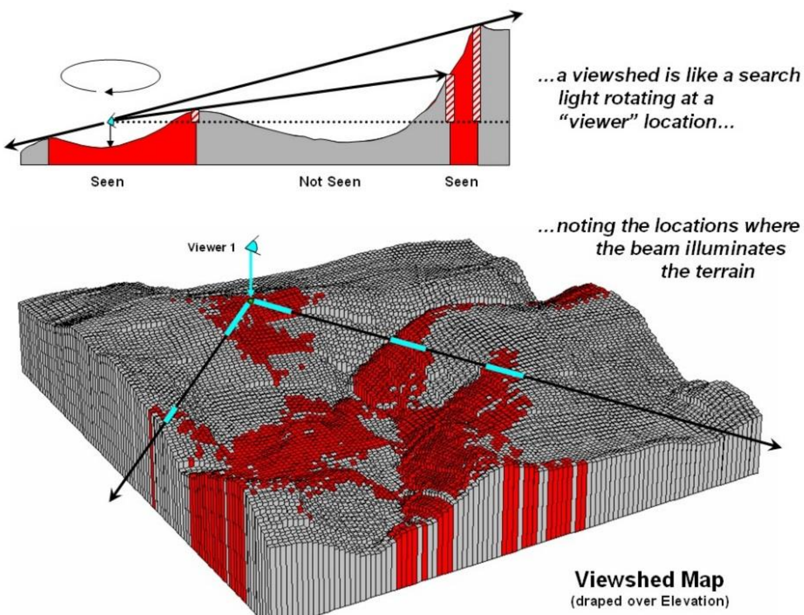
[13] Parks Canada-Activity Policies: National Marine Conservation Areas Policy. (2009, April 15). Retrieved October 16, 2014, from http://www.pc.gc.ca/eng/docs/pc/poli/princip/sec2/part2b.aspx

Appendix E

Question number two in the value shading section for the TCC Package

1. From the significant <u>viewpoints</u> already identified on the map, identify the **view shed** that is most valuable to you.

*A **view shed** is the geographical area that is visible from a location. It includes all surrounding points that are in line-of-sight with that location and excludes points that are beyond the horizon or obstructed by terrain and other features (e.g. buildings, trees).*



Reference: http://www.innovativegis.com/basis/mapanalysis/topic15/Topic15_files/image021.png

Most valuable = **GREEN**   Medium value = **YELLOW**   Least valuable = **RED**