UNDERSTANDING ATV USE: PERCEPTIONS OF IMPACT AND ACTUAL IMPACT ON DUNE SYSTEMS IN NEW BRUNSWICK, CANADA

by © Jessica L. Hogan

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Abstract

Increases in illegal all-terrain vehicle (ATV) in New Brunswick (NB), Canada, causes concern for the integrity of beaches and dune systems. Using self-administered questionnaires (n=289), we compared three NB communities: Pointe-Sapin, Escuminac, and Miscou Island. Findings show that Miscou residents perceived impacts upon dune photographs as higher than Pointe-Sapin and were more accepting of ATV management than Pointe-Sapin. In concert, we compared plant community characteristics between ATV trails on Miscou Island and non-ATV use dunes in Kouchibouguac National Park and found that where ATV trail ruts were greatest, measures of species richness increased with distance from the trail. Based on residents perceived main threat to dunes, residents may have ranked the dune photographs by vegetation cover which was seen to decrease due to rut depth on direct plots. Few studies link human dimensions with recreation ecology on coastal sand dunes, and these findings provide direction for managers in NB.

Keywords: all-terrain vehicles, human dimensions, recreation ecology, coastal sand dunes, conservation conflicts, vegetation.

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I would like to dedicate my thesis to my loving partner, Luke Driscoll, who not only encouraged me throughout these two years, but also spent weeks in the sharp dune grass to help me complete my fieldwork.

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List of Acronyms

ATV	All-terrain Vehicle
ANOVA	Analysis of variance
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DOPU	Drop-off and pick-up
EFA	Exploratory factor analysis
GLM	General linear models
GPS	Global Positioning System
HD	Human Dimensions
HDNR	Human Dimensions of Natural Resources
HDW	Human Dimensions of Wildlife
NGO	Non-governmental organization
OHV	Off-highway vehicle
ORV	Off-road vehicles
PA	Protected Area
SARA	Species at Risk Act
SBE	Scenic beauty estimations
PCI_2	Potential for Conflict $Index_2$

Overview

This thesis is organized into four chapters. Chapter 1, *Introduction*, presents how this project fits into the wider field of geography, a brief introduction to the fields of Human Dimensions and Recreation Ecology, background information on coastal sand dunes and the piping plover (*Charadrius melodus*), a study context, and the study areas. Chapter 1 also highlights the research purpose and objectives, significance of this research, and the chapter summaries. The following two chapters are comprised of scientific papers: Chapter 2, *All-Terrain Vehicle Use: Differences and Similarities in New Brunswick Communities Perceptions of Impact* and Chapter 3, *Spatial Extent and Severity of Impacts Caused by All-Terrain Vehicles (ATVs) on Coastal Sand Dune Vegetation on Miscou Island, Canada*. Chapter 2 and Chapter 3 are formatted for specific journals in which they will be submitted. Chapter 2 submitted to the *Journal of Outdoor Recreation and Tourism*, an international journal that publishes cutting edge research in the study of leisure and recreation that advances theory, methods, or the concept of outdoor recreation research, planning or management. Chapter 3 will be submitted to *Environmental Management*, a journal that publishes on use and conservation of natural resources, the protection of habitats and the control of hazards, including the field of environmental management without regard to traditional disciplinary boundaries. Chapter 4, *Summary and Conclusion*, summarises results from the scientific chapters, provides insight into the knowledge gaps this research filled, but also identifies areas upon which future research should focus. Lastly, this chapter provides final recommendations for conservation managers in New Brunswick conserving sand dune ecosystems. The research instrument is in the *Appendix*.

Co-authorship Statement

This dissertation includes two manuscripts written in collaboration with other individuals. The author is the primary and corresponding author for both manuscripts included in this dissertation. The author has been the primary researcher of the study for the literature review, the research proposal design, the applied aspects of the research, the data collection and analysis, and the manuscript preparation and completion. The co-authors provided significant intellectual contributions to each of the manuscripts by critiquing methods, data collection and analysis, by guiding the author through data interpretation and analysis, and by reviewing the final manuscripts. The following paragraphs state the journal that each manuscript will be submitted to, and after the author of this dissertation, the order of the co-authors.

The first manuscript "*All-Terrain Vehicle Use: Differences and Similarities in New Brunswick Communities Perceptions of Impact*" was a collaborative effort with Dr. Carly Sponarski and Dr. Alistair Bath. This paper was submitted to the *Journal of Outdoor Recreation and Tourism.*

The second manuscript, "*Spatial Extent and Severity of Impacts Caused by All-Terrain Vehicles (ATVs) on Coastal Sand Dune Vegetation on Miscou Island, Canada*." was a collaborative effort with Dr. Carissa Brown. This paper has been prepared to be submitted to *Environmental Management*.

Chapter 1 : Introduction

Geographers have long concerned themselves with the relationship between humans and their environment (Pattison, 1974). Resource geographers have explored a wide range of topics including environmental perception, values, human impact, and the incorporation of people in the decision-making processes (Saarinen et al., 1984; Tuan, 1990; Burton et al., 1993). These topics within natural resource management are often complex socio-ecological structures characterised by interactions between the ecological functioning and the human perspective (Aretano et al., 2017). The human and ecological components often study similar topics and situations; however, they are rarely linked together. It is vital that both perspectives, the human and the ecological, are documented alongside each other to achieve a holistic assessment of issues presented. As there are many crucial links across disciplines (e.g., human dimensions researchers study the people who use the ecosystems in which natural scientists study), it is important that research interprets where various scientific understanding are connected. To facilitate a better understanding of natural resource management complexities, this thesis will integrate both human dimensions, the study of people's relationships with the environment, and recreation ecology, the study of the impacts caused by recreation.

1.1 Human Dimensions

Throughout history, humans have been connected to the natural world whether by curiosity, fear, or the use of natural resources (Brown, 2009). However, it was not until the mid-1960s that the academic field of Human Dimensions (HD) emerged (Manfredo, 1989). The term *human dimensions* was coined in 1973 at the North American Wildlife and Natural Resource Conference by Hendee and Schoenfeld (Decker et al., 2001), but has since also been titled Human Dimensions of Wildlife (HDW) and Human Dimensions of Natural Resources (HDNR). HD has been described in multiple ways and is most commonly defined as how people value wildlife, how people want wildlife to be managed, how people affect wildlife and/or are affected by wildlife and wildlife management decisions (Decker et al., 2001). One of the primary objectives of the field is to identify dominant patterns of values and beliefs among individuals and interest groups who affect, and are in turn affected by, resource-related issues (Bath, 1998). By analysing public thoughts and actions toward natural resources over time, various management goals can be attained: (1) the public is encouraged to participate in environmental-related activities, (2) conflict among interest groups is minimized, (3) the public is more educated about management options and practices, and (4) the position of interest groups on the issues at hand are predicted in advance of managers making those decisions (Pierce et al., 2001).

HD uses a variety of concepts, tools, and techniques to provide representative data and insight on wildlife issues to the public (Vaske et al., 2006). Within the field of HD, the most prominent conceptual framework is the cognitive hierarchy. This framework is used to understand and describe human interactions with the natural world by organizing human thought into layers of cognitions (Pierce et al., 2001). Cognitions have been defined by Ashcroft (1994, pp. 12) as “the collection of mental processes and activities used in perceiving, remembering, thinking, and understanding, as well as the act of using these processes”. This hierarchy was first developed by Rokeach (1973) and Homer and Kahle (1988) and was then introduced to the field of HD by Fulton et al. (1996).

The cognitive hierarchy (Figure 1.1) examines cognitions from general to specific (Homer & Kahle, 1988). Often described as an inverted triangle, the concepts within this hierarchy are interdependent, working toward a more complete understanding of values (Fulton et al., 1996; Vaske & Donnelly, 1999). These layers of cognitions, specific beliefs, attitudes, and norms are used to better distinguish how cognitions affect, or influence, behaviours and behavioural intentions (Vaske, 2008). At the bottom of this inverted pyramid are values (Figure 1.1), described as the "most basic cognitions" (Whittaker et al., 2006). These are different from other elements within the model because values must stay consistent over other situations and issues (e.g., a person who is honest must also be honest when completing tax forms, directing business deals, and while with friends) (Vaske, 2008). Values are difficult to link to specific cognitions or behaviours because values are abstract (Whittaker et al., 2006). Therefore, values orientations are included next in the hierarchy as they provide meaning to the abstract values through "basic belief patterns", otherwise understood as the organization of beliefs into patterns of association (Whittaker et al., 2006). For example, value orientations have explored beliefs about "broad classes of objects" like wildlife or forests, which can be linked back to value-level cognitions (Manfredo & Dayer, 2004; Whittaker et al., 2006).

The next level of the pyramid is attitudes (i.e., positive or negative feelings toward some object) and norms (i.e., judgements about appropriateness in a specific situation). Attitudes are the most frequently studied concept in social sciences (Eagly & Chaiken, 1993; Manfredo et al., 2004). Attitudes are important as they can predict and influence behaviour (Vaske, 2008). Essentially, people's values define their attitudes which in turn affect their associated behaviours (Pierce, Manfredo, & Vaske, 2001).

Norms, on the other hand, can help to explain why individuals may act in certain ways (i.e., regular or irregular behaviour) (Heywood & Murdock, 2002). Similar to attitudes, norms are not static across people and situations. However, they do not always influence behaviour when outcompeted by other norms, attitudes, or motivations (Vaske, 2008). All of these attributes (beliefs, attitudes, and norms) are said to mediate the relationship between values and behaviour (Whittaker et al., 2006).

The final step in HD research is understanding how these elements within the inverted pyramid, the cognitive hierarchy, are linked to each other through statistical analysis. For example, this framework has been explored using structural equation modeling to understand how norms influence self-reported ecological behaviour (i.e., behavioural intention; Vaske et al., 2015). The cognitive hierarchy has been used for, but not limited to, wildlife issues (e.g., Engel et al., 2017; Manfredo & Fulton, 1997; Zinn et al., 1998), recreation and the environment (e.g., Vaske & Donnelly, 2007; Waight & Bath, 2014), and forest planning issues (Vaske & Donnelly, 1999, Vaske et al., 2001). Using Human Dimensions research as the foundation, the first manuscript, Chapter 2, "*All-Terrain Vehicle Use: Differences and Similarities in New Brunswick Communities, Perceptions of Impact"* helped guide the research questions for the recreational ecology chapter "*Spatial Extent and Severity of Impacts Caused by All-Terrain Vehicles (ATVs) on Coastal Sand Dune Vegetation on Miscou Island, Canada*".

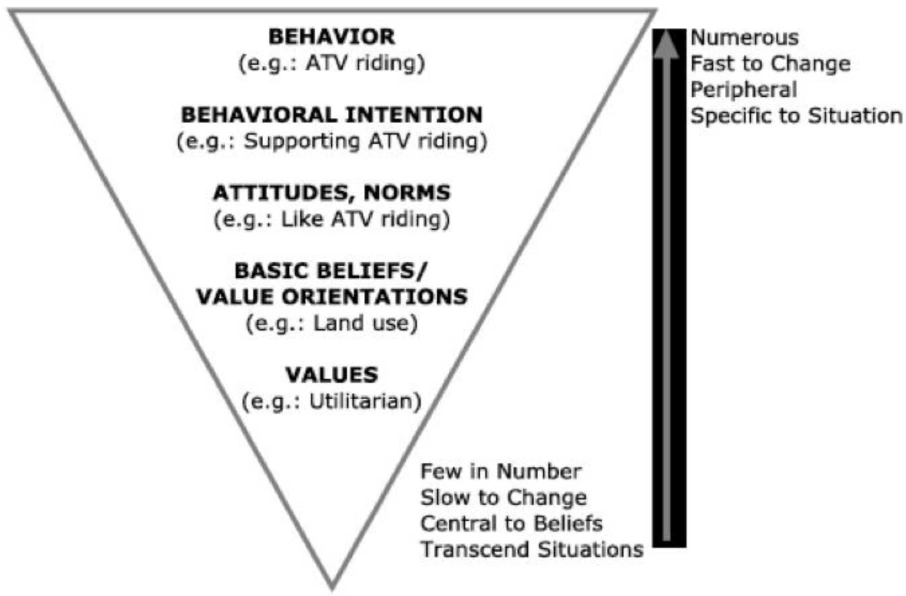

Figure 1.1 The cognitive hierarchy model of human behaviour (Adapted from Vaske & Donnelly, 1999 in Waight, 2014).

1.2 Recreation Ecology

The majority of research in recreation ecology has been as a sub-discipline of ecology (both conceptually and in practice; Van Vierssen Trip, 2014). Beginning in the 1920s and '30s, early research in recreation ecology was conducted through observations and early experimentation (Bates, 1935; Meinecke, 1928). In the 1970s, thorough research in the field began, leading to the application of results to management in the 1980s (Cole, 1987; Liddle, 1997; Leung & Marion, 2000). Recreation ecology developed from the necessity to monitor and evaluate the negative impacts of visitors and users (i.e., hikers, bird watchers, campers, ATV users) of wilderness areas and Protected Areas (PAs; Cole et al., 1987; Liddle, 1997; Leung & Marion, 2000). Recreation ecology is defined as the study that examines, evaluates, and monitors the impacts caused by outdoor recreation and nature-based tourism activities in natural or semi-natural environments (Hammitt & Cole, 1998; Leung & Marion, 2000; Liddle, 1997). Such research is valuable to natural landscape managers as it can help evaluate and identify direct and indirect impacts to improve prevention, mitigation, and management of impact on these landscapes (Leung & Marion, 2000). Like human dimensions research, recreation ecology is management oriented. Recreation ecologists have two goals: (1) to identify ways to decrease negative impacts of recreational users on landscapes so that they are protected and (2) assure that the requirements of recreational users are still met alongside protection (Cole et al. 1987; Liddle, 1997; Leung & Marion, 2000).

Recreation ecology research has examined impacts of hiking, camping, and other activities, where use is highly concentrated, such as formal trails and high-use destinations; or dispersed, where users are not confined to certain areas or trails (Monz et al., 2013). Wall & Wright (1977) suggest that recreational impact is divided into four categories: soil, vegetation, wildlife, and aquatic environments (as cited in Liddle, 1997). For the purpose of this study, vegetation is the most relevant to the second manuscript and will be discussed in more detail in chapter three. Although aquatic environment impacts are likely occurring due to all-terrain vehicle (ATV) use in these areas, this category of impact does not germane to this thesis and thus are not discussed further. By combining the fields of human dimensions alongside recreation ecology, a more holistic research practice is obtained and adds to the discussion of management of ATV users in New Brunswick.

1.3 All-Terrain Vehicles

The all-terrain vehicles (ATVs) club memberships in New Brunswick has increased about 126% from 9,334 memberships in 2012 to 21,071 in 2016 (New Brunswick All-Terrain Vehicle Federation, 2016). In the 1960's, the first ATV was created as a utility vehicle to help with cutting firewood (Bretzing, 2014). Similar designs continued to follow and in the 1970s', Honda designed the first official ATV (Bretzing, 2014). This provided individuals with access to new areas, improved mobility for the elderly, and a new recreational activity (Dunn, 1970). Growth in the activity coupled with an image often associated with ATV enthusiasts as "thrill-seekers" who disregard the environment and other recreationalists, ATV use is one of the most controversial recreation-related issues managers are facing today (Waight & Bath, 2014; Smith, 2000; Havlick, 2002). Specifically, in New Brunswick, these issues are intensified as ATV use on all coastlines in the province is illegal under the Trespass Act (Stewart et al., 2003). Due to increased participation, federal, provincial, and some local government agencies and non-government agencies have become more involved with users through planning and public participation efforts (Smith et al., 2010).

In the context of this research, ATVs were defined as "three-four-, or six-wheeled vehicles, quads, or side-by-sides designed for off-road use" (Waight & Bath, 2014; 166). Past research does not usually focus specifically on ATVs, but rather a combination of 4-wheel vehicles, off-road motorcycles, dirt bikes, and ATVs, which are referred to as off-highway vehicles (OHVs) or off-road vehicles (ORVs). Research on OHVs/ORVs have focused primarily on documenting impact to the environment (e.g., Arp & Simmons, 2012; Taylor, 2006; Ouren et al., 2007; Van Vierssen Trip, 2014) and species (e.g., Clark, 2004; Lodico, 1973, Primack, 1980, Vaske et al., 1994). OHVs users and their impact to the environment has been researched (Kelly et al., 2015; Kinderman & Gormally, 2010; Rosen et al., 2009; Schlacher et al., 2016; Thompson & Schlacher, 2008) but has limited application addressing ATV users perceptions of impact on coastal sand dunes. Initial studies explored environmental attitudes of OHV users to other, non-motorized, recreationalists (Van Liere & Noe, 1981; Nord et al., 1998; Theodori et al., 1998; Tarrant & Green, 1999; Teisl & O'Brien, 2003; Thapa & Graefe, 2003). Previous research explored attitude-behaviour parallels among OHV users as a distinct group of recreationists (Barker & Dawson, 2010; Smith et al., 2010; Kuehn et al., 2011) and how experiences of OHV and ATV riders shape environmental attitudes and behaviour, by applying desired benefits (Smith & Burr, 2011) and meanings-based approaches (Mann & Leahy, 2009; 2010).

More recently, research regarding ATV users found that beliefs, participation type, volunteer participation, number of days riding over the past 12 months, and residency type significantly predicted environmental attitudes of ATV users (Waight & Bath, 2014). Other research has compared OHV user and non-OHV user groups finding differences in terms of their intensity and relative ranking of their perceived experiences and settings (i.e., OHV users were more reactive to rules and regulations whereas non-OHV users expressed more inclination to protect the quality of environment used for recreation; Kil et al., 2011). Thapa and Graefe (2003) found that motorized recreationists, which included ATV users, had lower levels of environmental concern across all items in the study, and were significantly less likely to engage in green consumerism, political activism, and educational development pertaining to environmental issues. Also, motorized recreationalists were more likely to prioritize creating more recreational opportunity over habitat conservation (Thapa & Graefe, 2003). It should be noted that studies have also shown differences within ATV users including between recreational and utilitarian users (Waight & Bath, 2014). Although it can be difficult to distinguish between recreational and utilitarian ATV users, both applications of ATVs have important cultural, social, and phycological implications (Glass et al., 1990).

Many studies have also highlighted the use of the recreation specialization framework indicating differences between highly specialization OHV users and lower specialized users (Smith et al., 2010). Specialization is defined by Bryan (1977) as “a continuum of behavior from the general to the particular, reflected by equipment and skills used in the sport, and activity setting preferences” (p. 175). Smith et al. (2010) found that highly specialized OHV users were found to have stronger motivation for personal achievement and meeting, teaching, and leading others than less specialized riders, but did not differ in their environmental concern (Smith et al., 2010). Waight and Bath (2014) found that specialization among ATV users were negatively related to environmental attitudes, and that highly specialized users were less likely to agree that ATVs cause environment degradation and had more positive association of ATVs with social and subsistence aspects. As shown in past research, managers should better understand OHV users and their relationship to the environment, the activity, and utilization of the vehicles. There is an increase in research on ORVs and ATVs within the fields of recreation and tourism, but it is rare to compare human dimensions research alongside the ecological impacts, particularly for coastal sand dunes.

1.4 Coastal Sand Dunes

Coastal ecosystems are some of the most productive systems in the world (Calvão et al., 2013). While usually covering less area than most other systems, coastal ecosystems provide a tremendous amount of human benefits including erosion regulation and water purification (Millenium Ecosystem Assessment, 2005). Within these systems are coastal sand dunes which are established through complex interactions between both the land and sea (Brown & McLachlan, 2002; Gonçalves et al., 2013; Vallés & Cambrollé, 2013). Dunes play a significant role in the coastal sediment budget by storing and cycling sand to the backshore (Walker et al., 2013). Therefore, coastal dunes act as a buffer to protect shorelines again storm surge flooding, coastal erosion, and gradual sea-level rise (for examples see Davidson-Arnott, 2005; Houser et al., 2008; Mascarenahs & Jayakumar, 2008; Eamer & Walker, 2010). The use of recreational activities like all-terrain vehicles (ATVs), can lessen the resilience of coastal ecosystems and increase erosion by lowering dune crests and creating wind tunnels (Anders & Leatherman, 1987; Davenport & Davenport, 2005). Even at low levels of use, sandy coastal ecosystems are more sensitive to human pressures due to the interactions occurring between wind, waves, and sediments (Clark, 1996; Carter, 1988; Wong, 1993; Walker et al., 2013). As a result of this vulnerability, there are many threats to dunes including storms (Catto, 2002; Stancheva et al., 2011), human development (Rogers, 2002; Stancheva et al., 2011), other human disturbances such as tourism (Catto, 2002; Rogers, 2002; Talora, 2007; SARA, 2012), and ATV use (Carlson & Godfrey, 1989; Rickard, McLachlan & Kerley, 1994; Stephenson, 1999). ATV related ecosystem degradation has been highlighted by managers and NGOs as an activity which accelerates the erosion of coastal sand dunes (Bird Studies Canada, 2009) which may have serious impacts to beaches, the nesting habitat the piping plover (Nature Conservancy of Canada, 2016). Therefore, it is important that a better understanding of the human-environment relationship is found through the lens of both Human Dimensions and Recreation Ecology.

1.5 The Piping Plover

The Piping plover (*Charadrius melodus*) is a beach-nesting bird species in Atlantic Canada and Quebec listed as endangered under the Species at Risk Act (SARA) (Tarr et al., 2010; Environment Canada, 2006). This migratory bird is adapted to shifting sands and breeds in open or sparsely vegetated areas on coastal beaches, typically on beach habitat that is backed by sand dunes (Boyne et al., 2014; Gibson et al., 2018; Powell & Cuthbert, 1992). The Maritime population of the piping plover has seen a 32% decline between 1991 and 2011 (Abbott, 2015). The piping plover was designated as Endangered by COSEWIC in 2001 and officially listed under SARA in 2003 (Environment Canada, 2006). There are several threats to the piping plover including human disturbances (Flemming et al., 1998; Canadian Wildlife Service, 2015; SARA, 2016; Seavey et al., 2011), habitat loss (SARA, 2012), predators (Cohen et al., 2009; Murphy, Greenwood et al., 2003; Patterson et al., 1991), and environmental factors (Seavey et al., 2011; Canadian Wildlife Service, 2015). In terms of human disturbances, specifically off-highway vehicles, have had an impact on migratory birds (i.e., the piping plover) through fatal collisions (Warnock, 2003; SARA, 2012), multiple disturbances causing a reduction in the success of breeding (Flemming et al., 1998; Burger, 1994;

Williams et al., 2004; McGowan & Simons, 2006), and an increase in the amount of energy expended by the bird, impacting their body condition and other fitness related traits (Gill & Sutherland, 2000). Of these threats, the greatest to population recovery of the piping plover are predation, habitat loss, and human disturbance (Environment Canada, 2016). Gaining an understanding of the controversy surrounding the piping plover is important to the context of this thesis, particularly for coastline management.

1.6 Study Context

With the increase of all-terrain vehicle (ATV) use on New Brunswick coastlines, management agencies, such as the Nature Conservancy of Canada (NCC), Parks Canada, Bird Studies Canada, etc., have expressed concern for the dangers recreationalists have on piping plover populations numbers as they can disturb nests and attract predators (Nature Conservancy of Canada, 2014). Of these agencies, NCC is one of the primary funding bodies for this project, sharing an initial interest in this project due to issues pertaining to increased ATV use and little knowledge of the residents of communities in which they have properties. The mission of NCC is to lead and inspire other to join the agency in establishing a legacy for future generations to come by conserving natural systems and biodiverse areas across all of Canada's regions (The Nature Conservancy of Canada, 2018). With this in mind, NCC is taking the lead to integrate a higher level of community involvement and wants to understand the communities in which they have properties. This project works as the first form of understanding of these residents and NCC intends to continue to explore creating and maintaining relationships with these communities.

Although there is a lot of exposure to issues of the piping plover, there is also concern for the erosion of coastal sand dunes which provide important ecological and socio-economic services such as coastal protection (Bird Studies Canada, 2009; EPA, 2006; Thompson & Schlacher, 2008). Piping plovers and coastal sand dunes are often found in proximity to recreational activities, however, there has been minimal research on the potential for human-environment conflict, which occurs most often when there is competition for a shared resource (e.g., nesting habitat versus space for recreation) (Jorgensen & Brown, 2015). In certain areas, the type of protective measures used to protect birds and other environments have created negative attitudes, hindering efforts to recover the intended species (Harmon, 2014; Panzar, 2013; Steele, 2013). This kind of conflict has led to public debates about how coastlines should be managed.

Miscou Island, New Brunswick, one of the study areas for this research, has directly experienced conflict in relation to the piping plover. In the summer of 2006, ATV riders held the 15th annual rally where ATVs were ridden around the beaches of the island (CBC News, 2006). Although legislation states that is and was illegal to ATV on all coastlines in New Brunswick under the Trespass Act (Stewart, Rutherford et al., 2003), the article states that “An enforcement co-ordinator with the species-at-risk branch of Environment Canada, [had] stepped in and banned the ATVs from the beach” and even further the journalist states that the piping plover was the “spoil sport” to the event (CBC News, 2006). The personification of this species is evidence of the important historical context surrounding the management of these coastlines. The context within the community may help to further understand the communities’ evaluations of coastal management, specifically for coastal sand dunes.

Demonstrated by the potential for conflict which occurred in 2006 between ATV users and the piping plover in New Brunswick (CBC News, 2006), it is evident that there are complex management issues surrounding coastline ecosystems. This causes concern not only for the piping plover, but also for sandy beaches and dunes in the area, which are important barriers for coastal protection (Doody, 2013; Hanley et al. 2014). Coastal sand dunes face many impacts such as storms and tourism (Catto, 2002; Rogers, 2002; Talora, 2007; SARA, 2012), but the impacts caused by ATV use can accelerate beach erosion causing permanent damage to piping plover habitat (among other impacts like presence of foraging habitat or predation; Cohen et al., 2008; Boyne et al., 2014) as well as diminishing the ability of dunes to protect the coastline against storms and other threats such as coastal erosion (Rooney, 2005). The indirect and direct impacts occurring to coastal sand dunes and the piping plover emphasizes the importance of understanding the complex interactions between humans and the environment. Coastal sand dunes are also generally understudied in the field of human dimensions which may be due to studies focussing primarily on charismatic fauna such as wolves (Bath, 1998). However, they remain an important landscape providing both ecological and socio-economic services (EPA, 2006). Therefore, the purpose of this research is to help bridge the knowledge gap between human perceptions of impact caused by people and the ecological effects of ATVs on coastal sand dunes.

1.7 Study Areas

Data collection for chapter two occurred in the three communities of Pointe-Sapin, Escuminac, and Miscou Island, New Brunswick. Data collection for chapter three occurred in Miscou Island and Kouchibouguac National Park, New Brunswick. These areas were chosen based on high all-terrain vehicle (ATV) use, participation in ATV clubs, as well as where the Nature Conservancy of Canada, one of the funding agencies for this project, owns properties. They are all listed as Important Bird Areas as they are home to the nationally endangered species, the piping plover (Important Bird Area, 2016a; Important Bird Area, 2016b). The study areas in Chapter 2 are of particular interest as they have been suggested to have particularly high use of ATVs on their coastlines causing concern for the ecosystem and the species within it. For Chapter 3, Miscou Island was chosen based on previous human-wildlife conflict toward the piping plover which may influence issues pertaining to coastal management (as mentioned in Section 1.5). Kouchibouguac National Park was chosen as a control site for chapter three because the coastal sand dunes in this area have no permitted ATV use. Furthermore, as Miscou Island and Kouchibouguac share similar species assemblages (see results 3.3.1), we can assume that the differences in abundance and distribution in those species are not due to their regional absence.

The first study area, Pointe-Sapin, is situated north of Kouchibouguac National Park (46.9639° N, 64.8298° W) (Figure 1.3). This area includes habitats of tidal rivers/estuaries, mud or sand flats, coastal sand dunes, and beaches (Important Bird Area, 2016). The ongoing threats to these areas include recreation and tourism, which can include ATV use on sand dunes (Important Bird Areas, 2016c). The land area is about 72 km^2, the population is 477 people, there are 258 dwellings, and 219 of these dwellings are occupied by permanent residents (Statistics Canada, 2016).

Escuminac is situated north of Pointe-Sapin, on the south shore of Miramichi Bay, about 55 kilometres east of Miramichi (47.0769° N, 64.9139° W) (Figure 1.3). The area consists of an 11-kilometre stretch of coastline including sandy beaches and a few coastal lagoons backed by low-lying areas (Important Bird Areas, 2016b). Similar to Pointe-Sapin, there are ongoing threats to these habitats due to disturbance. It is the smallest community of the three study sites with a land area of about 13 km^2, a total population of 166 people, 112 private dwellings, of which about 80 are occupied by permanent residents (Statistics Canada, 2016b).

The final research site for chapter two was Miscou Island, situated off the northeastern tip of New Brunswick, between Baie des Chaleurs and the Gulf of St. Lawrence (47.9604° N, 64.5195° W) (Figure 1.3). This island was named “m’susqu” by the Mi’Kmaq people due to the “wet, boggy, low-lying terrain” (Nature Conservancy of Canada, 2016). It is home to many shorebirds and waterfowl during fall migration (Important Bird Areas, 2016a). Habitats found on the island include fens and bogs, coastal sand dunes and beaches, coniferous forest, mud or sand flats, freshwater lake, open sea, and marine inlets/coastal features (Important Bird Areas, 2016). Similarly, to both Pointe-Sapin and Escuminac, there are ongoing threats to these habitats caused by disturbance, specifically due to recreation/tourism (Important Bird Areas, 2016). It is a small island, approximately 64 km^2, with a population of 530 people and a total of 330 private dwellings, 253 of those dwellings which are occupied by permanent residents

(Important Bird Areas, 2016; Statistics Canada, 2016). This site was chosen to be studied in Chapter 2 and Chapter 3 because all beaches and dunes on Miscou Island are considered in critical condition, as seen in Figure 1.3, there is an active ATV club that is a part of the NB ATV Federation, and it is also where the Nature Conservancy of Canada (NCC), one of our funding agencies, has the most properties.

Kouchibouguac National Park is the control site for chapter three. Kouchibouguac is situated on the east coast of New Brunswick, about 47 km south-east of Miramichi (46º47’00.00” N, 65º01’00.00” W) (Environment Canada, 2016b) (Figure 1.2). This national park is a reserve, with over a hundred-square kilometers, comprising of salt marshes, forests, bogs. Over 25 km of the park’s shorelines consists of sand dunes (Parks Canada, 2010), most of which have no permitted recreational activities in proximity. Although there is a lot of foot traffic to Kouchibouguac National Park, the sampled areas chosen for this study were out of normal walking areas for visitors (i.e., taken to by boat or not within walking distance from high traffic areas), making it a suitable natural control for the ecological study, Chapter 3.

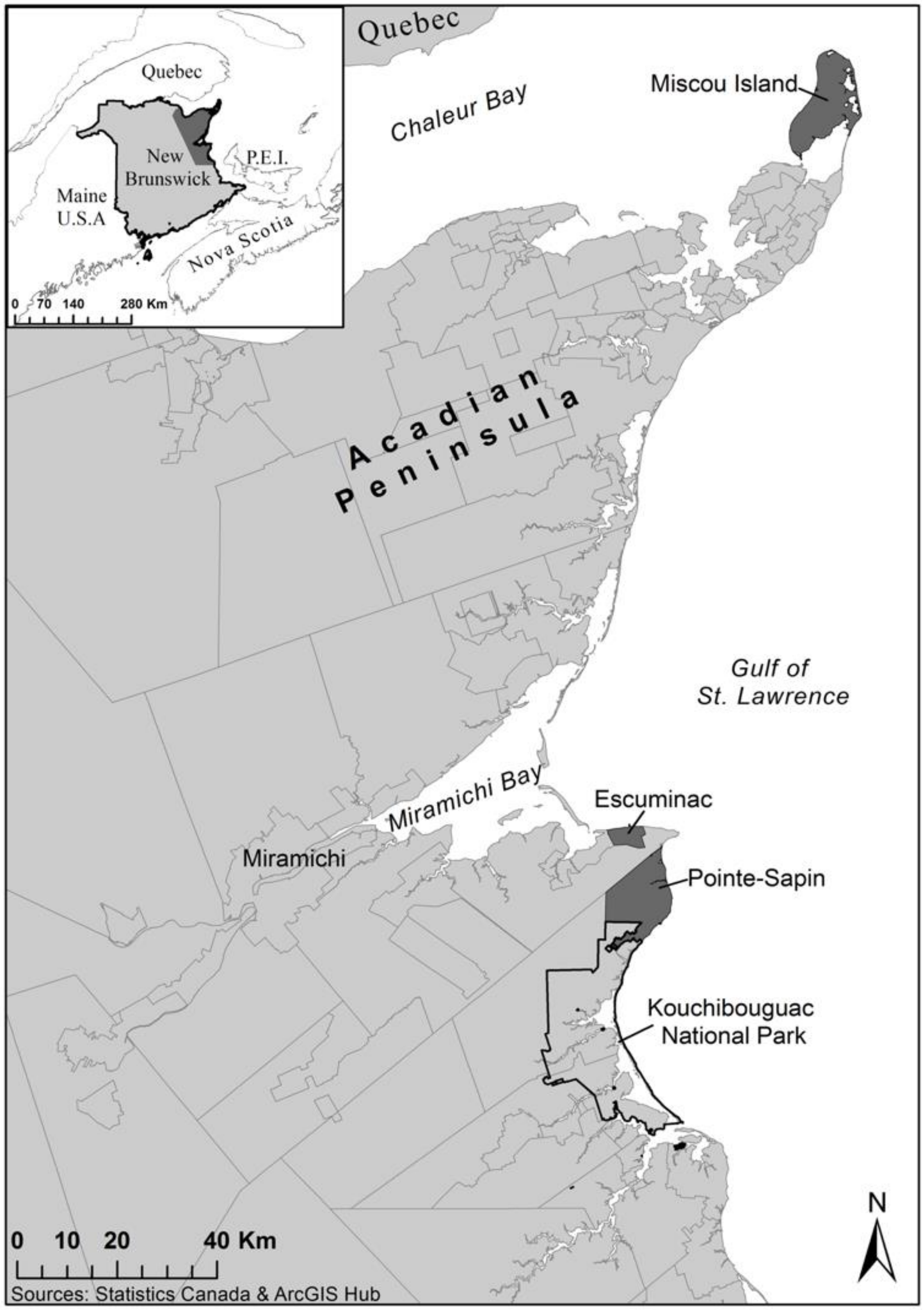

Figure 1.2. Study areas for Chapter 2, Pointe-Sapin, Escuminac, and Miscou Island, New Brunswick, Canada.

Figure 1.3. Map of Miscou Island from the Nature Conservancy in the Acadian Peninsula Bioregion Habitat Conservation Strategy (2003) identifying critical beaches and dunes on the Acadian Peninsula, New Brunswick, Canada.

1.8 Research Purpose and Objectives

It can be challenging to implement interdisciplinary research, but managers of natural landscapes must incorporate both the human and ecological perspective in everyday practice to achieve conservation success. Therefore, the purpose of this research is to analyse ATV use in NB from two different disciplinary perspectives: human dimensions and recreation ecology. It is also to clarify resource management issues in coastal New Brunswick communities by integrating these fields. This project has three objectives: (1) Assess whether there are similarities and differences between communities' perceptions of impacts on; perceived main threat to; value orientations toward; and acceptability of ATV upon, coastal sand dunes. Even though the communities share many demographic similarities (see Chapter 2, 2.3.1 Summary of demographics), it is unwise to assume that communities would have the same values and behaviours. We have also considered them separately based on concerns from Nature Conservancy Canada (NCC), our funding providers, and because it is important to explore when there are "null" or significant differences as both outcomes provide better insight into these communities. Comparing community perceptions also allows for an exploration of the role of context in natural resource management issues. 2) Evaluate whether there are effects on vegetation of coastal sand dunes from ATVs, where we expect increased intensity of ATV use to degrade dune vegetation and (3) provide recommendations and future direction for management of coastal areas.

1.9 Significance of Research

This dissertation on human dimensions coupled with recreation ecology has relevance in the realms of academia, policy, and applied practice. Firstly, the interactions seen with ATV use have been comprehensively studied from a natural science point of view (for example see Schlacher & Morrison, 2008; Kutiel, Zhevelev, & Harrison, 1999; Kelly et al., 2003), but is rarely coupled with human dimensions. Therefore, this research will address existing perceptions of ATV use on dune systems and whether this can be related to recreation ecology impacts. Secondly, the findings of the research will directly influence the New Brunswick conservation management decision-making process regarding the current use of ATVs. New Brunswick coastal dune regions are managed by a variety of agencies including Parks Canada and the Government of New Brunswick under trespass legislation. The results of this study will be presented to these decision makers, managers, and shared with community residents and members of ATV clubs. The goal of this research is to understand perceptions of ATV impacts between the three communities, Pointe-Sapin, Escuminac and Miscou Island, as well as identify the associated impacts on the ecology of the sand dunes. By developing a better understanding of these two elements, natural resource managers can establish a communication management framework that supports recreation while also protecting dune integrity and the habitats of species like the piping plover.

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Chapter 2 :
All-Terrain Vehicle Use: Differences and Similarities in New Brunswick Communities Perceptions of Impact

2.1 Introduction

The increase of illegal all-terrain vehicle (ATV) use on the coasts of New Brunswick, Canada, causes concern for the integrity of the sandy beaches and dune systems, barriers for coastal protection and habitat to a wide range of flora and fauna (Everard et al., 2010; Hanley et al., 2014). Even at low levels of use, sandy coastal ecosystems are naturally sensitive to recreational pressures due to interactions between wind, waves, and sediments (Carter, 1988; Clark, 1995; Kay & Alder, 1999; Wong, 1993). With an estimated 70% of the world's sand-based coastline vulnerable to erosion (Bird, 1985), impacts to dunes caused by vehicles have become a significant environmental concern (Defeo et al., 2009; Schlacher & Morrison, 2008; Schlacher, Thompson, & Price, 2007). Such impacts require improved regulation in order to minimize human impact on these ecosystems.

To minimize impacts by ATV users, it is essential that a sustainable equilibrium is maintained between environmental needs and human use of these landscapes. Recognizing that people are an essential part of conservation, public involvement initiatives have been mandated by many wildlife management agencies (Bath, 1998; Decker & Chase, 1997). In wildlife management, public meetings and open houses have been the primary method to incorporate the public in the decision-making process (Bath, 1998). While the individuals who attend these meetings are a part of the public, their perspectives are not necessarily representative of the entire constituency. By using Human Dimensions of Wildlife (HDW) research methods, we can balance vocal voices with lesser heard voices through a representative sample of the entire constituency. In this context, we examined residents in three New Brunswick communities relative to their: (a) perceptions of impact and main threat to; (b) value orientations toward; (c) acceptability of ATV use on, coastal dunes.

2.1.1 Perceptions of impacts and threats

Based on individuals' understanding of the impact caused by recreational activities, perceptions may be linked to whether an individual will accept specific management options (Bennett, 2016; Priskin, 2003). For example, local users of resources and communities may evaluate their support or opposition to conservation initiatives based on their perceptions of the ecological impacts caused by conservation (Bennett, 2016). Perceptions are defined as "the way an individual observes, understands, interprets, and evaluates a referent object, action, experience, individual, policy, or outcome" (Bennett, 2016, p. 585). Thus, we measured perceptions of impact by having respondents evaluate the object of coastal sand dunes through photographs illustrating different levels of erosion impact and then by indicating what they perceived as the main threat to dunes.

Scenic beauty estimations (SBE), is one technique developed by Daniel and Boster (1976) to evaluate scenic beauty values through photographed scenes. Photographs are an excellent tool to measure coastal perceptions (see Williams & Lavelle, 1990) because perceptions are closely related to the concept of preferences

(Kaplan et al., 1972). The utility of the SBE to understand people's evaluation of specific situations or events is not a new practice and has been used to evaluate coastal landscapes (Murphy, 2011; The Landscape Institute, 1995; Porteus, 1996; Williams & Lavelle, 1990). It has been used to evaluate a variety of topics including, but not limited to, scenic beauty of trails (Hull IV & Reveli, 1989), campers' scenic beauty assessment (Daniel et al., 1989), coastal landscape preferences (Eleftheriadis et al., 1990; Williams & Lavelle, 1990), and forests (Hull IV & Buhyoff, 1986; Hull IV, Buhyoff, & Cordell, 1987; Taylor & Daniel, 1984). More recently, the visual techniques have been strengthened by using theory to understand perceptions and acceptability of landscape quality and crowding using 5-point Likert scales (i.e., Laven et al., 2005; Manning et al., 2001). In this article, we are utilizing more recent visual impact techniques along with value orientations and acceptability of use and management to improve our understanding of perceptions of impact on coastal sand dunes.

2.1.2 Value Orientations

In HDW research, value orientations are useful in predicting people's differences in attitudes toward wildlife issues (Kellert, 1976; Purdy & Decker, 1989), evaluating the influence of wildlife on the quality of human life (Shaw, 1987), and identifying differences within the members of the public who participate in wildlife-related recreation (Bryan, 1980; Decker & Connelly, 1989). Value orientations (Kluckholn, 1951) are general objects (e.g., wildlife, forests, coastal sand dunes) obtained via patterns, direction, and intensity of basic beliefs regarding the general objects (Fulton et al., 1996; Vaske & Donnelly, 1999). In this study, we present value orientations on a non-mutually exclusive continuum seen from biocentric to anthropocentric value orientations (Shindler et al., 1993; Steel et al., 1994; Vaske & Donnelly, 1999). The biocentric value orientation is nature centered, where human wants and needs are still important, but seen as a part of a greater system (Vaske, 2008). People with this value orientation assume that the environment has inherent worth and that economic development is not the most crucial use of natural resources (Thompson & Barton, 1994). People with the anthropocentric value orientation see the environment from a human-centered point of view (Eckersley, 1992) and assume that natural resources are "material to be used by humans as they see fit" (Scherer & Attig, 1983). Within this continuum, for example, there is a tendency for individuals who have higher levels of environmental concern to be less accepting of recreational impacts (biocentric) whereas those with lower levels of environmental concern tend to be more accepting of impacts (anthropocentric) (Floyd et al., 1997). Generally, research has focused on wildlife value orientations (Bright et al., 2010; Fulton et al., 1996) and forests (Shindler et al., 1993; Steel et al. 1994; Vaske & Donnelly, 1999; Vaske et al., 2001) and has less often focused on other habitats such as coastal sand dunes. Comprehending value orientations toward coastal sand dunes will help identify how individuals relate to this environment (Decker et al., 2004).

2.1.3 Acceptability of use and management

The concept of acceptability is framed within the Limits of Acceptable Change (LAC) (Hoss & Brunson, 2000). This framework monitors standards for protection to identify when the specified landscape or species has experienced an 'unacceptable change' (Haider & Payne, 2009). Acceptability, therefore, is a result of two things: (1)

comparing the current situation with other known alternatives; and (2) a decision about whether or not the actual scenario is perceived better than the alternatives (Hoss & Brunson, 2000). Research to help formulate the acceptability of a certain action is often evaluated using structural norm theory (Vaske, 2008). Using this approach, public acceptance is driven by what an individual or society believes is appropriate in a given context (Shelby et al., 1996; Vaske et al., 2001). Within the context of this research, acceptability is defined as a "judgment or decision regarding the 'appropriateness' of a particular action or policy" (Bruskotter et al., 2009, p. 121). By accounting for a deeper consideration of acceptability of ATV use and management of dunes, managers and planners can understand whether the public is setting looser standards than what is legal when the acceptability may restrict their ATV use.

Here, we compare and contrast three New Brunswick coastal communities specifically, Escuminac, Pointe-Sapin, and Miscou Island, with respect to residents': (a) perceptions of human impact on; (b) perceptions of main threat to; (c) value orientations about; (d) acceptability of use and management of ATVs on; coastal sand dunes. As it is unwise to assume that all communities are the same, we have chosen to examine the communities individually. Further, by examining the communities separately, we can explore whether context influences residents' perceptions, value orientations, and/or acceptability of use and management. Comprehension of the similarities and differences among the communities will help provide managers and planners with direction for their communication efforts regarding the protection of dunes.

2.2 Methods

2.2.1 Study Area

All communities in this study are located along the coast in New Brunswick, Canada. Pointe-Sapin and Escuminac are neighbouring communities. Pointe-Sapin is situated north of Kouchibouguac National Park, and Escuminac is on the south shore of Miramichi Bay (Figure 1.2). Miscou Island is located off the northeastern tip of New Brunswick, between Chaleur Bay and the Gulf of St. Lawrence. The primary industries within these communities include fishing and aquaculture as well as peat moss extraction (Important Bird Area, 2016a; Important Bird Area, 2016b; Important Bird Area, 2016c). All communities have both French and English as official languages. Generally, Miscou Island residents speak French only (48%) or both French and English (46%; NB official languages) and few speak English only (6%) (Statistics Canada, 2016). The vast majority of Pointe-Sapin residents speak both official languages (80%), and some speak only French (18%) and only about 2% speak English only (Statistics Canada, 2016). Escuminac residents speak both official languages (76%), and some speak only English (24%) (Statistics Canada, 2016). The beaches in these communities are known as important bird areas, as there is suitable nesting habitat for the Piping Plover (*Charadrius melodus*), an endangered migratory bird (Environment Canada, 2006). With discussion between managers about an increase of neglect to the Trespass Act (Stewart et al., 2003), which includes laws to prevent ATV use on coastlines, managers have shown increased interest in working with communities to solve conservation issues.

2.2.2 Data Collection

Data were collected from residents (age $\geq$ 18) living in three communities: Pointe-Sapin, Escuminac, and Miscou Island. A quantitative research instrument was designed based on previous literature (Laven et al., 2005; Vaske & Donnelly, 1999; Waight & Bath, 2014), later pre-tested, and then translated into French by a Canadian company, Worldwide Express. Following the TCPS2 protocols, our methods and questionnaire were approved by Memorial University's Interdisciplinary Committee on Ethics in Human Research (ICEHR; ICEHR # 20171603-AR). We utilized Riley and Kiger's (2002) drop-off and pick-up (DOPU) method. The questionnaires were administered from May to August 2017. Each potential participant was recruited by going door to door using a systematic random sample of half of the households in each community. The questionnaires, both English and French, were initially handed out in a packet including a doorknob bag to facilitate collection, and instructions that the completed questionnaire would be picked-up in two days. If a completed questionnaire was not available at the time of pick-up, a stamped envelope addressed to the primary researcher with a reminder card was provided. If the questionnaire packet remained untouched on a doorknob for seven days and contact could not be established with the resident, the packet was removed. Budget constraints did not allow for any additional contact to be made with the residents. The overall response rate was 45% (n= 129 usable questionnaires). The response rates for each community were as follows: Pointe-Sapin 45% (n= 43 of 96 households), Escuminac 39% (n=22 of 57 households), and for Miscou Island 47% (n=64 of 135 households).

2.2.3 Variables

For the purposes of this research, we focussed on the communities as independent variables to explore differences and similarities in perceptions of impact (4 items), main perceived threat (1 item), value orientations about ATV use (7 items), and acceptability of ATV use and management of dunes (4 items), a total of 16 variables. During data collection, the questionnaires used a Likert scale from (1) to (5) (See Appendix) and was recoded using SPSS to (-2) to (+2) as required for statistical analysis (Vaske, 2008).

Perceived Impact. We used methods similar to Laven et al. (2005), using 5-point Likert Scale to examine four different photographs with varying levels of landscape quality. Four perceptions of impact stimuli asked residents to rate “In your opinion, how much human impact (if any) has happened on the following dunes?” for each of the four photographs of sand dunes (Table 2.2). The 5-point Likert scale ranged from “No Impact” (-2), “Slight Impact” (-1), “Moderate Impact” (0), “High Impact” (1), “Extreme Impact” (2). The photographs in the Results section are displayed from low impact to a high impact to help better display the sequence of impact. The photographs appeared in random on the questionnaire and were supplied by Catto (2009) from a study on coastal sand dunes in Sandhills, Prince Edward Island.

Perceived Threats. There was one variable for the main perceived threat to sand dunes. Residents were asked to pick “From the list of potential threats in the above section, which do you feel is the one main threat to dunes?”. There were 12 possible variables to choose from: a) ATVs driving over vegetation; b) Habitat loss due to human development (e.g., Building homes, camps or cottages); c) ATVs flattening hills of sand, d) Bonfires; e) Drought; f) ATVs creating deep trails within the sand; g) Tourism; h) Storms; i) ATV trails growing wider; j) Garbage dumping; k) Raking the beach; l) Animals eating the dune grass. Residents were asked to identify only one reason.

Value Orientations. Value orientation statements asked residents to rate to what extent they agree or disagree with seven statements (Table 2.4). Each statement was to be rated on a 5-point Likert scale ranging from "Strongly Disagree" (-2) to "Strongly Agree" (+2). Three of these statements were biocentric value orientations and four were anthropocentric (see Table 2.4).

Acceptability. There were four Acceptability questions asking residents to rate "what [they] consider to be unacceptable or acceptable for the following actions?" (Table 2.3). Each question was ranked on a 5-point Likert scale from "Extremely Unacceptable" (-2) to "Extremely Acceptable" (+2).

2.2.4 Statistical Analysis

An exploratory factor analysis (EFA) with varimax rotation was computed to validate the two proposed dimensions in value orientations, biocentric and anthropocentric. Cronbach's alpha reliability coefficients were used to measure the internal consistency of the value orientations scales of biocentric and anthropocentric. One-way analysis of variance (ANOVA) compared Pointe-Sapin, Escuminac, and Miscou Island across each of the 16 variables. The Levene Statistic was used for the test of homogeneity of variances. Effect size (ETA^2) examines the strength of the relationship between the independent variable and the dependent variable (i.e., compared the three communities responses for each perception, value orientation, and acceptability question; Vaske, 2008).

Differences and similarities between the three communities were examined using ANOVAs for perceptions of impact, value orientations, and acceptability. To display the results from the ANOVAs and the level of consensus within and between the communities, the Potential for Conflict Index$_2$ (PCI$_2$) was used (Vaske et al., 2010). PCI$_2$ includes statistical differences tests which calculate whether there is a significant difference between PCI$_2$ values using simulations, the default being 400 simulations (Vaske et al., 2010). PCI$_2$ and statistical differences tests were calculated using an openly available software for excel retrieved from http://warnercnr.colostate.edu/~jerryv/PCI2/index.htm. As the differences test assumes that the distribution is normal (Vaske et al., 2010), we calculated the skewness for all of the variables using the PCI$_2$ excel package. As none of the skewness values were more than +1.0 or less and -1.0, we can assume approximate normality (Vaske et al., 2010).

2.2.5 Potential for Conflict Index$_2$

In the field of Human Dimensions of Wildlife (HDW), one of the fundamental objectives is to use scientific information to influence decision making (Manfredo et al., 2003). However, when using abstract statistical methods like standard decisions and standard errors to explain differences and similarities between groups, “understanding gaps” can occur between managers and researchers (Manfredo et al., 2003). To fill these “gaps” in understanding, a visual tool called the Potential for Conflict Index (PCI) was created to help summarize findings in a way that is more meaningful to the reader (Manfredo et al., 2003). This tool was advanced by Vaske et al. (2010) for many reasons such as to increase the scale widths in which researchers can use it on (i.e., from 3, 4, 7, and 9 (PCI) to 2, 3, 4, 5, 6, 7, 8, and 9 (PCI_2)) as well as to be applied to a bipolar scale (with or without a neutral value) as well as to unipolar scales (Vaske et al., 2010).

Specifically, PCI_2 uses a scale from 0 to 1, where 0 is the least potential for conflict (e.g. everyone in the study strongly agrees with a statement) and 1 is the most potential for conflict (e.g. 50% strongly disagree and 50% strongly agree with a statement). It can also be displayed on a graph with the scale on the y-axis (e.g. from no impact to extreme impact) with a line down the middle of the graph and the different statements or stimuli asked in the questionnaire on the x-axis. The groups are displayed as bubbles, where the smaller the bubble (PCI_2 value closer to the 0) the more consensus and the larger the bubble (PCI_2 value closer to 1) the more potential for conflict, or less consensus. The location of each bubble, relative to the middle line, will display the level in which the data is skewed, drawn to one side of the scale or the other (Vaske et al., 2010). Thereby, using this visual tool, one can facilitate a better understanding of various elements including: (1) how the means are similar or different between the groups (seen on the y-axis scale); (2) whether the groups are experiencing high or low levels of consensus (seen in size of the bubbles and the PCI_2 values); (3) and how this might change over situations or statements (seen in different questionnaire statements or stimuli along the x-axis).

2.3 Results

2.3.1 Summary of demographics

For all communities, ages ranged from 25 to over 75 (Table 2.1). For Pointe-Sapin, the majority of respondents were male and completed the questionnaire in French (Table 2.1). For Escuminac participants, the majority of respondents were male and almost all of the questionnaires, except one, were completed in English (Table 2.1). The majority of Miscou Island participants were male and completed the questionnaire in French (Table 2.1).

Table 2.1. Percentage of respondents in each of the age, sex, and language in which the questionnaire was completed for Pointe-Sapin, Escuminac, and Miscou Island.

Demographics		Pointe-Sapin	Escuminac	Miscou Island
Age	25-29	8.8 %	0.0 %	2.4 %
	30-34	2.9 %	5.3 %	0.0 %
	35-39	14.7 %	5.3 %	2.4 %
	40-44	2.9 %	5.3 %	17.1 %
	45-49	5.9 %	26.2 %	4.9 %
	50-54	11.9 %	21.1 %	17.1 %
	55-59	5.9 %	10.5 %	9.8 %
	60-64	8.8 %	5.3 %	12.2 %
	65-69	8.8 %	10.5 %	24.4 %
	70-74	11.8 %	10.5 %	2.4 %
	75+	17.6 %	0.0 %	7.3 %
Sex	Female	24.2 %	35.0 %	34.1 %
	Male	75.8 %	60.0 %	58.5 %
	Prefer not to say	0.0 %	5.0 %	7.4 %
Language Completed	French	61.8 %	5.0 %	63.4 %
	English	38.2 %	95.0 %	36.6 %

Sample size for Pointe-Sapin (n=43), Escuminac (n=22), and for Miscou Island (n=64).

2.3.2 Perceived Impacts

The ANOVAs comparing perceived impacts between the communities revealed that there was little difference between all the communities for "No Impact" ($p > 0.05$; Figure 2.1 represented by numbers within the bubbles, Table 2.2, [a,b,c]). For "Moderate Impact", "High Impact", and "Extreme Impact" photographs, Miscou Island residents perceived higher impact than those in Pointe-Sapin ($p = 0.036$; $p = 0.025$; $p = 0.04$; respectively, Figure 2.1 represented by numbers within the bubbles, Table 2.2, [a,b,c]). Escuminac residents were found to perceive less impact on "Moderate Impact" than Miscou Island residents ($p = 0.035$; Figure 2.1 represented by numbers within the bubbles, Table 2.2, [a,b,c]), but there was little difference between Escuminac residents and either community for any other photo ($p > 0.05$; Figure 2.1 represented by numbers within the bubbles, Table 2.2, [a,b,c]).

The differences test comparing PCI_2 values found little difference for "No Impact" between communities of Miscou Island, Pointe-Sapin, or Escuminac ($p > 0.05$; Figure 2.1 represented by the size of the bubble and PCI_2 value beside bubbles with significant difference denoted by [a,b,c]). For "Moderate Impact" Miscou Island had a higher PCI_2 value than Pointe-Sapin, but little difference was found between Escuminac residents and either community ($p < 0.05$; Figure 2.1 represented by the size of the bubble and PCI_2 value with significant difference denoted by [a,b,c]). For "High Impact and "Extreme Impact", Miscou residents had lower PCI_2 values than Pointe-Sapin and Escuminac ($p < 0.05$; Figure 2.1 represented by the size of the bubble and PCI_2 value with significant difference denoted by [a,b,c]).

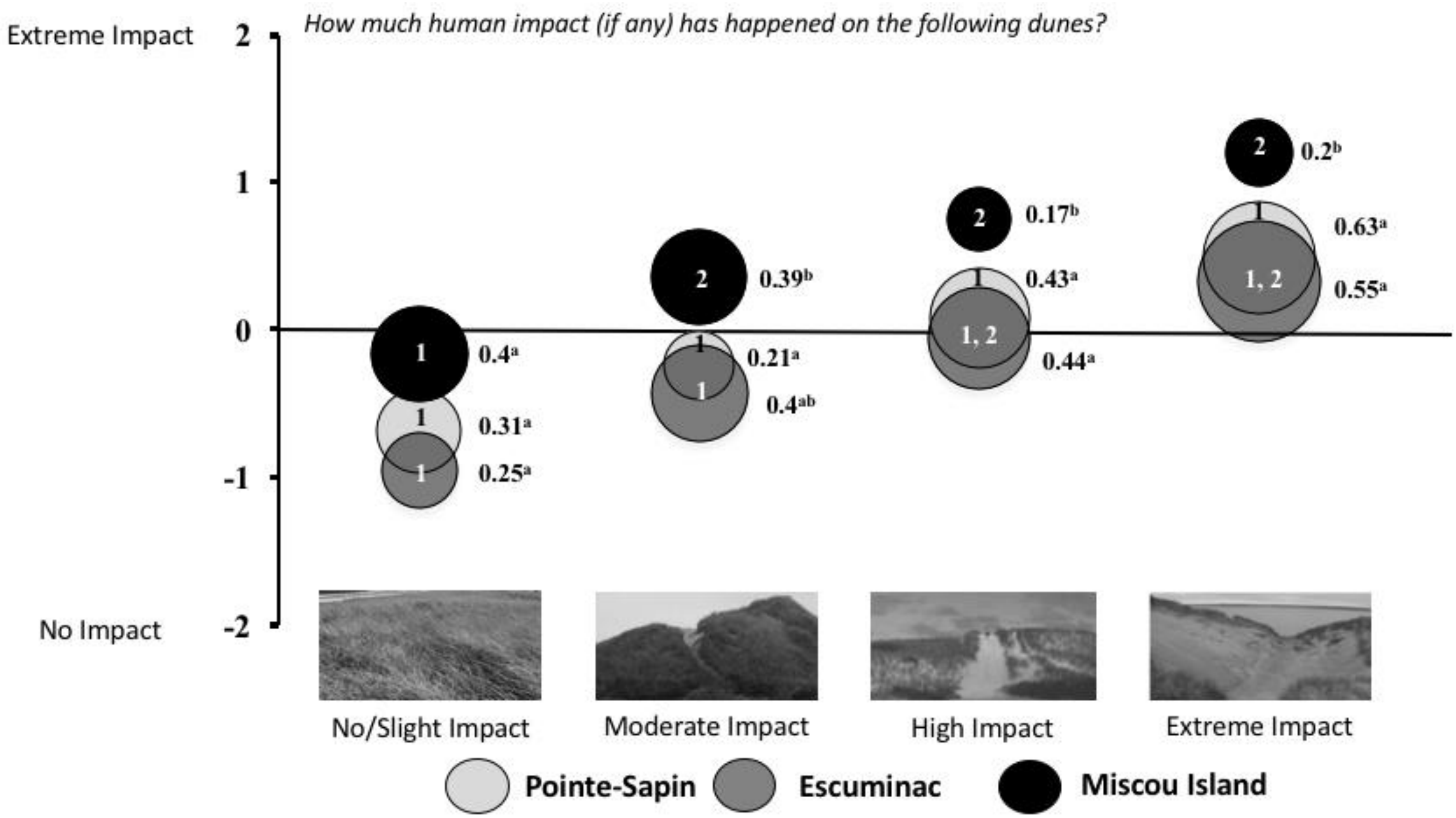

Figure 2.1. The mean response for Pointe-Sapin, Escuminac, and Miscou Island and PCI_2 values for the four perceived impact photographs. The numbers within the bubbles (1, 2, 3) denote if there is a significant difference between the means tested using one-way ANOVAs. The superscript letters (a, b, c) beside the PCI_2 value show whether there is a significant difference in the PCI_2 for the three groups tested using differences test. If there is no difference in number within the bubbles (i.e., all 1s) and/or a superscript beside the PCI_2 value, then there is no significant difference.

Table 2.2. One-way analysis of variance comparisons between Pointe-Sapin, Escuminac, and Miscou Island for four perception of impact photographs during a study of the differences and similarities between New Brunswick communities for coastal sand dune management, conducted in 2017.

	Mean					
Survey item[1]	Pointe-Sapin ($\bar{x}$)	Escuminac ($\bar{x}$)	Miscou Island ($\bar{x}$)	F Value	p Value	Eta[2] (η)
*In **your opinion,** how much human impact (if any) has happened on the following dunes?*						
	-0.68^{ab}	-0.95^{a}	-0.16a	3.69	0.028	0.05
	-0.24^{a}	-0.42^{a}	0.36^{b}	5.14	0.007	0.08
	0.07^{a}	-0.04^{ab}	0.75^{b}	5.64	0.005	0.08
	0.48^{a}	0.33^{ab}	1.20^{b}	5.28	0.006	0.08

[1]All photographs were measured using a 5-point Likert scale from "Extreme Impact" (2), "High Impact" (1), "Moderate Impact" (0), "Slight Impact" (-1), "No Impact" (-2).

[a,b,c] The letter superscripts denote significant differences between means based on the Tamhane post hoc test.

2.3.3 Main Perceived Threat

The majority of respondents in Pointe-Sapin and Escuminac perceived the main threat to dunes as storms (69% and 52.6%, respectively; Figure 2.2, (8)), whereas the majority of Miscou Island residents responses were spread with the top being "ATVs driving over vegetation" (30.6%; Figure 2.2, (2)) and "storms" as the second (22.2%; Figure 2.2, (8)). If all four ATV-related impacts were combined (Figure 2.2, (1-4)), then 61.2% of Miscou Island's residents believed ATVs were the main threat to dunes. This compares to only 10.3% from Pointe-Sapin and 26.3% from Escuminac (Figure 2.2). No residents indicated that bonfires, raking the beach, or animals eating the grass were the main threat to coastal sand dunes.

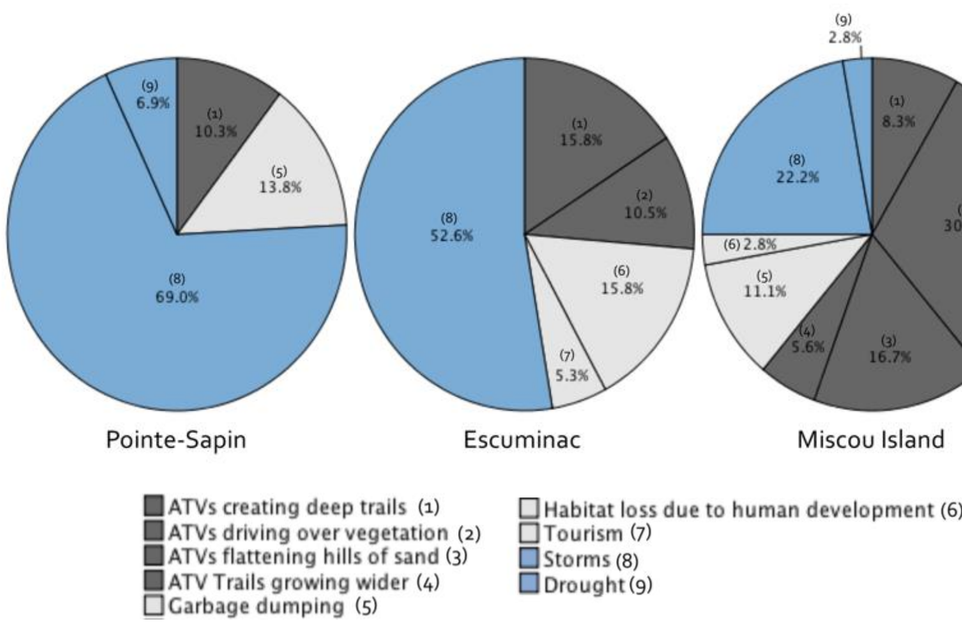

Figure 2.2. The percentage of responses for Pointe-Sapin, Escuminac, and Miscou Island in regard to their perceived main threat to coastal sand dunes.

2.3.4 Value Orientations

Using an exploratory factor analysis, we verified that all items loaded on their associated constructs of biocentric and anthropocentric values with all their factor loadings being ≥ 0.70 and all above the acceptable low of 0.4 (Table 2.3, Factor Loadings). The internal reliability for biocentric was 0.78 and for anthropocentric was 0.82 (Table 2.3, Cronbach's Alpha). Thus, the following results indicated two value orientations of biocentric and anthropocentric and will now be treated as two sub-concepts of value orientations.

Table 2.3. *Reliability analyses of biocentric to anthropocentric value orientations toward sand dunes.*

	Exploratory factor analysis		Reliability Analysis	
Value orientation/ survey item[1]	Biocentric	Anthropocentric	Alpha if item deleted	Cronbach's alpha
We should strive for a society that emphasizes environmental protection rather than economic growth.	0.811		0.77	0.78
Sand dunes should be protected for their own sake rather than to simply meet our needs.	0.847		0.59	
The rights of sand dunes to exist is more important than the negative effects that their recovery may have on humans.	0.825		0.72	
It is my right to ride where I want on beaches and dunes in the area.		0.753	0.78	0.82
Recreational use of coastal environments is more important than protecting sand dunes.		0.816	0.77	
The needs of people are always more important than any rights sand dunes may have.		0.835	0.74	
Sand dunes should not be recovered unless there is a direct benefit to humans.		0.802	0.80	

[1]All statements were measured using a 5-point Likert scale from "Strongly Disagree" (-2), "Disagree" (-1), "Neutral" (0), "Agree" (1), "Strongly Agree" (2).

We constructed two PCI_2 graphics, one for biocentric (Figure 2.3) and one for anthropocentric (Figure 2.4) value orientations. The ANOVAs comparing biocentric value orientations between the communities reveal that there was little difference across any statement ($p > 0.05$; Figure 2.3 represented by numbers within the bubbles, Table 2.4, [a,b,c]). The differences test comparing PCI_2 values between communities found that Pointe-Sapin residents had more consensus than Miscou Island residents for statement one ($p < 0.05$; Figure 2.3 represented by the size of the bubble and PCI_2 value with significant difference denoted by [a,b,c]). There were little differences found between communities PCI_2 values' for all other biocentric statements ($p > 0.05$; Figure 2.3 represented by the size of the bubble and PCI_2 value with significant difference denoted by [a,b,c]).

The ANOVAs comparing anthropocentric value orientation statements revealed that Miscou Island disagreed more with statement three than Pointe-Sapin ($p = 0.039$; Figure 2.4 represented by numbers within the bubbles, Table 2.4, [a,b,c]). The differences test revealed little differences between communities for PCI_2 values ($p > 0.05$; Figure 2.4 represented by the size of the bubble and PCI_2 value with significant difference denoted by [a,b,c]).

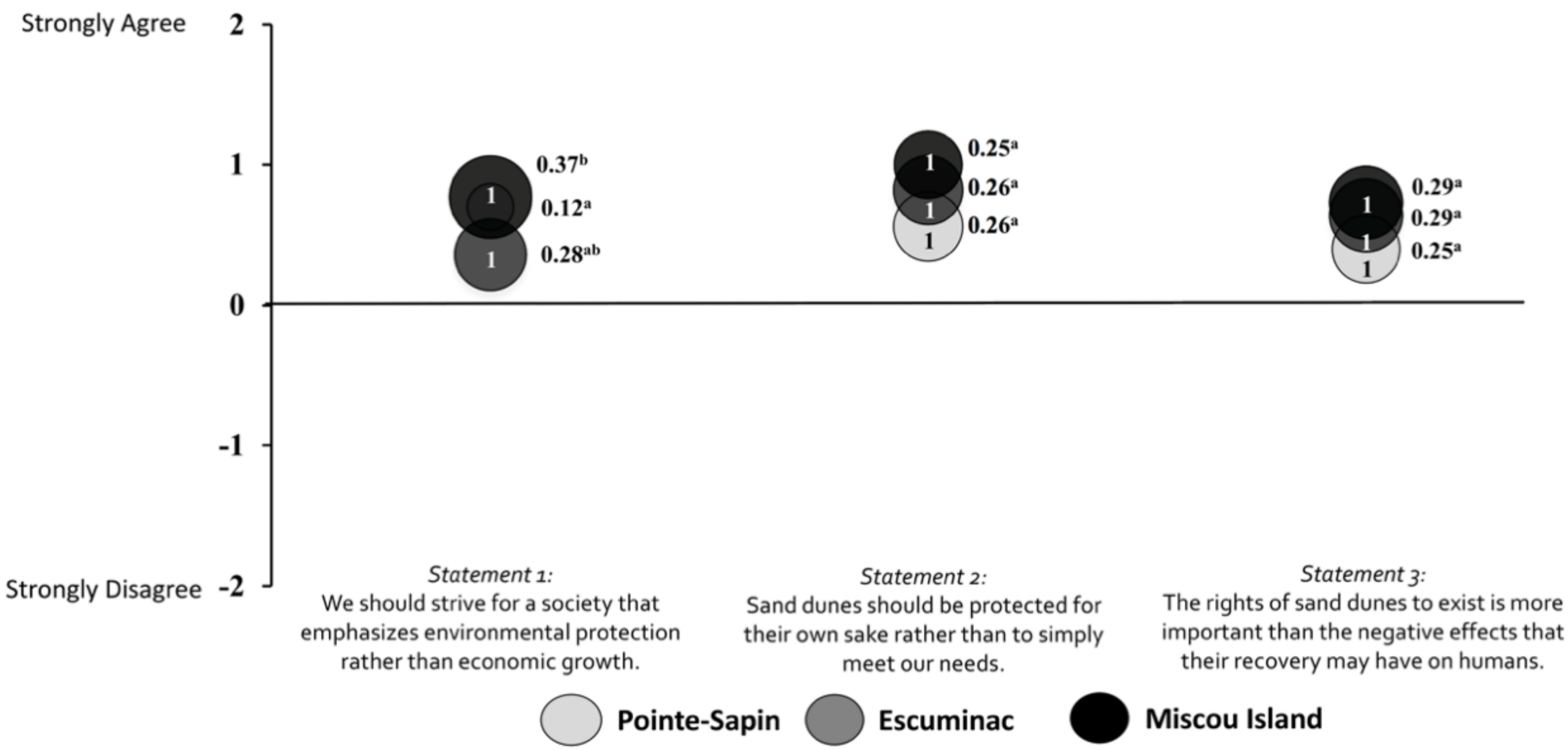

Figure 2.3. The mean response for Pointe-Sapin, Escuminac, and Miscou Island and PCI_2 values for the four biocentric value orientation statements. The numbers within the bubbles (1, 2, 3) denote if there is a significant difference between the means tested using one-way ANOVAs. The superscript letters (a, b, c) beside the PCI_2 value show whether there is a significant difference in the PCI_2 for the three groups tested using differences test. If there is no difference in number within the bubbles (i.e., all 1s) and/or a superscript beside the PCI_2 value, then there is no significant difference.

Table 2.4. One-way analysis of variance comparisons between Pointe-Sapin, Escuminac, and Miscou Island for seven value orientations statements (three biocentric and four anthropocentric) during a study of the differences and similarities between New Brunswick communities for coastal sand dune management, conducted in 2017.

Value Orientation Survey item[1]	Mean			F Value	P Value	Eta[2] (η)
	Pointe-Sapin ($\bar{x}$)	Escuminac ($\bar{x}$)	Miscou Island ($\bar{x}$)			
Biocentric:						
We should strive for a society that emphasizes environmental protection rather than economic growth.	0.69[a]	0.36[a]	0.81[a]	1.22	0.29	0.01
Sand dunes should be protected for their own sake rather than to simply meet our needs.	0.55[a]	0.81[a]	1[a]	2.00	0.13	0.03
The rights of sand dunes to exist is more important than the negative effects that their recovery may have on humans.	0.4[a]	0.63[a]	0.73[a]	1.07	0.34	0.01
Anthropocentric:						
It is my right to ride where I want on beaches and dunes in the area.	-0.64[a]	-0.72[a]	-1.09[a]	1.74	0.17	0.02
Recreational use of coastal environments is more important than protecting sand dunes.	-0.46[a]	-0.90[a]	-1[a]	2.59	0.07	0.04
The needs of people are always more important than any rights sand dunes may have.	-0.25[a]	-0.71[ab]	-0.93[b]	3.48	0.03	0.05
Sand dunes should not be recovered unless there is a direct benefit to humans.	-0.23[a]	-0.45[a]	-0.61[a]	1.01	0.36	0.01

[1]All statements were measured using a 5-point Likert scale from:
"Strongly Disagree" (-2), "Disagree" (-1), "Neutral" (0), "Agree" (1), "Strongly Agree" (2)
[a,b,c] The letter superscripts denote significant differences between means based on the Tamhane post hoc test.

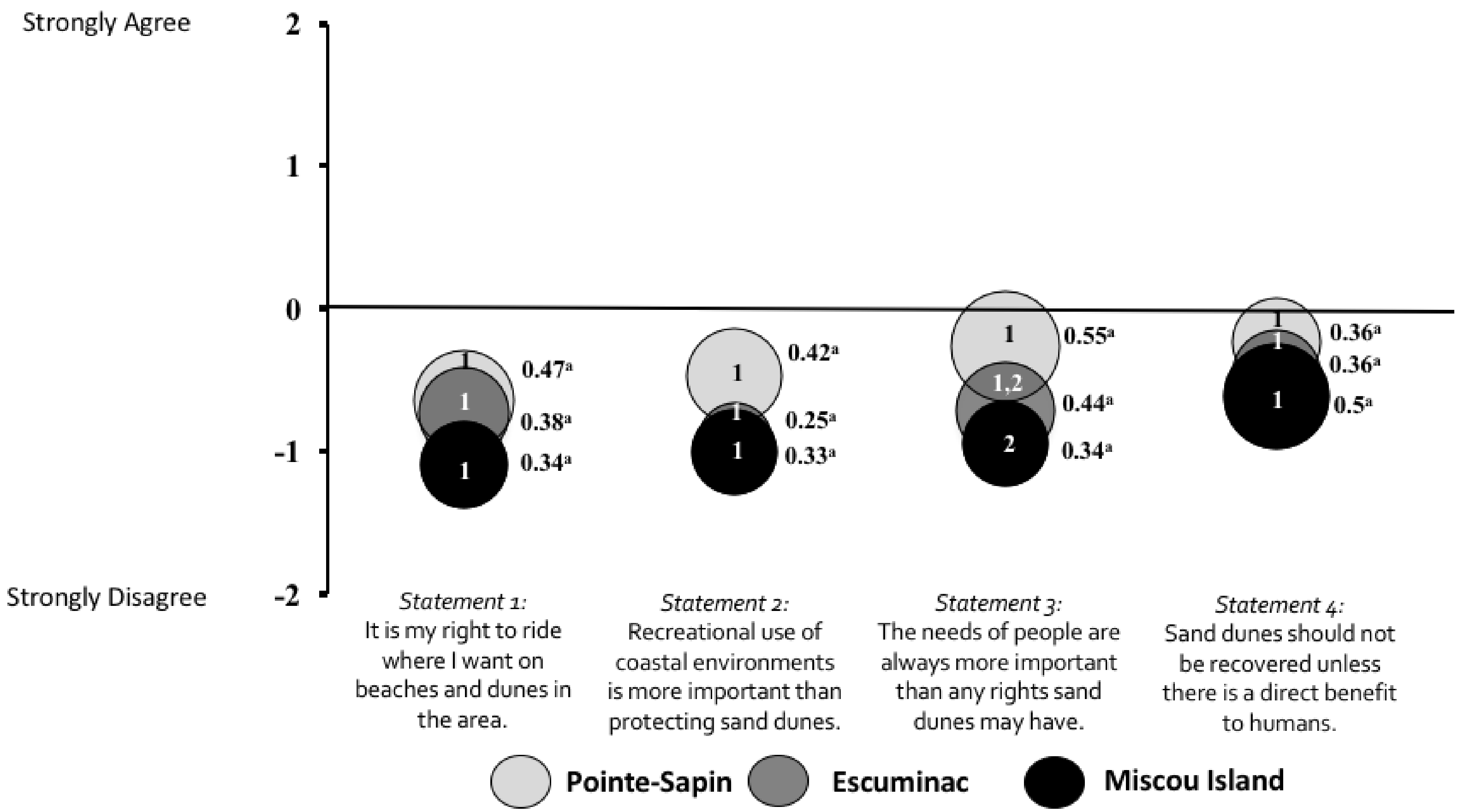

Figure 2.4. The mean response for Pointe-Sapin, Escuminac, and Miscou Island and PCI_2 values for the four anthropogenic value orientation statements. The numbers within the bubbles (1, 2, 3) denote if there is a significant difference between the means tested using one-way ANOVAs. The superscript letters (a, b, c) beside the PCI_2 value show whether there is a significant difference in the PCI_2 for the three groups tested using differences test. If there is no difference in number within the bubbles (i.e., all 1s) and/or a superscript beside the PCI_2 value, then there is no significant difference.

2.3.5 Acceptability of ATV use

The ANOVAs found that there was little difference between all communities for acceptability statements one through three ($p > 0.05$; Figure 2.5 represented by numbers within the bubbles, Table 2.5, [a,b,c]) and on average, the communities believed these statements were unacceptable (i.e., Figure 2.5, means below the neutral line). However, for statement four, the only statement that dealt with restricting residents access to dunes, the ANOVAs found that Pointe-Sapin residents believe it was more unacceptable than Miscou Island ($p = 0.018$; Figure 2.5 represented by numbers within the bubbles, Table 2.5, [a,b,c]). The PCI_2 differences test indicated that there was little difference found between any of the communities PCI_2 values across any of the statements ($p > 0.05$; Figure 2.5 represented by the size of the bubble and PCI_2 value with significant difference denoted by [a,b,c]).

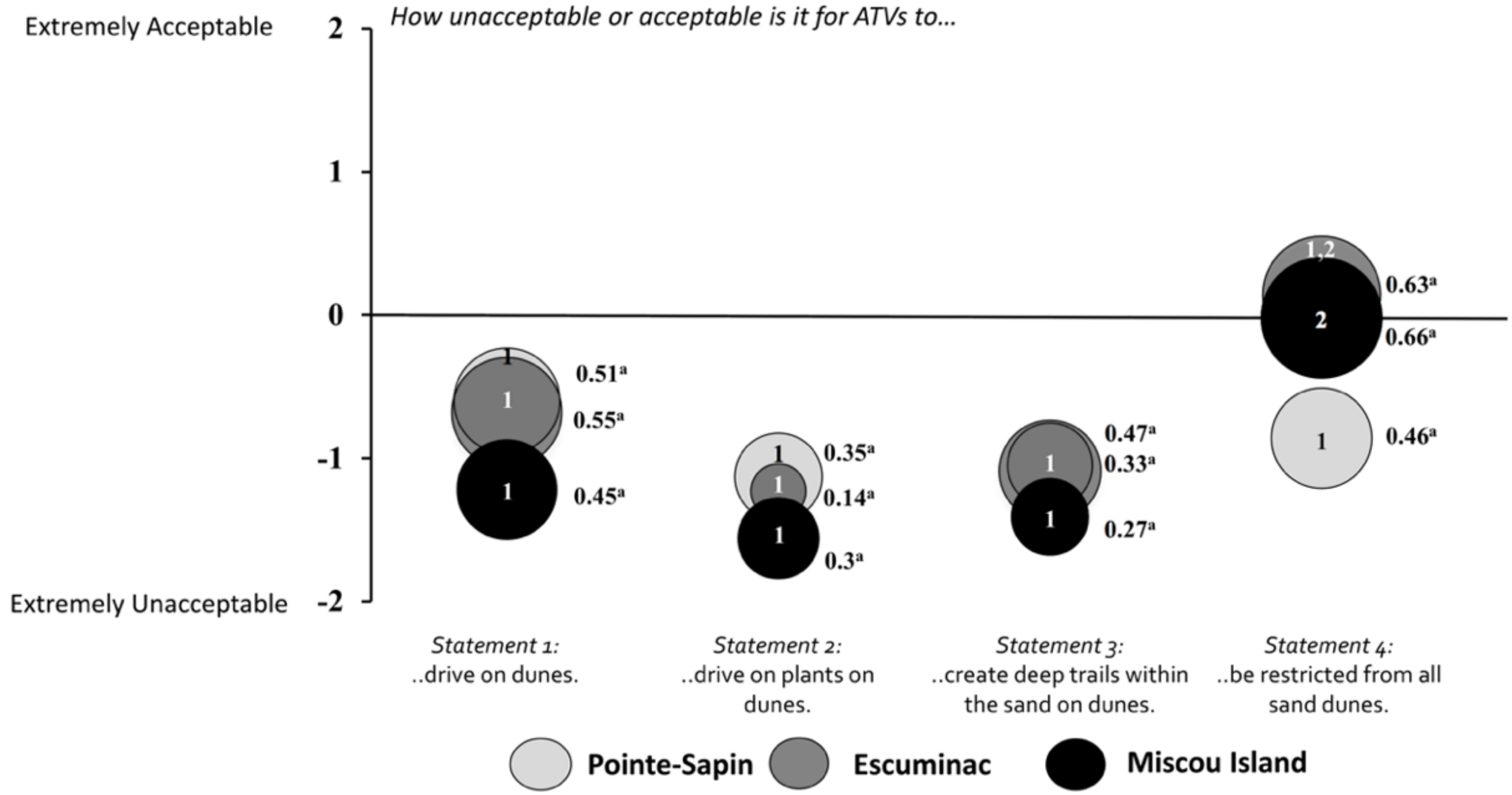

Figure 2.5. The mean response for Pointe-Sapin, Escuminac, and Miscou Island and PCI_2 values for the four acceptability of use statements. The numbers within the bubbles (1, 2, 3) denote if there is a significant difference between the means tested using one-way ANOVAs. The superscript letters (a, b, c) beside the PCI_2 value show whether there is a significant difference in the PCI_2 for the three groups tested using differences test. If there is no difference in number within the bubbles (i.e., all 1s) and/or a superscript beside the PCI_2 value, then there is no significant difference.

Table 2.5. One-way analysis of variance comparisons between Pointe-Sapin, Escuminac, and Miscou Island for four acceptability of ATV use statements during a study of the differences and similarities between New Brunswick communities for coastal sand dune management, conducted in 2017.

Survey item[1]	Mean			F Value	P Value	Eta[2] (η)
	Pointe-Sapin ($\bar{x}$)	Escuminac ($\bar{x}$)	Miscou Island ($\bar{x}$)			
Acceptability						
How unacceptable or acceptable is it for ATVs to…						
Drive on sand dunes	-0.60[a]	-0.68[a]	-1.22[a]	3.14	0.04	0.04
Drive on plants on dunes	-1.12[a]	-1.22[a]	-1.46[a]	1.28	0.27	0.02
Create deep trails within the sand on dunes	-1.04[a]	-1.09[a]	-1.41[a]	1.43	0.24	0.02
Be restricted from all sand dunes.	-0.85[a]	0.13[ab]	-0.01[b]	4.61	0.01	0.07

[1]All statements were measured using a 5-point Likert scale from “Extremely Unacceptable” (-2), “Unacceptable” (-1), “Neutral” (0), “Acceptable” (1), “Extremely Acceptable” (2).
[a,b,c] The letter superscripts denote significant differences between means based on the Tamhane post hoc test.

2.4 Discussion

Miscou Island residents’ were found to perceive higher impacts in most photographs and were more neutral to statement four in acceptability, “..be restricted from all sand dunes”, than Pointe-Sapin. The majority of Miscou Island residents perceived the main threat to coastal sand dunes as ATV-related, whereas, the majority of Pointe-Sapin and Escuminac residents perceived the main threat as storms. Pointe-Sapin, Escuminac, and Miscou Island residents showed little difference across biocentric and anthropocentric value orientations as well as for the first three statements of acceptability. Escuminac residents rarely differed significantly from either community. Our findings suggest that there was little difference for value orientations or acceptability of use; however, perceptions of impact and acceptability of ATV management may be context specific.

Published research findings on landscape perceptions, otherwise known as Scenic Beauty Estimations (SBE), has been traditionally looked at as uniform across different public groups (Buhyoff & Leuschner, 1978; Daniel & Boster, 1976). Our study shows this may not be the case as the perceptions of impact on the landscape of coastal sand dunes vary between communities. Such inconsistency suggests that perceptions of impact may be context specific and community specific. A similar study using the SBE method to evaluate coastal landscape preferences in Greece found differences based on the nationality of the respondent; however, there was more consensus among the groups in the extremes (i.e., the most and least preferred coastal landscape; Eleftheriadis et al., 1990). In our study, even with low and extreme impacts appearing on the photographed sand dunes, Miscou Island residents perceived the impacts as significantly higher than Pointe-Sapin residents. These differences further suggest that perceptions of impact on coastal sand dunes may be context specific. Another reason for the differences between these findings may be that research which has examined the SBE for coastal landscapes have asked about perceptions of beauty (i.e., low scenic quality/high scenic quality) rather than impact (i.e., no impact/extreme impact). Regardless of the differences found between past research, the differences found between Miscou Island and Pointe-Sapin may suggest that perceptions are context specific. Management of coastal sand dunes, therefore, will require community-specific approaches to create conservation solutions.

Differences found between Pointe-Sapin and Miscou Island may be due to fear, more specifically, a loss of perceived control. Perceived control is defined as ‘‘the belief that one has at one’s disposal a response that can influence the averseness of the event’’ (Thompson, 1981, p. 89). Pointe-Sapin may feel a loss of perceived control due to its proximity to Kouchibouguac National Park. Researchers have investigated the impacts of various protected areas on local populations such as restricted access to resources, divided lands, and a loss of heritage (Bell, 1987; Campbell & Humphries, 2008; Holmes & Cavanagh, 2016). Thus, Pointe-Sapin residents may believe they have lost perceived control over the use of their landscapes after the creation of this park. The history of the development of Kouchibouguac National Park, similar to the history of many other protected areas, was not peaceful for the locals living in this area. A book by Dr. Ronald Rudin (2016), "Kouchibouguac: Removal, Resistance, and Remembrance at a Canadian National Park," explores the emotional stories of conflict for the 260 families that were displaced during the development of the park. The conflict preceding the displacement may help explain a comment left by a resident of Pointe-Sapin stating "We live in a small community full of ATV's. We're not living in a national park. We should be able to go on the beach or wherever we want". This quote suggests that there may be a human-human conflict occurring rather than a human-wildlife conflict, which is often the case in conservation issues (Redpath et al., 2015).

Our results found little difference among Escuminac residents and the other community except in their perceived main threat to dunes. Although it is a neighbouring town to Pointe-Sapin, Escuminac is about a 24km drive from Kouchibouguac and therefore, may not have been as directly impacted by the park, at least in terms of ATV use. Due to their proximity, however, Escuminac and Pointe-Sapin are likely to experience similar weather including storms. This similarity may help explain why the majority of Escuminac and Pointe-Sapin residents perceived the main threat to dunes as related to storms, whereas Miscou Island residents were more spread with the majority focusing on ATV related impacts. Moreover, Escuminac experienced a hurricane in 1959, known as “The Escuminac Disaster”, where 22 fishing boats sank, and 35 men drowned (CBC News, 1975). As Escuminac is a small community which depends on the fishing industry (Important Bird Areas, 2016), this hurricane had significant repercussions on their livelihoods (CBC News, 1975) and may have contributed to why the majority of residents perceived storms as the main threat. It is essential, therefore, that managers are aware of the context occurring at a local level, whether current or historical, as identifying the nature of conflicts is an integral step prior to finding a solution (Linnell et al., 2010; Young et al., 2013). As we only know the main threat, it is unclear if there are other perceived threats within the communities. Future research should allow the respondent to choose more than one option and rank the order of threat that this has on sand dunes. This adjustment would allow a more in-depth understanding of what residents believe to be of concern for dunes in their area.

Reliability and the exploratory factor analysis showed that the statements provide valid and reliable measures of value orientations toward coastal sand dunes. These results were consistent with past research toward other resources (e.g., wildlife, forests; Needham, 2010). Regarding the value orientations of the groups, however, there were few differences found between the communities. Despite the differences in the geographic location within the province and other characteristics (i.e., perceptions of impact and perceptions of main threat to sand dunes), residents’ value orientations were similar across sites. Similar to findings found in Needham (2010) for value orientations toward coral reefs, our research suggests that user value orientations may stay consistent across a range of coastal settings. Future research is needed to confirm these results in other coastal-related areas and to increase the generalizability of these findings to other coastal areas. Further research is also needed to identify additional value orientation statements to improve the understanding of value orientations toward coastal sand dunes in recreational areas.

Our results of acceptability add to the literature demonstrating the utility of using structural norm theory to understand issues of management practices (see Donnelly et al., 2000; Shelby & Vaske, 1991; Shelby et al., 1996; Vaske & Donnelly, 2002, for reviews). Our study also provides an interesting comparison between the acceptability of use and management. Norms of management may be more context-specific than norms of use, as suggested by the differences between use and management for Miscou Island (i.e., residents believed it was unacceptable to use their ATVs various ways but were neutral to being restricted from all dunes). More research in other coastal-related areas is needed to confirm these results and to increase the generalizability of acceptability of use and management to other coastal regions. Due to this research only including one acceptability of management statement, further research is also needed to provide additional management options (i.e., a continuum of less protection to full protection), thus, providing a better understanding of the differences and similarities between the acceptability of use and management.

2.4.1 Management Implications

Acknowledging the differences and similarities between communities will help enhance communication methods chosen by managers in these areas. Due to the differences between Miscou Island and Pointe-Sapin, it is clear that natural resource management agencies must carefully consider the communication methods chosen for each. To create better communication initiatives, Ajzen (1992) states that it requires four elements: (a) source, (b) receiver, (c) channel, and (d) message factors. The source is the group or person communicating the message, the receiver is the demographic who will receive the information, the channel is the way in which the receiver would best acquire this information (e.g., social media, interpretation boards, fliers), and the message factors are how the information is presented to the public (e.g., emotional vs non-emotional strategies) (Vaske & Donnelly, 2007). The results of this study suggest that differences between the Miscou Island and Pointe-Sapin may be context specific. The source of the information may be more critical to Pointe-Sapin because of historical interactions with protected areas, for example. Using this information, communication campaigns and education programs must be context specific to increase the understanding of the impacts caused by ATVs on coastal ecosystems and increase the acceptability of management (i.e., prior to communicating messages, current or historical background must be understood for each separate community). Further consideration must be taken that even though Miscou Island perceives impact on the dunes as higher than the other two communities, it does not necessarily mean that they have the greatest amount of impact occurring on their sand dunes. Thus, it is essential to obtain an understanding of dune impact caused by ATV use in Miscou Island to identify the impacts of ATVs on local sand dunes. Fundamentally, these communities share similar views across most variables as our results found little difference among biocentric and anthropocentric value orientations or with acceptability of use (i.e., acceptability statement one, two and three). Therefore, future research needs to address what may be influencing the differences in perceptions of impact between Miscou Island and Pointe-Sapin. Context may be an imperative explanation for the perceptions of impact results; therefore, it is essential that it is monitored to improve conservation messages. Our research suggests the need to address perceptions of impact using methods similar to SBE in future research.

2.6 Acknowledgements

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Chapter 3 :
Spatial Extent and Severity of Impacts Caused by All-Terrain Vehicles (ATVs) on Coastal Sand Dune Vegetation on Miscou Island, Canada.

3.1 Introduction

Coastal ecosystems are among the most productive systems in the world (Calvão et al., 2013), providing disproportionately more services to the well-being of humans than most other systems, even those covering larger areas (Millennium Ecosystem Assessment, 2005). One component of these systems are coastal dunes, complex ecosystems that interact with both terrestrial and marine systems (Brown & McLachlan, 2002; Gonçalves et al., 2013; Vallés & Cambrollé, 2013). Dunes provide important ecological and socio-economic services like coastal protection by absorbing the impact of high-energy storms (Curr et al., 2000; EPA, 2006; Thompson & Schlacher, 2008), slow erosion (Thompson & Schlacher, 2008), and recreation (Liddle & Greig-Smith, 1975; Defeo et al., 2009). They also provide habitat to a diversity of species including arthropods, gastropods, reptiles, plants, and birds (Acosta et al., 2009; Acosta et al., 2013; Carranza et al., 2008; Fenu et al., 2012; Martínez et al., 2004; McLachlan & Brown, 2006; Thompson & Schlacher, 2008).

Not only do coastal dunes provide direct habitat and services, they have an important indirect influence on adjacent communities. In eastern Canada, beaches, often backed by dunes, provide critical shelter for nesting beaches of the piping plover (*Charadrius melodus*), an endangered migratory bird under the Species at Risk Act

(SARA) (Powell & Cuthbert, 1992; SARA, 2012). With the increase of anthropogenic pressure on coastal dunes, which absorb the impact of high-energy storms (Thompson & Schlacher, 2008), beaches are more vulnerable to erosion (Prisken, 2003) which could limit the availability of suitable nesting habitat for the piping plover (COSEWIC, 2014). Given this and other ecosystem services that dunes provide, it is essential that they are a management priority.

Of all the coastal ecosystems, coastal sand dunes have suffered the greatest level of human pressure (Carter, 1988). Coastal dunes are particularly vulnerable to anthropogenic pressures because of the natural disturbances already acting on them via the interactions of wind, waves, and sediments (Carter, 1988; Wong, 1993; Clark, 1996; Kay & Alder, 1999). Compounding the effects of ongoing natural disturbances, dunes experience storms (Catto, 2002; Stancheva et al., 2011), human development (Rogers, 2002; Stancheva et al., 2011), tourism (Catto, 2002; Rogers, 2002; Talora, 2007; SARA, 2012), and all-terrain vehicle (ATV) use (Carlson & Godfrey, 1989; Rickard et al., 1994; Stephenson, 1999). Since dune stability is related to vegetation cover (Davenport & Davenport, 2006), even low levels of disturbance from anthropogenic use creates tracks that can remove vegetation and lessen the resilience of the ecosystem by increasing erosion (Anders & Leatherman, 1987; Davenport & Davenport, 2006). With a surge of ATV use (Havlick, 2002; Holsman, 2004) and the popular perception of ATV users as "thrill seekers", ATVs in particular have become one of the most controversial conservation issues facing resource managers today (Waight, 2014). In eastern Canada specifically, managers have indicated that one of their main concerns is the controversy related to ATV use in coastal ecosystems (Waight & Bath, 2014; Connolly, 2001).

All-terrain vehicle research has less often been studied by itself, but rather as one component of off-road vehicles (ORVs), a combination of 4-wheel jeeps/trucks, off-road motorcycles, dirt bikes, dune buggies, and ATVs (Waight, 2014). ORVs can have multiple impacts on vegetation including crushing, abrasion, introduction of non-native or invasive species, overall reduction of biomass, and shifts in species composition (Rooney, 2005; Hill et al., 2010; Garbary et al., 2013). In the context of coastal sand dunes, ATVs/ORVs damage vegetation by creating deep ruts on the sand surface and damaging developing foredunes via tire tracks, leading to the destabilization of the dunes (Anders & Leatherman, 1987; Kutiel et al., 1999; Priskin, 2003; Thompson & Schlacher, 2008). By trampling the vegetation, ORV tracks can also decrease species richness and vegetation ground cover (Luckenbach & Bury, 1983; Rickard et al., 1994; Groom et al., 2007), and can result in decreased species richness under the wheel ruts (i.e., where the soil compaction is the greatest) compared to track margins (Liddle & Greig-Smith, 1975). Understanding the spatial extent of ATV effects on dune ecosystems is an essential step in landscape management.

Despite an increase in ATV use, there has been limited research on the spatial extent of ATV disturbances (but see Cole, 2004; Brooks & Lair, 2005; Ouren et al., 2007; Van Vierssen Trip & Wiersma, 2015; Hernandez-Yanez et al. 2016). Brooks & Lair (2005) characterize three distinct scales of impacts of motorized vehicles: (1) direct effects; (2) indirect effects; and (3) landscape effects. Direct effects are those that occur on the trail, such as loss of vegetation cover or erosion caused by rutting (Van Vierssen Trip & Wiersma, 2015). Indirect effects occur in areas adjacent to the trails, such as nutrient loading onto the surrounding vegetation (Van Vierssen Trip & Wiersma, 2015).

Lastly, landscape effects are those that occur throughout the landscape and are usually difficult to quantify, such as habitat fragmentation and the spread of invasive species (Van Vierssen Trip & Wiersma, 2015). Indirect and landscape effects are context specific as each landscape is influenced by environmental factors, ecological gradients, and past/current land-use regimes (Brooks & Lair, 2005). Despite these difficulties, it remains critical to comprehend the spatial scale of vehicle impact (Brooks & Lair, 2005), particularly when management decisions are generally made on the landscape level (Van Vierssen Trip & Wiersma, 2015).

To better understand whether sensitivity to ATV impacts changes based on landscape type, dunes may be separated into pioneer and shrub zones (Rickard et al., 1994). In the context of this research, we have defined shrub dunes as dunes where shrubs were present and usually further inland (i.e. not beside the beach) and pioneer were all other dunes (i.e., usually beside the beach). Past research has shown that pioneer zones are less sensitive than the shrub zones because they are exposed to changes in stabilisation due to harsher environmental factors such as windblown sand, sea spray, and nutrient deficiencies (Brodhead & Godfrey, 1979; Rickard et al., 1994). Specifically, research has identified that pioneer dunes recover faster from ORVs and trampling than dunes further inland (Rickard et al., 1994). It is vital that sensitivity between landscape types is examined as this may help create more effective management procedures (Rust & Illenberger, 1996).

Beyond the physical effects to dune structure and vegetation trampling, ATVs may indirectly influence the species richness of coastal dune ecosystems. As ATVs move from roadways into dunes, they may act as a vector to facilitate the invasion of non-native plant species (Bajwa et al., 2017; Rew et al., 2017). A study assessing the transport of seeds by vehicles using road way tunnels indicated that long-distance transport is the rule rather than the exception (Rew et al., 2017). Introductions may increase the species richness, but not positively if the non-native species outcompete important native species (Rew et al., 2017). For example, non-native species introductions have resulted in less suitable habitat for American Dune Grass (*Ammophila breviligulata),* a key dune stabilizing species that managers use to prevent dune erosion in restoration projects (Holmstrom et al., 2010; Nordstorm et al., 2018). There is evidence that ATV use affects vegetation patterns in coastal sand dunes (Hosier & Eaton, 1980; McAtee & Drawe, 1980; Carlson & Godfrey, 1989), sometimes positively (Westhoff, 1967; van der Maarel, 1971), but always eventually leads to the degradation of flora (van der Maarel, 1971). By understanding both the physical and ecological spatial effects of ATVs on coastal sand dunes, managers can create better approaches to mitigating damage.

Our aim was to quantify differences in plant communities between coastal dune ecosystems with (i.e., impacted area) and without (a protected area, acting as natural control site) ATV use. Specifically, we aimed to assess total, native, and non-native species richness, and *Ammophila breviligulata* presence and cover: (1) between coastal dunes with and without ATV use and with varying severities of ATV impact; (2) with increasing distance from the ATV trail in each region; and (3) between pioneer and shrub zones of dunes within each region; to quantify direct, indirect, and landscape effects of ATV impacts. We predicted: (i) there would be more species, in general, on impacted dunes than protected dunes because ATVs may act as a vector to facilitate the invasion of non-native plant species (Bajwa et al. 2017; Rew et al. 2017); and (ii) total, native, and non-native species richness, as well as the presence and cover of the dune stabilizing species *A. breviligulata*, would increase with distance from the ATV trail, and that pattern will be strongest with distance from the deepest ruts. We also predicted that (iii) shrub dunes would experience greater impacts than pioneer zones because they have previously been found to be more sensitive to anthropogenic impacts (Brodhead & Godfrey, 1979; Richard et al., 1994).

3.2 Methods

3.2.1 Study Area

Our study was carried out in New Brunswick, Canada, where there has been an increase of illegal all-terrain vehicle (ATV) use on coastlines (Connolly, 2001). Research was conducted on Miscou Island and in Kouchibouguac National Park (Figure 1.2). Both sites are listed as important bird areas because the beaches are nesting habitat for the piping plover. Miscou Island is situated off the northeastern tip of New Brunswick, between Baie des Chaleurs and the Gulf of St. Lawrence (48º00’32.002” N, 64º23’39.008” W; Environment Canada, 2016). It is home to many shorebirds and waterfowl during fall migration (Important Bird Area, 2016). Habitats found on the island include fens, bogs, coastal sand dunes, beaches, coniferous forest, mud or sand flats, freshwater lake, open sea, and marine inlets/coastal features (Important Bird Area, 2016). Kouchibouguac National Park was selected as a reference site to compare to Miscou Island since it has similar dune environments to Miscou Island and because recreational vehicle use is not permitted on the dunes in the Park. Kouchibouguac is situated on the east coast of New Brunswick, about 47 km south-east of Miramichi (46º47’00.00” N, 65º01’00.00” W) (Environment Canada, 2016). This national park is a 104 km^2 preserve composed of salt marshes, forests, bogs, and over 25 km of the park consists of healthy sand dunes (Parks Canada, 2010).

Six sites were measured in each of Miscou Island and Kouchibouguac National Park. ATV trails, identified as ruts created by the wheels of the vehicle, were chosen as measurement sites within Miscou Island because the direct impacts could be visually assessed. On Miscou Island, trails were selected based on a gradient of impact by observation (i.e., rut depth; see Figure 3.1 for photos) and by using Google Maps (Google Maps, 2017) and Service New Brunswick Geographic Data and Maps (Service New Brunswick, 2017). Kouchibouguac sites were chosen to mirror the landscape similarities (e.g., backed by forests, near estuary, etc.) of Miscou Island sites, as described below. While we cannot be certain that illegal ATV use is absent in Kouchibouguac, we chose study sites as inaccessible as possible to maximize the probability of sampling areas without ATV use.

Figure 3.1. Photograph of the scale of impacted dunes from high impact to low impact (right to left) for the six surveyed trails on Miscou Island, New Brunswick.

3.2.2 Field Measurements

Field surveys occurred in August 2017 at Miscou Island and Kouchibouguac National Park. Each of the 12 sites described above consisted of 1 to 3 line transects, depending on the width of the coastal dune, running at right angles to the ATV trail (Miscou) or running parallel to the coastline on a dune with no pedestrian or ATV use and with similar surrounding habitat (Kouchibouguac) to measure direct and indirect impact of vehicle tracks (Figure 3.2). Specifically, at Kouchibouguac, using Google Maps (Google Maps, 2017) and Service New Brunswick Geographic Data and Maps (Service New Brunswick, 2017), sites were chosen by identifying similar surrounding habitats such as dunes backed by forests or beside estuary. At each site transects were laid parallel to the coastline (and at right angles to the ATV trail at Miscou) to avoid capturing the natural gradient in species richness that occurs between the pioneer and shrub zones of the dune (i.e., more species in shrub than pioneer zones; Maun, 2009). For all transects, 13 0.25 m^2 plots were evenly placed; i.e., five on each side of the ATV trail, two on the edge of the ATV trail, and one in the center, for a total of 13, 26, or 39 plots per ATV trail (dependent on whether there was one, two, or three transects). In total, 455 plots were sampled, of which 247 plots were on Miscou Island and 208 in Kouchibouguac National Park (i.e., 35 line transects total, 19 on Miscou Island and 16 in Kouchibouguac). However, due to differences between pioneer and shrub zones, only those plots that were at 90-degree angles to the coastline were used for this analysis. Therefore, the total of plots analyzed was 351, with 169 plots on Miscou and 182 plots in

Kouchibouguac (i.e., 27 line transects total, 13 in Miscou Island and 14 in Kouchibouguac).

Vegetation was estimated within each plot by quantifying species richness of vascular plants and estimating the percent cover of *A. breviligulata*. We targeted *A. breviligulata* because of its key role in dune stabilization. Gully or rut depth, a proxy for erosion (Snakin et al., 1996; Meyer, 2002), was measured at the center plot of each line transect on Miscou Island. While rut depth is our best proxy for ATV-caused dune disturbance, we note that we do not know the processes that led to the formation of each measured rut. For example, we cannot conclude that deeper ruts are caused by more frequent trail use, as a deeper rut may be the result of a heavier vehicle or tire spinning during travel. On all trails at Miscou Island, rut depth was measured at the center of each line transect (i.e., 27 measurements across all trails) and then an average rut depth was calculated for each trail. Furthermore, when evaluating the right angles away from trails, gully ruts were opportunistically recorded when there were other ATV trails nearby (within 25 meters). As there was no ATV use in Kouchibouguac, rut depth was not measured. At the center of each transect, geographic coordinates and the wind speed were measured using a Global Positioning System (GPS) receiver (Garmin Erred 20x) and an anemometer (Kestrel 3500), respectively.

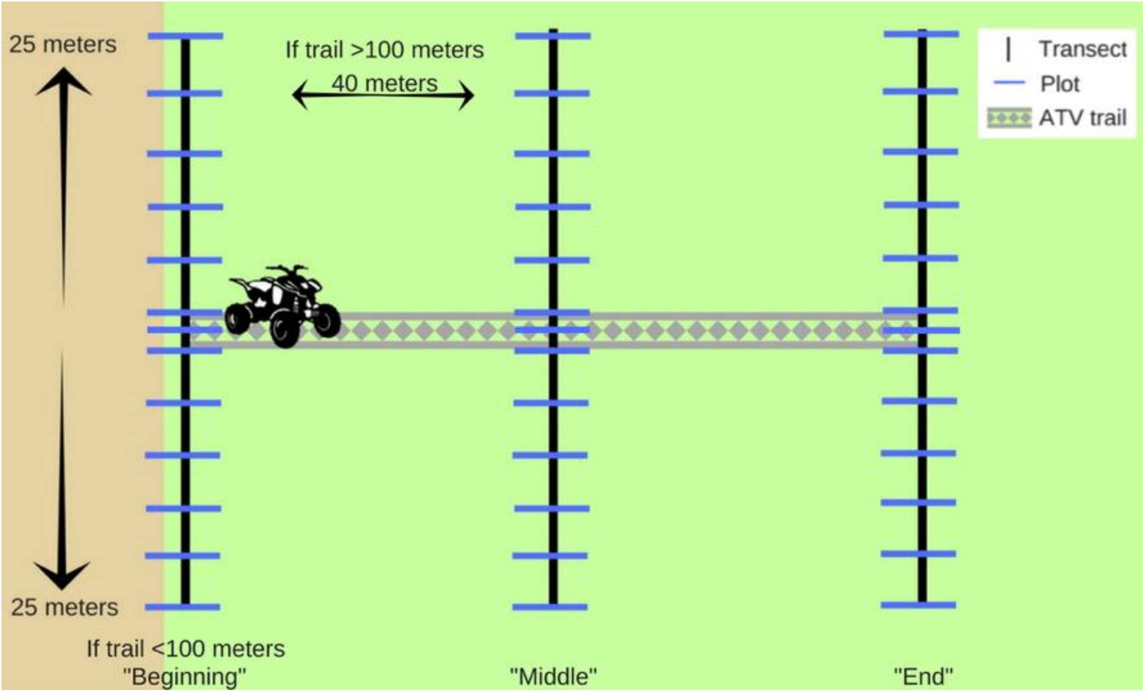

Figure 3.2. Sampling design for plant surveys across ATV trails on Miscou Island. Surveys at Kouchibouguac had no ATV trails and therefore line transects were placed based on similar landscape characteristics to each trail on Miscou Island. The ATV trail is represented by the grey line; perpendicular black lines represent the line transects where 0.25 m^2 plots were placed every 5 meters (measurements in blue) until 25 meters. Although each site differed somewhat in the distribution of pioneer and shrub dunes, pioneer dunes were always located closest to the water; i.e., in this figure, they were more highly associated with the trail "beginning".

3.2.3 Data Analyses

All statistical analyses for this study were completed in R (R Development Core Team, 2009). We analyzed data on total, native, and non-native species richness, and presence and cover of *A. breviligulata* separately. For each response variable, we first compared between regions with (Miscou Island) and without (Kouchibouguac National Park) ATV use, to provide context for the background species richness in our study area.

As the sites were not chosen completely at random, we tested for spatial autocorrelation using Moran's I in the package ape version 5.2 (Paradis & Schliep, 2018). This test is used to assess if the occurrence of a variable at one sampling point is likely or unlikely to occur at a neighbouring site (Moran, 1950). We used GPS coordinates (point data) taken on direct plots (i.e., center of each transect) to act as the location of each trail. We detected no spatial autocorrelation for any of the five response variables of interest (p-values ranged from 0.27-0.92). Therefore, we are confident that our sampling locations are spatially independent.

To understand differences between varying severity of ATV impact (i.e., rut depth) and the spatial extent of impact, we used generalised linear models (GLMs) of count (total, native, and non-native species richness; Poisson distributions), presence-absence (*A. breviligulata* presence; binomial distribution), and percent cover (*A. breviligulata* percent cover; normal distribution), predicted by rut depth and distance from the ATV trail (Zuur et al., 2009). Regions were modelled separately, as rut depth was absent in Kouchibouguac and thus not measured, for a total of 10 GLMs (5 response variables x 2 regions). For all models, we assessed model fit using residual diagnostics (Zuur et al., 2009).

One-way ANOVAs were used to better understand the spatial extent of ATV effects using Brooks & Lair's (2009) spatial characteristics, as follows. We compared total, native, and non-native species richness, and presence and cover of *A. breviligulata* between regions with and without ATV presence (i.e., Miscou vs. Kouchibouguac) and between spatial extents (direct (i.e., plot directly on the trail), indirect (i.e., plot on edge of the trail), and landscape plots (i.e., plots $\geq$ 5 meters from the trail) with full interactions. Similarly, one-way ANOVAs were used to examine the differences in vegetation differences between landscape types (i.e., pioneer and shrub zones).

3.3 Results

3.3.1 Vegetation Patterns: Regional Differences

In total, 41 species were surveyed in our Miscou Island and Kouchibouguac National Park study areas. Most of the species were native to the region (n = 27), but non-native species were also detected (n =14). Regionally, 37 species were present in Miscou Island, 26 of which were native and 11 non-natives. Kouchibouguac had 19 species of which 13 were native and 6 were non-native. For Miscou Island, the mean species richness at the plot level was 2.3 ± 1.8 standard deviation (mean of 2.0 ± 1.4 native species, 0.3 ± 0.6 non-native species). For Kouchibouguac the mean plot level species richness was 2.3 ± 1.1 (mean of 2.1 ± 0.9 native species, 0.22 ± 0.5 non-native species). The mean presence and cover of *A. breviligulata* was 85% ± 36.2% and 14.5% ± 14.0%, respectively, on Miscou Island and 99% ± 7% and 26.72% ± 11.5%, respectively, in Kouchibouguac. ANOVAs revealed no difference between Miscou Island and Kouchibouguac in regard to total ($p = 0.83$; Figure 3.3A) and native species richness ($p = 0.0726$; Figure 3.3B), but there were more non-native species ($p = 0.0021$; Figure 3.3C) and fewer occurrences ($p < 0.001$) and less cover ($p < 0.001$, Figure 3.4) of *A. breviligulata* on Miscou Island than Kouchibouguac. However, there were very few non-native species in each area in general (Figure 3.3C) and these results were interpreted accordingly (see discussion).

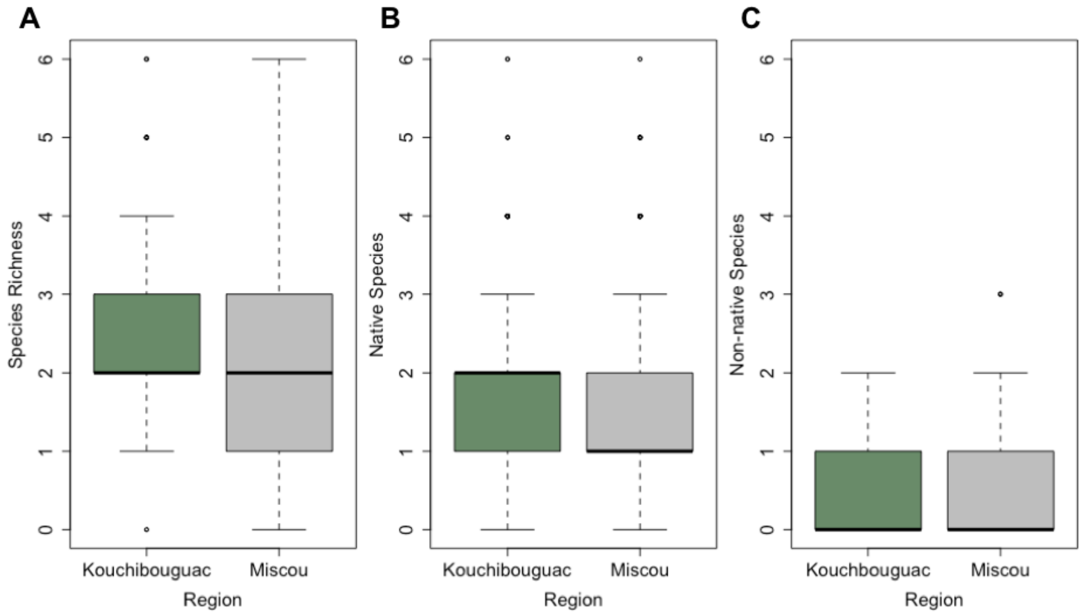

Figure 3.3. Total number of species (a = total species richness, b = native species, c = non-native species) are grouped by region (i.e., Kouchibouguac and Miscou Island). The green boxes indicate sites located in the control site, Kouchibouguac National Park (n=182) and the grey boxes indicate sites located on Miscou Island (n=169). The boxes are comprised of the 25–75% quartiles of the data and the median is indicated by the line through the centre of the box. The whiskers extending from the box comprises of the 95% quartiles, and extreme observations are shown as hollow circles.

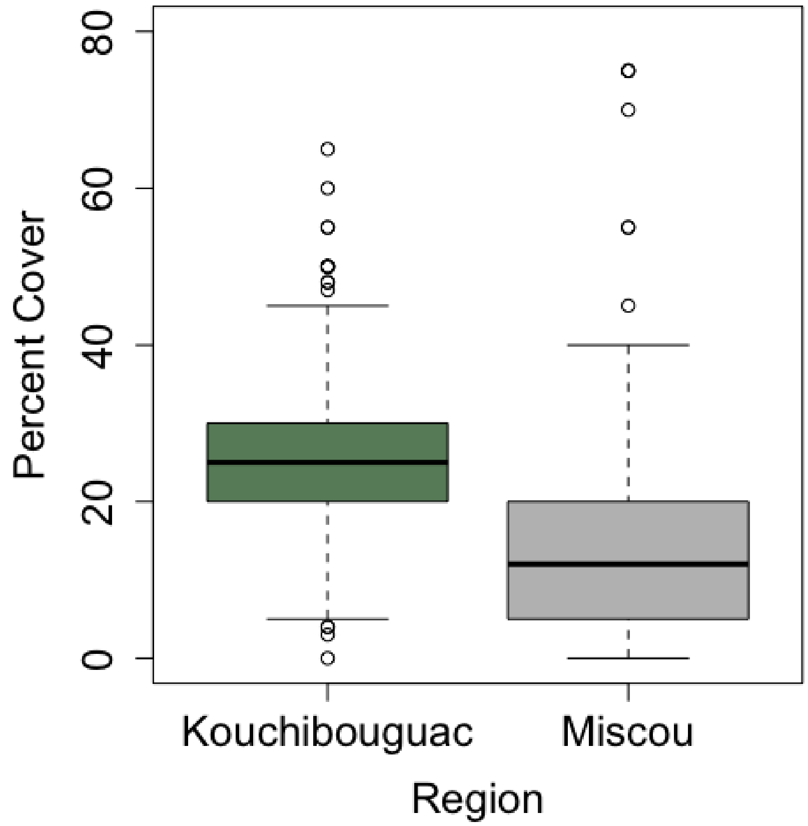

Figure 3.4. Percent cover of *Ammophila breviligulata* grouped by region (i.e., Kouchibouguac and Miscou Island). The green box indicates sites located in Kouchibouguac (n=182) and the green boxes indicates sites located on Miscou Island (n=169). The boxes are comprised of the 25–75% quartiles of the data and the median is indicated by the line through the centre of the box. The whiskers extending from the box comprises of the 95% quartiles, and extreme observations are shown as hollow circles.

3.3.2 Spatial Extent and Severity of ATV Impact

General linear models (all models summarized in Tables 3.1 and 3.2) revealed no direct relationships between total, native, or non-native species richness and distance from ATV trails, or between *A. breviligulata* presence or cover and distance from trail for both Miscou Island and Kouchibouguac. There was, however, a significant interaction between distance from trail and rut depth for total, native, and non-native species richness and *A. breviligulata* cover on Miscou Island (recall: rut depth analyses only done for Miscou as ATV ruts were not present in Kouchibouguac), where species richness (or *A. breviligulata* presence) increased with distance from ATV trails with the deepest ruts. Increasing rut depth also had direct effects on species richness, where deeper ruts resulted in a decrease in all species richness measures and *A. breviligulata* presence on Miscou Island, but rut depth did not affect *A. breviligulata* cover.

The pattern of total, native, non-native species richness (Figure 3.5), and the pattern of presence and percentage cover of *A. breviligulata* (Figure 3.6), suggest that all measures decreased with deeper rut depths. This decrease with depth was more evident for direct (on the trail; Figure 3.5A-C) and indirect (trail edge; Figure 3.5D-F) impacts, particularly when rut depths exceeds 50 cm. Beyond five metres from the ATV trail (landscape scale in this context), rut depth had less effect on total (Figure 3.5G) and native species richness (Figure 5H), or presence and percentage cover of *A. breviligulata*.

Table 3.1. General linear models for Miscou Island describing the relationships between distance, rut depth, and species richness as well as the presence/absence and cover of *Ammophila breviligulata*. Italicized headings in the first column designate the response variable for each model.

	Estimate	Standard error	t-value	p-value
Total Species Richness				
Distance	0.024	0.0177	1.34	0.18
Rut depth	-0.0092	0.0024	-3.84	0.00017***
Rut depth*distance	0.00073	0.00016	4.45	1.59e-05***
Native Species				
Distance	0.0154	0.015	1.046	0.3
Rut depth	-0.007	0.002	-3.53	0.00055***
Rut depth*distance	0.00052	0.00014	3.78	0.00022***
Non-native Species				
Distance	8.282e-03	7.357e-03	1.13	0.26
Rut depth	-2.151e-03	9.901e-04	-2.18	0.031*
Rut depth*distance	2.120e-04	6.805e-05	3.12	0.0022**
Presence/absence of A. breviligulata				
Distance	0.0045953	0.0037	1.24	0.22
Rut depth	-0.0021564	0.00045	-4.32	2.68e-05***
Rut depth*distance	0.0001058	0.000034	3.09	0.0024**
Percentage cover of A. breviligulata				
Distance	0.186	0.15	1.21	0.23
Rut depth	-0.038	0.021	-1.84	0.067
Rut depth*distance	0.0010	0.0014	0.72	0.48

Table 3.2. General linear models for Kouchibouguac National Park, the natural control site, describing the relationships between distance and species richness as well as the presence/absence and cover of *Ammophila breviligulata*. Italicized headings in the first column designate the response variable for each model.

	Estimate	Standard error	t-value	p-value
Total Species Richness				
Distance	-0.0032	0.0099	-0.32	0.75
Native Species				
Distance	-0.0012	0.0084	-0.142	0.89
Non-native Species				
Distance	-0.002	0.0043	-0.46	0.64
Presence/absence of A. breviligulata				
Distance	-0.00061	0.00063	-0.96	0.34
Percentage cover of A. breviligulata				
Distance	-0.058	0.098	-0.59	0.56

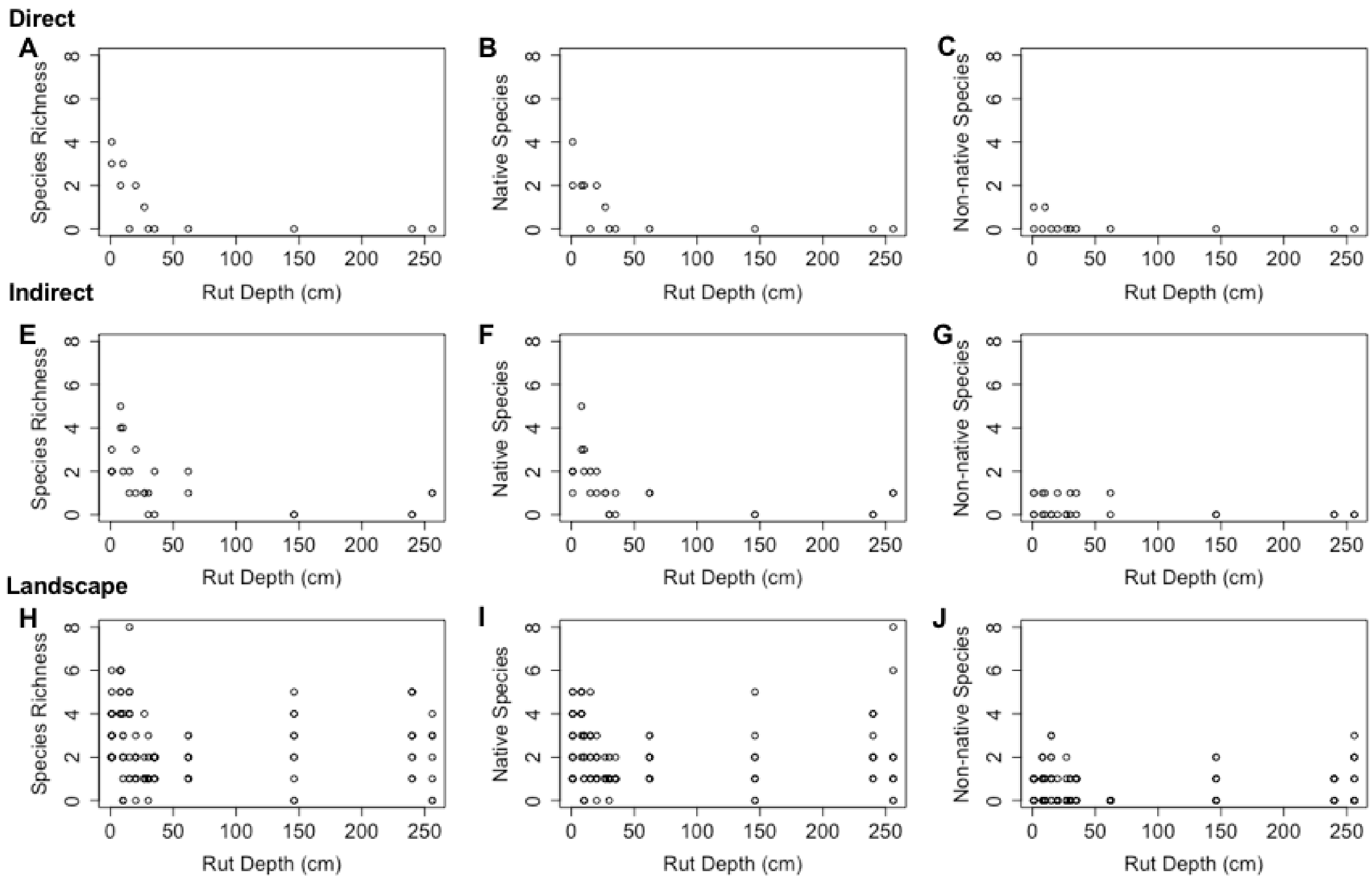

Figure 3.5. Total number of species (A, E, H = total species richness; B, F, I = native species; C, G, J = non-native species) and rut depth in comparison to direct (i.e., plots on trail; n= 13), indirect (i.e., edge plots; n = 26) and landscape plots (i.e., plots ≥ 5 meters from ATV trail; n = 130) in Miscou Island.

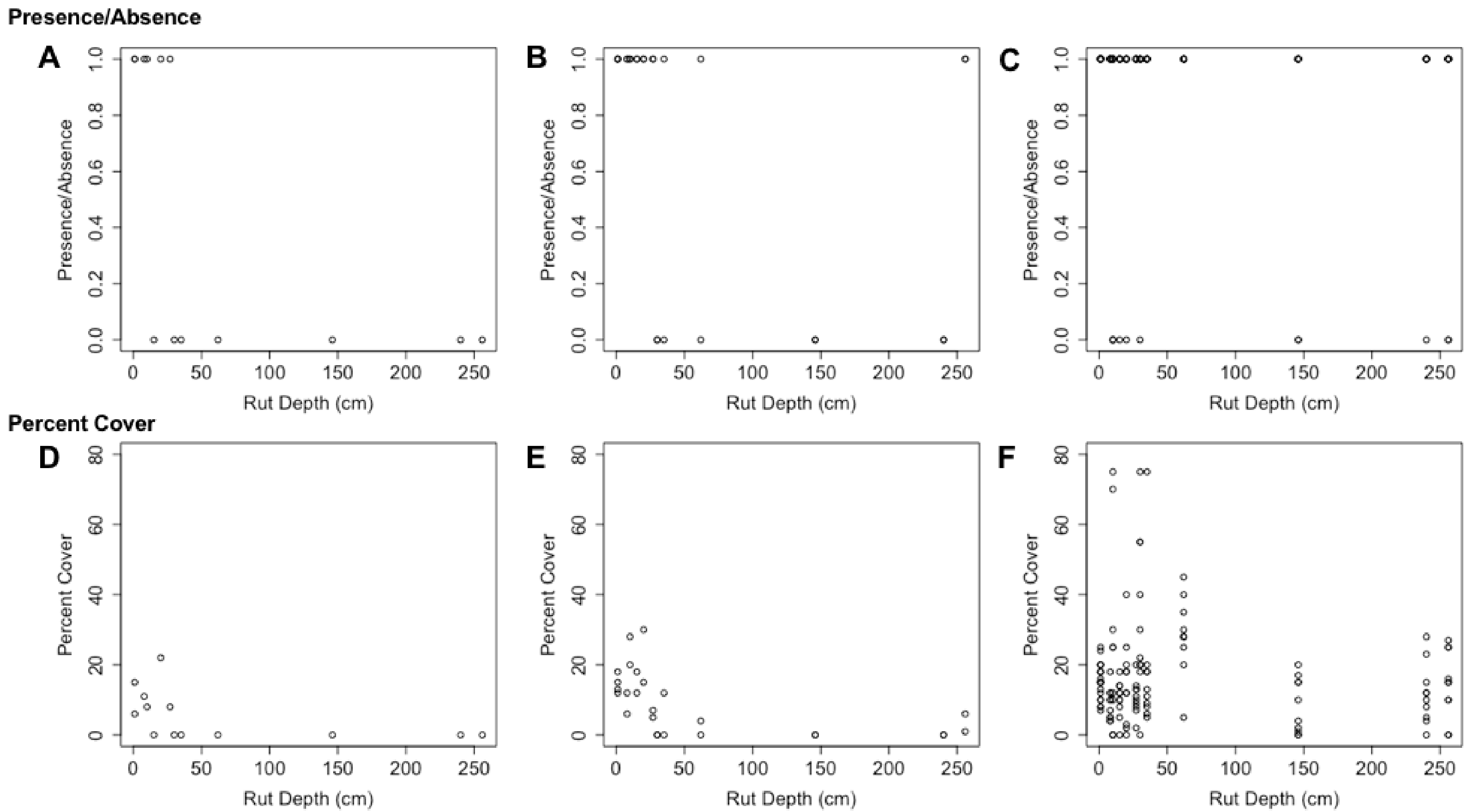

Figure 3.6. (*A. breviligulata*) Presence/absence (top row), percent cover (bottom row) across rut depth in comparison to distance from the ATV trail (A & D = direct (i.e., plots on trail; n = 13), B & E = indirect (i.e., edge plots; n = 26) and C & F = landscape plots (i.e., plots ≥ 5 m from ATV trail; n = 130)) in Miscou Island.

3.3.3 Spatial Extent of ATV Impact

The ANOVAs comparing regions revealed that Miscou Island had less total richness on direct plots ($p = 0.026$; Figure 3.7 A & D; distance = 0 m) and indirect plots ($p = 0.043$; Figure 3.7 A & D, distance = 1 m) than Kouchibouguac, but no differences were detected for landscape plots ($p = 0.25$; Figure 3.7 A & D, distance ≥ 5 m). The same pattern occurred for native species where there were fewer on direct plots ($p = 0.026$; Figure 3.7 B & E, distance = 0 m) and indirect plots ($p = 0.014$; Figure 3.7 B & E, distance = 1 m), but no difference was detected for landscape plots ($p = 0.67$; Figure 3.7 B & E, distance ≥ 5 m). We did not detect differences between Miscou Island and Kouchibouguac for non-native species on direct plots ($p = 0.43$; Figure 3.7 C & F, distance = 0 m) or indirect plots ($p = 0.92$; Figure 3.7 C & F, distance = 1 m). However, there were more non-native species on Miscou Island landscape plots than in Kouchibouguac ($p = <0.001$; Figure 3.7 C & F, distance = ≥ 5 m); albeit very few non-native species were being compared.

Our results also indicated that Miscou Island also had less presence of *A. breviligulata* than Kouchibouguac on direct ($p = 0.00066$; Figure 3.8 A-B, distance = 0 m), indirect ($p = 0.00108$; Figure 3.8 A-B, distance = 1 m), and landscape plots ($p = 0.00194$; Figure 3.8 A-B distance ≥ 5 m). The same pattern occurred for the percent cover of A. breviligulata on direct ($p < 0.001$; Figure 3.8 C-D, distance = 0 m), indirect ($p < 0.001$; Figure 3.8 C-D, distance = 1 m), and landscape plots ($p < 0.001$; Figure 3.8 C-D, distance ≥ 5 m). These patterns were most accentuated on direct and indirect plots (As seen in Figure 3.8, distance = 0 or 1 m).

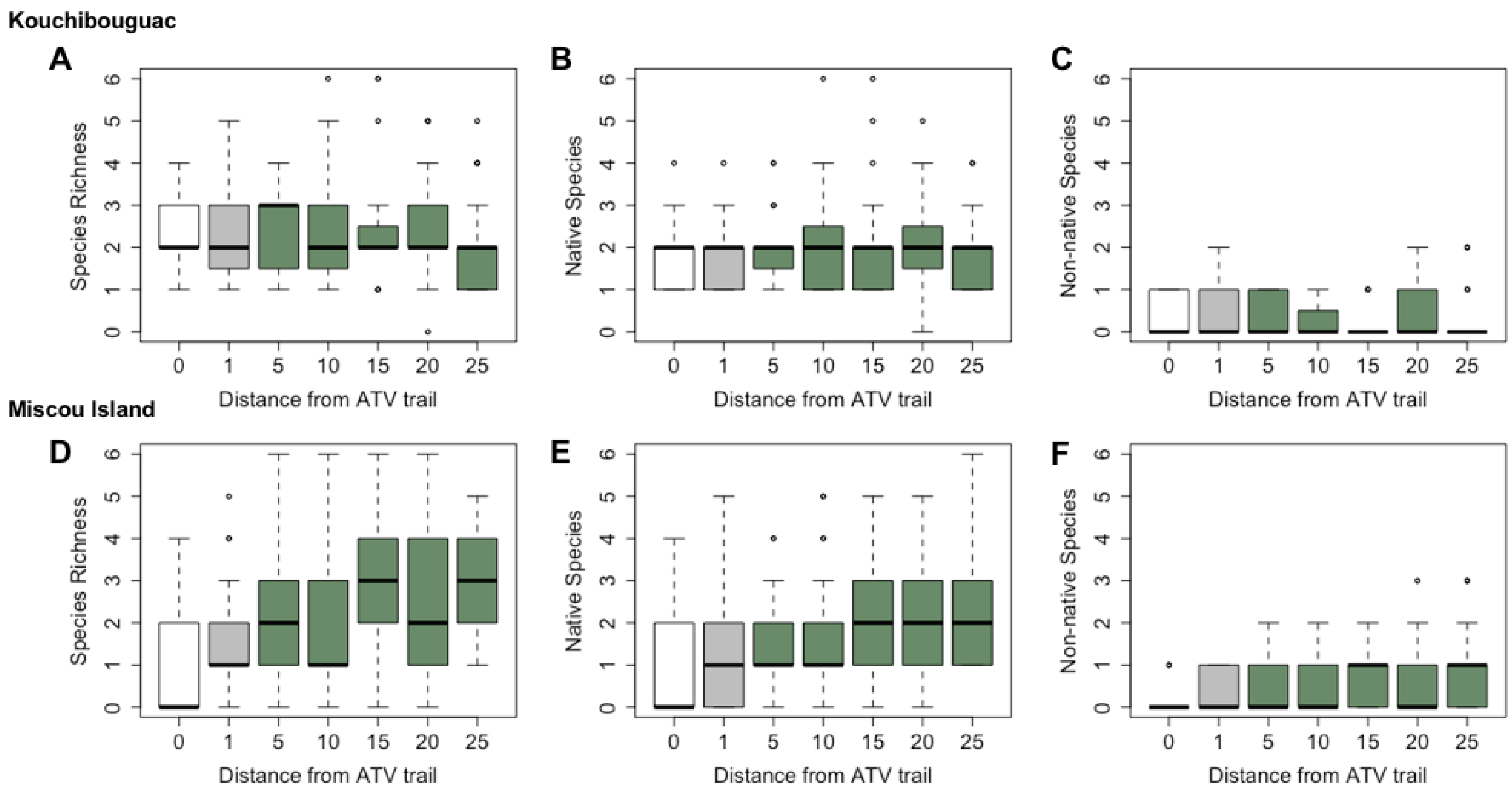

Figure 3.7. Total number of species (A & D = total species richness, B & E = native species, D & F = non-native species) are grouped by distance from the ATV trail (i.e., 0 is directly on the trail (white column), 1 is on the edge of the trail (grey column) and ≥ 5 meters are the landscape plots (green column)) and are displayed for two regions (A-C = Kouchibouguac and D-F = Miscou Island). The boxes are comprised of the 25–75% quartiles of the data and the median is indicated by the line through the centre of the box. The whiskers extending from the box comprises of the 95% quartiles, and extreme observations are shown as hollow circles.

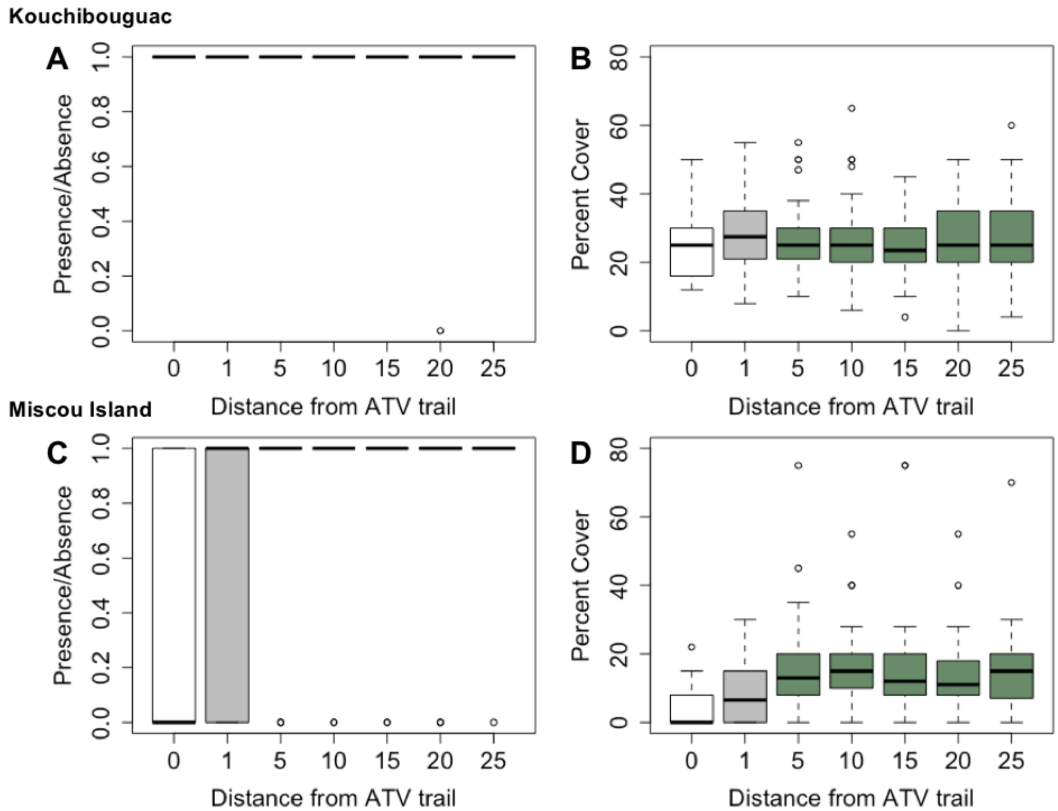

Figure 3.8. Presence/absence and percent cover of *Ammophila breviligulata* (A & C = Presence/absence, B & D = Percent Cover) are grouped by distance from the ATV trail (i.e., 0 m is directly on the trail (white column), 1 m is on the edge of the trail (grey column) and ≥ 5 m are the landscape plots (green column)) and are displayed for two regions (A & B = Kouchibouguac and C & D = Miscou Island). The boxes are comprised of the 25–75% quartiles of the data and the median is indicated by the line through the centre of the box. The whiskers extending from the box comprises of the 95% quartiles, and extreme observations are shown as hollow circles.

3.3.4 Dune Landscape Type

Kouchibouguac had higher richness in the shrub than in the pioneer zone for total ($p < 0.001$; Figure 3.9A), native ($p < 0.001$; Figure 3.9B) and non-native species ($p = 0.023$; Figure 3.9C). There was also more *A. breviligulata* cover in the shrub zone than the pioneer ($p < 0.001$; Figure 3.10B) but no difference in its presence ($p = 0.68$; Figure 3.10A). In contrast, on Miscou Island, ANOVAs showed no detectable difference between the shrub and pioneer zones for total ($p = 0.072$; Figure 3.9D) and native species ($p = 0.39$; Figure 3.9E), but shrub zones had more non-native species than pioneer zones ($p = 0.005$; Figure 3.9F). Miscou also had less percent cover of *A. breviligulata* in shrub than pioneer zones ($p = 0.03$, Figure 3.10D), but no difference in the presence of *A. breviligulata* between zones ($p = 0.13$, Figure 3.10C).

As summarized above, ANOVAs comparing regions indicated that there was not a difference in total or native richness between regions, however, when further divided by dune zones, Miscou Island had fewer native species within the shrub zone ($p = 0.0027$; Figure 3.9B & E) and more non-native species in the pioneer zone ($p = 0.016$; Figure 3.9C & F) than Kouchibouguac. Miscou Island also had less presence and cover of *A. breviligulata* than Kouchibouguac in both the pioneer zone ($p < 0.001$; 15.78 ± 25.25, 26.16 ± 11.89, respectively; $p < 0.001$, Figure 3.10) and the shrub zone ($p = 0.0078$; $p < 0.001$, respectively, Figure 3.10).

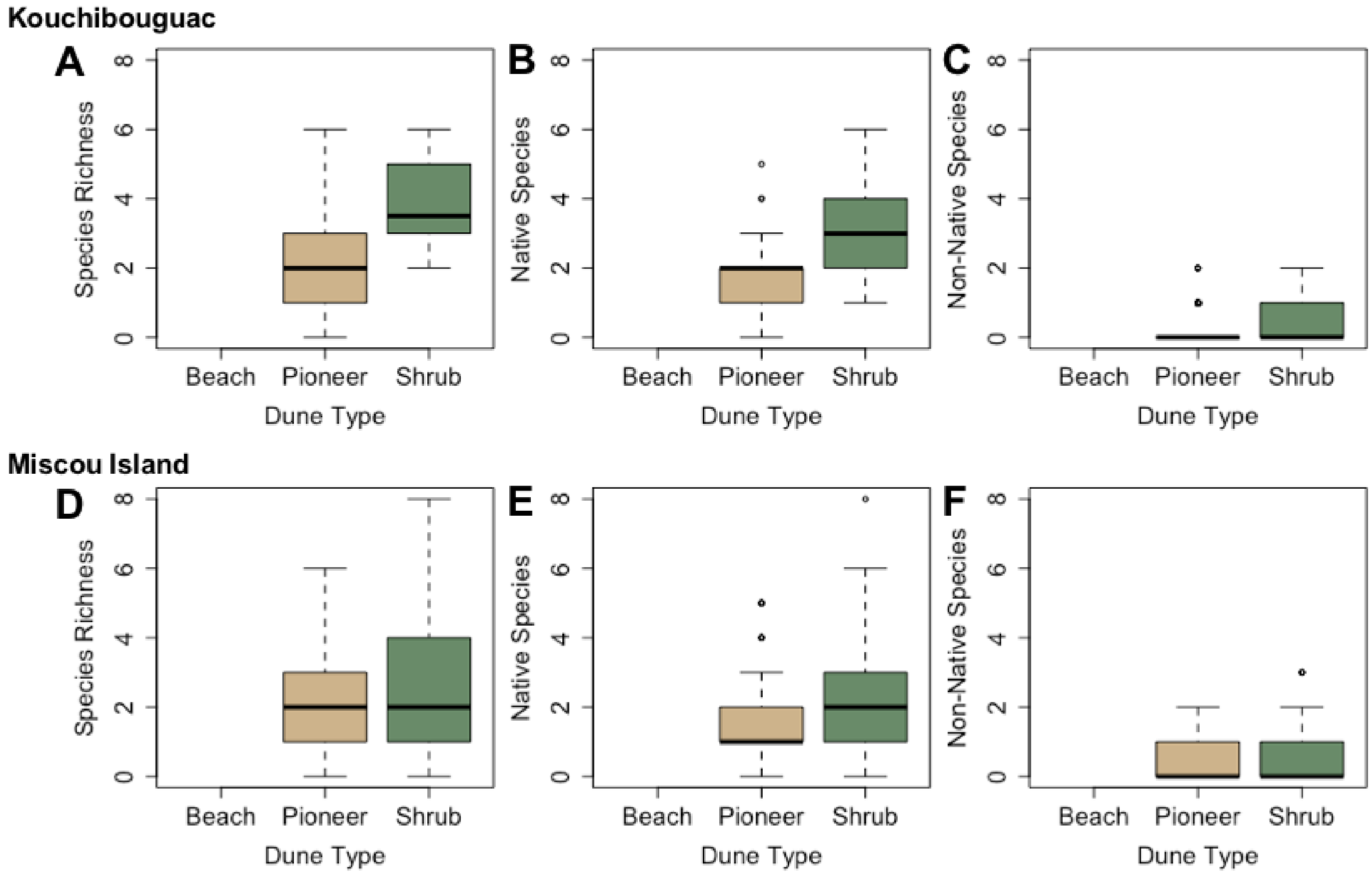

Figure 3.9. Total number of species (A and D = total species richness, B and E = native species, C and F = non-native species;) are grouped by landscape type (i.e., beach, pioneer, and shrub) and displayed for two regions (A-C = Kouchibouguac and D-F = Miscou Island). The brown boxes indicate sites located in the pioneer zone (n=156) and the green boxes indicate sites located in shrub part of the dune (n=26). The boxes are comprised of the 25–75% quartiles of the data and the median is indicated by the line through the centre of the box. The whiskers extending from the box comprises of the 95% quartiles, and extreme observations are shown as hollow circles. No plant species found on the beach transect.

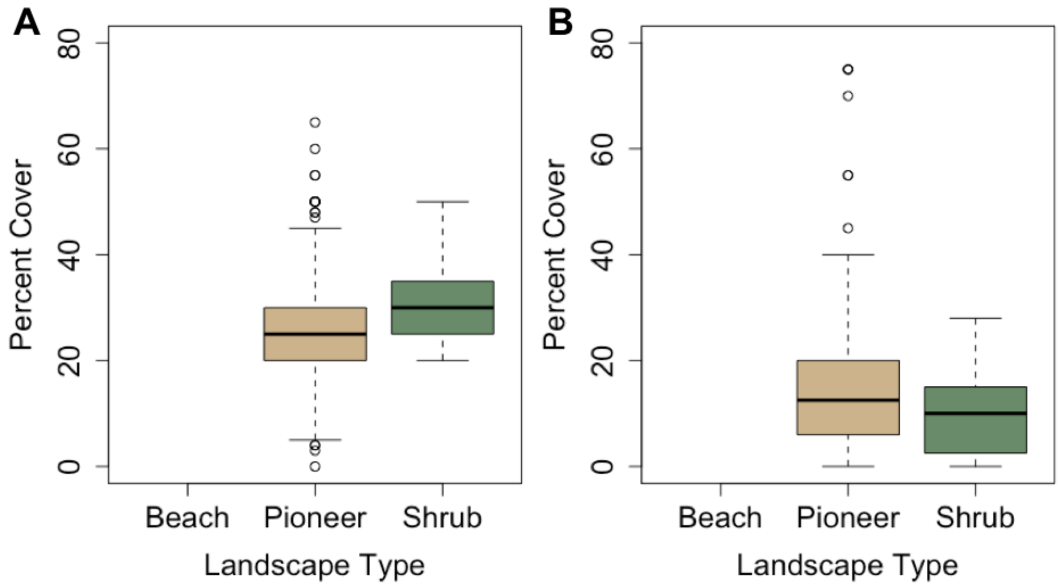

Figure 3.10. Percent cover of *A. breviligulata* grouped by landscape type (i.e., beach, pioneer, and shrub) and displayed for two regions (A = Kouchibouguac, B = Miscou Island). The brown boxes indicate sites located in the pioneer zone (n=156) and the green boxes indicate sites located in shrub part of the dune (n=26). The boxes are comprised of the 25–75% quartiles of the data and the median is indicated by the line through the centre of the box. The whiskers extending from the box comprises of the 95% quartiles, and extreme observations are shown as hollow circles. No plant species found on the beach transect.

3.4 Discussion

We found that all-terrain vehicle (ATV) use limited the distribution of native vegetation but may have promoted the occurrence of non-native species on coastal sand dunes. ATV rut depth was a key driver of species richness patterns, decreasing the number of total and native species on ATV trails and on the trail edge and slightly increasing the amount of non-native species on beyond the trail edges (i.e., distance ≥ 5 m from ruts caused from ATV use). There were fewer occurrences and less cover of the dune stabilizing species *A. breviligulata* where ATV activity occurred. Past research observed greater localized impact with greater rut depth (Kutiel et al., 1999); however, our findings suggest that there are also adjacent landscape effects via a small increase in non-native species. Our findings indicate that ATV use plays a major role in the vegetation changes observed on coastal sand dunes.

3.4.1 Plant community composition with and without ATV use

We found neutral and negative effects of ATV use on species richness, depending on the context, alluding to the complexity of coastal sand dune vegetation. Specifically, we found that there was little difference in total and native species richness between areas with or without ATV use. However, there were slightly more non-native species and less dune-stabilizing *A. breviligulata* in the ATV use region compared to the protected area.

While there was an increase in non-native species associated with ATV use, there were very few non-native species found within the study region; on average, the presence of non-native species in each plot was less than one in both regions. We detected 14 non-native species, which made up 34% of the total species surveyed in our study. While we could find few eastern North American data for comparison, that proportion (34%) is higher than has been found in coastal sand dunes of Europe, where the proportion of non-native species has been observed from 7-13% (see Carboni et al., 2010; Del Vecchio et al., 2015; Marcantonio et al., 2014; Stešević et al., 2018). Increases in species richness have been associated with moderate trampling (Liddle & Greig-Smith, 1975; Westhoff, 1976; van der Marrel, 1971), but with trampling eventually leading to vegetation degradation (van der Marrel, 1971). Species richness can increase immediately following a disturbance in response to increased availability of resources (space, light, nutrients) allowing for colonizers to establish, including non-native species (McAtee & Drawe, 1980). After the initial increase in richness, however, there is often a decline as poorly adapted initial colonizers die, or as invasive species outcompete and exclude other colonizers (Rew et al., 2017). With ongoing, active ATV use on Miscou Island sand dunes, we suspect that these plant communities do not have the opportunity to proceed beyond the colonizer stage.

While we detected few differences in species richness between regions with and without ATV use, other studies have found that the main differences found between species is based on cover and frequency (Stešević et al., 2018) rather than richness. Here, we examined those metrics for a critical dune stabilizing species, and found that there were fewer occurrences and lower cover of *A. breviligulata* in the ATV use region. ATV use reduces the cover of species (Kelly, 2014), whether short or long term (McAtee & Drawe, 1980), by root systems being crushed which in turn prevents continued growth of developing dunes (Broadhead & Godfrey, 1977; Leatherman & Godfrey, 1979; Zaremba et al., 1978). Thus, the reduction of just one species can have critical impacts on dune development and persistence.

We determined that increased rut depth caused by ATV use plays a significant role in the changes to plant community composition. Deeper ATV ruts had fewer total, native, and non-native species, and fewer occurrences of *A. breviligulata*. Rutting, along with displacement and compaction, is one of the most visible and prominent environment impacts caused by off-road vehicles (Anders & Letherman, 1987; Calvão et al., 2013; Defeo et al., 2009; Acosta et al., 2013). As described above, ruts destroy plants that stabilize the sand and increase the amount of bare ground (Hesp et al., 2010), leaving dunes more susceptible to breaches (i.e., blowouts) (Calvão et al., 2013; see Figure 3.11

for example of a blowout on Miscou Island). Notably, we did not detect an association between the percent cover of *A. breviligulata* and rut depth, likely due to the overall very low cover of this species on Miscou in comparison to Kouchibouguac (Figure 3.4). *A. breviligulata* is sensitive to disturbance and even low use on the same trail is enough to cause damage to the rhizomes, underground stems important for quick regeneration (Brodhead & Godfrey, 1979; Anders & Leatherman, 1981; Anders & Leatherman, 1987). Our results suggest a visible threshold of approximately 50 cm rut depth (Figures 3.7 and 3.8), beyond which an abrupt decline is seen across all species groups. If this threshold is related to damage of the rhizomes, it may have larger implications for management. Therefore, it is essential that rut depth effects are further explored to increase the generalizability of this study to other dune ecosystems. Further research is also warranted on whether deeper ruts are caused by repeated use of trails or via single damaging events; i.e., can a single ATV-use event cause long-term changes to dune ecosystems? How can the type of vehicle, the weight of the vehicle, how it was driven, etc. increase the amount of rut depth?


Figure 3.11. Example of a blowout on Miscou Island dune system caused by ATV use.

3.4.2 Spatial extent of ATV impacts

By using Brooks & Lair's (2005) spatial characteristics (i.e., direct, indirect, and landscape effects), we obtained a better understanding of the spatial effects of ATV use Overall, there were fewer total and native species on direct and indirect plots (on and beside trails) and more non-native species on landscape plots ($\geq$ 5 m from ATV trail). Disturbance is the most severe in direct and indirect plots due to soil compaction on a trail (i.e., wheel ruts and track margins; Liddle & Greig-Smith, 1975), and we expect few species can withstand those conditions. Our spatial comparisons provide further evidence that ATVs may act as a vector to facilitate the introduction of non-native species particularly on landscape plots (Bajwa et al. 2017; Rew et al. 2017). We believe that introduction occurred on landscape plots because high trampling would make it more difficult to colonize on and directly adjacent to the trail. Further investigations into the spatial extent of the introduction of non-native species by ATVs using methods similar to Brooks & Lair's (2005) are warranted.

We found that all species groups increased in richness with distance from the highest severity of impact (i.e., deepest ruts). Similar patterns have been found in other studies where the higher the use, the greater change in vegetation with distance from the trail (Kutiel et al., 1999). High-use trails were also seen to have more localized effects, within 1 metre on each side, than on a landscape level (Acosta et al., 2006; Jucker et al.,, 2013; Kutiel et al., 1999; Lechuga-Lago et al., 2016; Wiedemann & Pickart, 2008). Similarly, we found that direct and indirect plots associated with more deeply rutted trails had fewer total and native species and less *A. breviligulata*.

In contrast, we found that areas around the deepest ruts had the most non-native species in landscape plots. Our findings, therefore, suggest that severely disturbed trails may experience few effects on total and native species richness on landscape plots. However, due to the increase of non-native species in the same areas, the increase seen in species richness may be ephemeral if the non-native species are invasive, outcompeting and excluding other species (Rew et al., 2017). It is important to differentiate the changes found between native and non-native species as this could lead to an improved understanding of the dynamics found in coastal sand dune vegetation.

3.4.3 Pioneer versus shrub zone effects

We found some evidence that vegetation in pioneer and shrub zones have differential responses to ATV use. Healthy dune systems typically have more vegetation found in the shrub zone than the pioneer zone (Maun, 2009), as we found in the dunes in Kouchibouguac. However, Miscou Island dunes showed little difference between these landscape types, except for an increase in non-native species and less cover of *A. breviligulata* in shrub dunes. When the regions were compared, Miscou Island had fewer native species in the shrub zone, more non-native in the pioneer zone, and fewer occurrences and cover of *A. breviligulata* in both. These results suggest that native species in shrub dunes may be more sensitive to ATV impact than in the pioneer zone. However, the pioneer zone may be more susceptible to an increase in non-native species introductions. The pioneer zone has been found to be less sensitive and faster at recovering than shrub dunes because they are more exposed to changes in stabilisation caused by environmental factors (Brodhead & Godfrey, 1979; Richard et al., 1994) and thus have fewer species in general. However, because species in pioneer zones are limited by harsher environmental conditions (Maun, 2009), there may be more space for possible introductions of disturbance-adapted species with limited competition. Here, we have shown that classifying dunes into zones, pioneer and shrub, gives a more informed understanding of where ATV impacts occur. It is, therefore, essential that these landscape types are further explored. If there are consistent differences in sensitivity between pioneer and shrub zones, custom-designed functional and effective management procedures will be crucial (Rust & Illenberger, 1996).

3.4.4 Management implications

With increasing evidence of the impacts caused by ATVs and other traffic (see Defeo et al., 2008; Kelly, 2014; Schlacher & Morrison, 2008, for reviews), land managers are faced with the challenge of minimizing ecological damage along with maintaining socio-ecological balance. As demonstrated in our results and past research on coastal sand dunes, management of these ecosystems should take into account the amount of time after the occurrence of high impact disturbance, the types of species remaining after impact (i.e., ‘gap-colonizing’ species) (Rickard et al. 1994), along with the severity of the impact (i.e., rut depth), the spatial characteristics of ATV impacts, and the dynamic nature of the systems (i.e., the difference between pioneer and shrub dunes) (Calvão et al., 2013).

Our evidence of a potential rut depth threshold for species richness impacts is of particular relevance to dune management. Managers should consider finding a method to monitor changes over time to ensure landscape protection. One method that is often used is to set limits of acceptable change (Hoss & Brunson, 2000), which identifies when a specific landscape has experienced an ‘unacceptable change’ and is usually decided by the landscape manager (Haider & Payne, 2009). Based on our results, we may suggest that rut depth over 50 cm may be a sign of ‘unacceptable change’ as it caused significant effects to the vegetation composition of dune ecosystems. Due to the seeming intolerance of *A. breviligulata* to disturbance, we note that disturbances seemingly less severe than ATV rut damage may impact its distribution. In Kouchibouguac, management of off-trail hiking and intensive use of dune systems will be important for the preservation of this important dune-stabilizing species. Although our transect sites in Kouchibouguac were non-ATV or pedestrian use sites, many of the dune systems in the park are heavily used by tourists. It is vital that managers consider the implications of these high use visitor areas.

Finally, as people are an essential part in conservation (Bath, 1998; Decker & Chase, 1997), public involvement initiatives should be a mandated part of the management process and should be continued throughout. By taking into account the ecological and social factors along with ways to mitigate the impact such as creating controlled routes that are straight with no sharp turns and avoid steep gradients to prevent further damage (Rickard et al., 1994), management of these ecosystems should improve. However, future research is needed to confirm the results of this study using methods similar to Brooks & Lair (2005) to create more generalizable management options for coastal sand dunes globally. Implementing more effective management plans will help preserve coastal sand dunes, enabling more effective defenses against the sea at a lower cost than engineered interventions (Calvão et al., 2013).

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Chapter 4:
Summary and Conclusion

Topics within natural resource management are often complex socio-ecological systems characterised by interactions between ecological functions and the human perspective (Aretano et al. 2017). The human and ecological components are often studied within their respective disciplines, they are rarely studied together. The purpose of this thesis was to incorporate the human and ecological fields of research, to help build on past research, and to clarify a resource management issue in coastal New Brunswick communities. This was completed in the first three chapters of this thesis by taking an interdisciplinary approach to understanding complex social-ecological systems within coastal sand dunes. Over time, by analysing public thoughts and actions toward natural resources and creating and maintaining relationships, various management goals can be achieved: (1) the residents are encouraged to participate in environmental-related behaviours, (2) conflict among interest groups is reduced, (3) the residents understand more about the various management options and practices, and (4) the understanding of the position of interest groups on current management issues are listened to before managers make decisions (Pierce et al., 2001). This research establishes a starting point for natural resource managers to begin achieving these goals. Based on the research findings in Chapters 2 and 3, this section will highlight a summary of the thesis, suggest directions for new research, and supply recommendations to improve the management of coastal landscapes in New Brunswick, Canada, particularly coastal sand dunes.

The quantitative questionnaires and the ecological surveys used for the thesis helped achieve the goal of incorporating the fields of human dimensions and recreation ecology. The Nature Conservancy of Canada funded this research in order to better understand the individuals who are affected by resource management and to be proactive in managing important areas for flora and fauna within New Brunswick. While the data collected are not generalizable to the entire province of New Brunswick, we are able to generalize our findings to the communities involved in the research (i.e., Pointe-Sapin, Escuminac, and Miscou Island), which are all areas of interest to the Nature Conservancy of Canada, and the findings can inform research on sand dunes in other regions of northeastern North America.

4.1 Summary

This thesis provides a foundation for examining a similar situation, increased illegal all-terrain vehicle (ATV) use on coastal ecosystems, from two fields of research: human dimensions and recreation ecology. The first manuscript, Chapter 2, identified areas of potential consensus and conflict between and within three New Brunswick communities in regard to coastal sand dunes and their management. The second manuscript, Chapter 3, examined the effects of ATV use on the ecology of coastal sand dunes. By approaching the research from these different perspectives, a more holistic understanding of the system is achieved.

In Chapter 2, we found that there are differences between Miscou Island and Pointe-Sapin in their perceptions of impact, their perceived main threat to dunes, and their acceptability of management to ATV on sand dunes. Specifically, we found that

Pointe-Sapin residents perceived lower impacts in most photographs, perceived the main threat to sand dunes as naturally occurring (i.e., storms), and believed it was more unacceptable to restrict all ATVs from dunes. Miscou Island perceived the main threat to coastal sand dunes as spread over various impacts, but were mostly ATV related. Contrary to our results on photographs between Pointe-Sapin and Miscou Island, methods using Scenic Beauty Estimations (SBE) showed uniformity across different public groups (Daniel and Boster, 1976, Buhyoff & Leuschner, 1978). Similarly, however, Escuminac showed little difference between either community. To help explain these differences in perceptions, Chapter 2 also explored how these communities may be influenced by different contexts, more specifically, a difference in perceived control.

Pointe-Sapin may feel a loss of perceived control due to its proximity to Kouchibouguac National Park, a park known for the relocation of residents during its development (Rudin, 2016). This may have lead residents of Pointe-Sapin to perceive impacts lower and be less accepting of management than Miscou Island, because they already experience restrictions due to the park. Escuminac did not share many differences between either community except for their perceived main threat to sand dunes (i.e., storms). Although it is a neighbouring town to Pointe-Sapin, Escuminac is about a 24km drive from Kouchibouguac and therefore, may not have been as directly impacted by the park, at least in terms of ATV use. Due to their proximity, however, Escuminac and Pointe-Sapin are likely to have similar weather including storms. This may help explain why the majority of both Escuminac and Pointe-Sapin perceived the main threat to sand dunes as storms. Specifically, Escuminac experienced a storm in 1959, known as “The Escuminac Disaster”, which sank 22 fishing boats and downed 35 men (CBC News, 1975). As a small community which depends on the fishing industry (Important Bird Areas, 2016b), this had direct impacts on their livelihoods (CBC News, 1975). It is essential, therefore, that managers are aware of the context occurring at a local level, whether current or historical, as identifying the nature of conflicts is an integral step prior to finding a solution (Linnell et al., 2010; Young et al., 2013).

In Chapter 3, we found that all-terrain vehicle (ATV) use was a significant limiting factor of vegetation patterns in coastal sand dunes. The severity of effects changed depending on the landscape type, where shrub zones were usually more sensitive than the pioneer zones (Brodhead & Godfrey, 1979; Richard et al., 1994; Rust & Illenberger, 1996). Rut depth was found to be one of the main limiting factors to the growth of vegetation. Our results suggest a visible threshold of approximately 50 cm rut depth, beyond which an abrupt decline is seen across all species groups. This decrease may be due to ruts destroying plants that stabilize the sand which in turn increases the amount of bare ground (Hesp et al., 2010), leaving dunes more susceptible to breaches (i.e., blowouts; Calvão et al., 2013). We also found that there was little difference in total and native species richness between the regions with and without ATV use. However, there were slightly more non-native species, potentially due to an increase in resources with disturbance (McAtee & Dawe 1981), and less dune-stabilizing *A. breviligulata* in the ATV use region compared to the protected area. Finally, ATV use caused a decrease in total and native species locally (i.e., on the trail) and an increase in non-native species on the landscape plots (i.e., $\geq$ 5 meters from ATV trail). This suggests that the spatial extent of ATV use effects on vegetation surpasses the trail itself and could, therefore, cause serious vegetation changes if non-native species outcompete and exclude other colonizers (Rew et al., 2017).

In summary, it was observed in Chapter 2 that Miscou Island residents perceived higher impacts to photographed sand dunes, perceived the main threat to be ATV related, and were more accepting of restrictions to ATVs on sand dunes than Pointe-Sapin. The results from Chapter 3 suggest that vegetation of the sand dunes, the species richness and the occurrence and cover of *Ammophila breviligulata*, on Miscou Island are affected by ATVs, particularly due to greater rut depth. To reconcile these results, there may be a link between Miscou Island's perceptions and actual ATV impact on coastal sand dune vegetation. In Chapter 2, perceptions of impact were quantified using photographs that illustrated impact based on the increase of observational rut depth and decreased vegetation cover. It was found that all the communities' perception of impact increased as the photographs appeared to have greater rut depth (Chapter 2, Figure 2.1). However, few of Miscou Island residents perceived the main threat to sand dunes as "ATVs creating deep trails", but rather indicated it was "ATVs driving over vegetation" (Figure 2.2). Therefore, it is possible that individuals ranked the photographs based on decreasing vegetation cover which has been seen to decrease due to rut depth on direct plots (as seen in Chapter 3). Overall, although not directly linked to rut depth, individuals were able to identify that impact increased. This finding is important as knowledge is an essential aspect of processing information and decision-making (Johnson & Russo, 1984; Raju, Lonial, & Mangold, 1995). Future research needs to address the important linkages between the fields of human dimensions and recreation ecology, especially if the goal is to improve management.

Due to financial and time constraints, along with our research team's geographic distance from the field sites, this research only had one field season, which limited the range of the participants involved in this study. Particularly in the areas of Pointe-Sapin and Escuminac, which are more accessible on ATVs from other communities, future research should incorporate other sample areas (e.g., Kouchibouguac or Baie-St. Anne). Future research should similarly include more sample areas for the recreation ecology study to allow to a better understanding differences between the communities (e.g., Pointe-Sapin and/or Escuminac). Although the communities are aging, with most of their population above the age of 40 years old (Statistics Canada, 2016), it would still be interesting to consider sampling high school students within the study sites. Unfortunately, for Miscou Island, which has no school (i.e., primary or high school) on the Island, this would be more challenging to address. Furthermore, future research interested in using similar methods should integrate the recreation ecology study before the human dimensions study as this would allow for context specific questionnaires. In the following section of this chapter, with some of the limitations of this study in mind, I outline recommendations for future research as well as recommendations for management of these landscapes.

4.2 Recommendations for Future Research

4.2.1 Future Research in Human Dimensions

i. Identify additional belief statements to improve the understanding of value orientations toward coastal sand dunes in recreational areas and explore and confirm the results of value orientation toward coastal sand dunes in other coastal related areas. This will help to increase the generalizability of these findings to other areas with recreational use (See Needham, 2010).

ii. Further explore the method of Scenic Beauty Estimations (SBE) and its applicability in measuring perceptions of impact. To complete this, a comparison between the SBE method and the structural norm theory should be explored to access the utility of each method for accessing perceptions of impact in photographs (see Laven, Manning, & Krymkowski, 2005; Manning et al., 2001, for more information on norm theories using photographs).

iii. Due to this research only including one acceptability of management variable, further research is also needed to provide additional management options (e.g., a continuum of less protection to full protection), thus, providing a better understanding of the differences and similarities between acceptability of use and management (see Donnelly et al., 2000; Shelby & Vaske, 1991; Shelby et al., 1996; Vaske & Donnelly, 2002, for reviews).

iv. More in-depth research on how proximity to a national park (i.e., scale of distances) may influence communities' behaviour, attitudes, and acceptability of management options. For example, in the context of our research, it would be important to measure other residents living beside Kouchibouguac to investigate similarities and differences among communities.

v. As communication is an important element in conservation, future research should address the best method through which individuals would like to be accessed (e.g., newspapers, radio, signs, town hall, village council, social media, etc.) and assess feasibility of education campaigns (See Vaske & Donnelly, 2007 for examples of questions).

4.2.2 Future Research in Recreation Ecology

i. As there were low numbers of non-native species common in coastal sand dunes (Carboni, Santoro, & Acosta, 2010; Campos et al., 2004; Del Vecchio, Pizzo, & Buffa, 2015; Marcantonio, Rocchini, & Ottaviani, 2014; Stešević et al., 2018), it is essential that cover and frequency of species are examined. These factors have often been more useful in understanding vegetation effects because species with greater cover, height, or frequency may influence the structure and appearance of plant communities (Stešević et al., 2018; Novoa et al., 2013; Daisie, 2009).

ii. The influence of rut depth needs to be further explored to understand whether our results are generalizable. It is of particular interest to better document the amount of rut depth responsible for significant changes to vegetation. For example, it would be worthwhile to investigate if a rut depth of about 50 cm the point of unacceptable change or is this dependent on the dune or other factors.

iii. Methods similar to Brooks & Lair's (2005) spatial characteristics (i.e., direct, indirect, and landscape effects), have shown value in understanding the spatial extent of ATV use and should be further used (see Kutiel et al., 1999 for an example).

iv. Identifying the differences between the effects that ATVs had on native and non-native species proved valuable when addressing the spatial extent of the impact. If non-native species are invasive, they may outcompete and exclude other colonizers (Rew et al., 2017). It is, therefore, essential that future studies differentiate between these species because they may react within the environment differently.

v. We found that by classifying dunes into zones (pioneer and shrub zones), there were differences in effects based on landscape type. It is essential that future studies further explore these differences in landscape types as this may help establish custom-designed functional and effective management procedures (Rust & Illenberger, 1996; see Brodhead & Godfrey, 1979 and Richard et al., 1994 for examples).

4.3 Recommendations for Managers and Decision Makers

i. Continued work must be completed to maintain and improve the relationships with these communities. This will help provide an environment where different interest groups involved in the stewardship and/or use of these ecosystems can openly discuss their concerns or approval in regard to coastal management together, through continued applied human dimensions facilitated workshops (see Bath, 2009).

ii. Ecological monitoring must be sustained for the piping plover and the ecosystems that benefit from its protection (i.e., coastal sand dunes) to better understand if or when there is more social science research needed in other areas of New Brunswick.

iii. Communication campaigns and education programs must be designed to be context specific to increase knowledge about the impacts of ATVs on coastal ecosystems and increase the acceptability of management (i.e., prior to creating messages, current or historical context must be understood for each individual community).

iv. Communication campaigns should follow guidelines provided by past research such as Ajzen's (1992) four elements to better communication messages: (a) source, (b) receiver, (c) channel, and (d) message factors. The source is the group or person communicating the message, the receiver is the demographic who will receive the information, the channel is the way in which the receiver would best acquire this information (e.g., social media, interpretation boards, etc.), and the message factors are how the information is presented to the public (e.g., emotional vs. non-emotional strategies) (Vaske & Donnelly, 2007).

4.4 Conclusion

In conclusion, this thesis has relevance to the field of human dimensions as it explored and identified communities': (1) perceptions of impact on; (2) perceived main threat to; (3) value orientations toward; and (4) acceptability of use and management on coastal sand dunes. Furthermore, this thesis also adds relevance to the field of recreation ecology by exploring all-terrain vehicle (ATV) impact on (a) species richness, (b) native species, (c) non-native species, and (d) American Dune Grass (*Ammophila breviligulata*). Throughout the chapters, I also identified the implications that this research has on the management of coastal sand dunes. The work presented in this thesis represents a small body of literature that aims at combining the social and ecological components for focused outcomes (for examples see Aretano et al., 2017; Prisken et al. 2013). I am hopeful that this will lead to further investigation into improving methods to integrate these fields of research as I believe it to be essential for successful management of dune landscapes.

4.5 References

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Appendix: Questionnaire

What do you think about all-terrain vehicle (ATV) use?

Dear Resident,

Thank you for agreeing to participate in this research project. Memorial University in collaboration with the Nature Conservancy of Canada are interested in learning more about the opinions, motivations, and goals of residents in Escuminac, Pointe-Sapin, and Miscou Island toward ATV use in your areas. Your answers will provide valuable insight into how the people of New Brunswick feel about ATVing and how you would like the activity to be managed your area.

You have been randomly selected to give your opinions on this issue. The questionnaire should take about 15 minutes. We request that one person **19 years of age or older** participate in the study. **If there are several interested residents in the household, the adult who is having the NEXT BIRTHDAY should complete the questionnaire.**

When you have completed the questionnaire, please seal it in the envelope provided and hang it on your front door in the plastic doorknob bag.
A research assistant will be by to collect your completed questionnaire on ____________________________between the hours _____ and _____.
NOTE: For this study, an ATV is defined as a three, four or six-wheeled all-terrain vehicle, quad, or side by side designed for off-road use. Snowmobiles and dirt bikes are not included as ATVs for the purpose of this study.

Please answer all questions as completely as possible. We encourage you to voice your opinions, whether for, against, or neutral. Your answers will be grouped with those of others. All individual responses will be kept **strictly confidential**.

Thank you very much for your help by participating in this study about ATV use. If you have any questions about the study or need help completing it, please do not hesitate to contact Jessica Hogan at (506) 337-2124 or by email at nbATVstudy@gmail.com. Your assistance with this project is greatly appreciated.

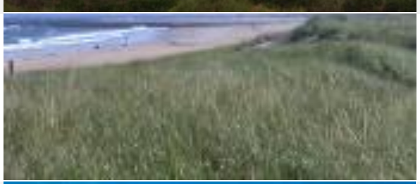
Sincerely,

Jessica Hogan
Project Manager

Alistair Bath
Project Supervisor

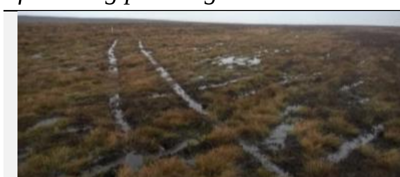
A. Below is a photograph of a coastal sand dune. *Sand dunes are small ridges or hills of sand (sometimes covered with vegetation) found at the top of a beach, above the usual maximum reach of the waves.*

B. *The first few questions ask you to* ***rank the level of human impact (if any)*** *seen* ***in each*** *of these* ***photographs of sand dunes.*** *(***Please circle*** *the number that best represents your response for* ***each statement****).*

*In **your opinion,** how much human impact (if any) has happened on the following dunes?*	**No Impact**	**Slight Impact**	**Moderate Impact**	**High Impact**	**Extreme Impact**	**Unsure**
	1	2	3	4	5	U
	1	2	3	4	5	U
	1	2	3	4	5	U
	1	2	3	4	5	U

C. Below is a photograph of a peat bog. *Peat bogs are areas of wet and spongy vegetation (known as peat moss) that have been broken down in layers over thousands of years.*

D. *The first few questions ask you to* ***rank the level of human impact (if any)*** *seen* ***in each*** *of these* ***photographs of peat bogs.*** *(**Please circle** the number that best represents your response for **each statement**).*

*In **your opinion,** how much human impact (if any) has happened on the following peat bogs?*	**No Impact**	**Slight Impact**	**Moderate Impact**	**High Impact**	**Extreme Impact**	**Unsure**
	1	2	3	4	5	U
	1	2	3	4	5	U
	1	2	3	4	5	U
	1	2	3	4	5	U

E. *The following questions ask about* ***your experience with ATVs.*** *Please* ***circle*** *your response:*

1. Have you ever participated in ATVing either as an operator or a passenger?
   a) Yes
   b) No ->**if no, skip to section G**

2. If you answered yes to the above question, how do you usually participate?
   a) As an operator
   b) As a passenger
   c) Both

3. Do you own an ATV? a) Yes b) No

4. If yes**, how many** ATVs do you own (*Give specific number*. Ex. 2)
   a) ATV: _______ b) Side by Side: _______

5. How many years have you been riding? ________

6. During the past 12 months, approximately how many days did you ride? ________

7. During which months do you usually ride? (*Circle all that apply*)

a) January b) February c) March d) April e) May f) June
g) July h) August i) September j) October k) November l)December

F. How often do you use your ATV in the following ways? *(Circle* ***ONE*** *number for* ***EACH*** *statement).*

I use my ATV…	Never	Rarely	Sometimes	Mostly	All the time
…to help with woodcutting.	1	2	3	4	5
…to help with hunting.	1	2	3	4	5
…to help bring my fishing gear to the beach.	1	2	3	4	5
…to help collect lobster pots from the beach.	1	2	3	4	5
…for exploring trails and public lands.	1	2	3	4	5
…for excitement and thrills.	1	2	3	4	5
…to get to the cabin.	1	2	3	4	5
…to get to the beach to walk.	1	2	3	4	5
…to ride on sand dunes.	1	2	3	4	5
…to ride on peat bogs.	1	2	3	4	5
…to ride on designated ATV trails.	1	2	3	4	5
…to ride on beaches.	1	2	3	4	5
…on beaches (on wet sand).	1	2	3	4	5

G. *The next questions ask about* ***your feelings toward ATV use in your community.*** *Please circle your response that best represents your opinion.*

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
ATV riding is an important part of my community culture.	1	2	3	4	5
It is important to protect the environment even though it prevents ATV use in some areas.	1	2	3	4	5
It is my right to ride where I want on beaches and dunes in the area.	1	2	3	4	5
Recreational use of coastal environments is more important than protecting sand dunes.	1	2	3	4	5
The needs of people are always more important than any rights sand dunes may have.	1	2	3	4	5
Sand dunes should not be recovered unless there is a direct benefit to humans.	1	2	3	4	5
We should strive for a society that emphasizes environmental protection rather than economic growth.	1	2	3	4	5
Sand dunes should be protected for their own sake rather than to simply meet our needs.	1	2	3	4	5
The rights of sand dunes to exist is more important than the negative effects that their recovery may have on humans.	1	2	3	4	5

H.** The next questions ask about **your knowledge about sand dunes.

1. Prior to receiving this survey, had you ever heard of sand dunes?	Yes	No

2. Please indicate if you believe that **each** of the following statements related to sand dunes is true or false. (Circle **ONE** letter for **EACH** statement)

Sand dunes…	**True**	**False**	**Unsure**
…are near my community.	T	F	U
…are constantly changing and moving.	T	F	U
…protect the coast from wave damage during storms.	T	F	U
…protect wetland habitat behind them.	T	F	U
…need plants to help hold down the sand.	T	F	U
…need water to help hold down the sand.	T	F	U
…need wind to help move the sand.	T	F	U
…provide habitat for many shorebirds.	T	F	U

***I.** This section asks about **your opinion** on what you consider to be **unacceptable or acceptable** for the **following actions**? (Circle **ONE** number for **EACH** statement).*

How unacceptable or acceptable is it for ATVs to..	**Extremely Unacceptable**	**Moderately Unacceptable**	**Neither**	**Moderately Acceptable**	**Extremely Acceptable**
…drive on designated ATV trails.	1	2	3	4	5
…drive on land where no one has ATVed before.	1	2	3	4	5
…drive on sand dunes.	1	2	3	4	5
…drive on beaches (on the wet sand).	1	2	3	4	5
…drive on peat bogs.	1	2	3	4	5
…drive on plants on dunes.	1	2	3	4	5
…drive on all beaches.	1	2	3	4	5
…create deep trails within the sand on dunes.	1	2	3	4	5
…be restricted from all sand dunes.	1	2	3	4	5
…be restricted from all beaches.	1	2	3	4	5

J. *Sand dunes face many problems.* ***How do you think each of the following impact sand dunes****? (Circle* ***ONE*** *number for* ***EACH*** *statement).*

	No Impact	**Slight Impact**	**Moderate Impact**	**High Impact**	**Extreme Impact**	**Unsure**
a. ATVs driving over vegetation.	1	2	3	4	5	U
b. Habitat loss due to human development (Ex. building homes, camps or cottages).	1	2	3	4	5	U
c. ATVs flattening hills of sand.	1	2	3	4	5	U
d. Bonfires.	1	2	3	4	5	U
e. Drought.	1	2	3	4	5	U
f. ATVs creating deep trails within the sand.	1	2	3	4	5	U
g. Tourism.	1	2	3	4	5	U
h. Storms.	1	2	3	4	5	U
i. ATV trails growing wider.	1	2	3	4	5	U
j. Garbage dumping.	1	2	3	4	5	U
k. Raking the beach.	1	2	3	4	5	U
l. Animals eating the dune grass.	1	2	3	4	5	U

From the list of potential threats in Section J (above), which do you feel is the one main threat to sand dunes? **(Write only ONE LETTER)** ____________

K. *In this section, we would like to know how **you feel** about **the Justice and Public Safety NB Conservation Officers, the Nature Conservancy of Canada, and the NB ATV Federation.***

1. **Justice and Public Safety NB Conservation Officers**.

a) These questions are about your feelings toward the **NB Conservation Officers**.

I trust NB Conservation Officers to provide:	**Strongly Disagree**	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
Truthful information about management issues on beach nesting birds.	1	2	3	4	5
The best available information to decide what action I should take regarding ATV management.	1	2	3	4	5
Timely information regarding ATV related issues.	1	2	3	4	5

b) With respect to ATV management, I feel that NB **Conservation Officers** …

	Strongly Disagree	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
…share similar values as me.	1	2	3	4	5
…think in a similar way as me.	1	2	3	4	5
…take similar actions as I would.	1	2	3	4	5
…share similar goals as me.	1	2	3	4	5

c) With respect to ATV management, I feel confident that NB **Conservation Officers**…

	Strongly Disagree	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
…can effectively enforce the laws.	1	2	3	4	5
…will respond to ATV conflict properly.	1	2	3	4	5
…will listen to the residents' concerns about ATV management.	1	2	3	4	5

d) What grade would you give the **Conservation Officers** for managing ATVs?

	Perfect				**Fail**
Please circle *the letter that best represents your response.*	A	B	C	D	F

2. **New Brunswick ATV Federation (NB ATV Federation)**

a) These questions are about your feelings toward the **NB ATV Federation**.

I trust NB ATV Federation to provide:	**Strongly Disagree**	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
Truthful information about management issues on beach nesting birds.	1	2	3	4	5
The best available information to decide what action I should take regarding ATV management.	1	2	3	4	5
Timely information regarding ATV related issues.	1	2	3	4	5

b) With respect to ATV management, I feel that the **NB ATV Federation** …

	Strongly Disagree	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
…share similar values as me.	1	2	3	4	5
…think in a similar way as me.	1	2	3	4	5
…take similar actions as I would.	1	2	3	4	5
…shares similar goals as me.	1	2	3	4	5

c) With respect to ATV management, I feel confident that the **NB ATV Federation** …

	Strongly Disagree	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
…can effectively manage ATVs.	1	2	3	4	5
…will respond to ATV conflict properly.	1	2	3	4	5
…will listen to the residents concerns about ATV management.	1	2	3	4	5

d) What grade would you give the **NB ATV Federation** for managing ATVs?

	Perfect				**Fail**
Please circle *the letter that best represents your response.*	A	B	C	D	F

3. **Nature Conservancy of Canada (NCC)**

a) These questions are about your feelings toward the **Nature Conservancy of Canada (NCC).**

I trust NCC to provide:	**Strongly Disagree**	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
Truthful information about management issues on beach nesting birds.	1	2	3	4	5
The best available information to decide what action I should take regarding ATV management.	1	2	3	4	5
Timely information regarding ATV related issues.	1	2	3	4	5

b) With respect to ATV management, I feel that the **Nature Conservancy of Canada** …

	Strongly Disagree	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
…share similar values as me	1	2	3	4	5
…think in a similar way as me.	1	2	3	4	5
…take similar actions as I would.	1	2	3	4	5
…shares similar goals as me.	1	2	3	4	5

c) With respect to ATV management, I feel confident that the **Nature Conservancy of Canada**…

	Strongly Disagree	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
…can effectively manage ATVs.	1	2	3	4	5
…will respond to ATV conflict properly.	1	2	3	4	5
…will listen to the residents concerns about ATV management.	1	2	3	4	5

d) What grade would you give the **Nature Conservancy of Canada** for managing ATVs?

	Perfect				**Fail**
***Please circle** the letter that best represents your response.*	A	B	C	D	F

L. *Of the following groups that could offer you* ***information about ATVs and ATV management*** *in your community how much* ***do you*** *agree or disagree with the statement* ***"I trust the information coming from these agencies".***

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Not Familiar
Justice and Public Safety NB Conservation Officers	1	2	3	4	5	NF
The Nature Conservancy of Canada	1	2	3	4	5	NF
NB ATV Federation	1	2	3	4	5	NF
Nature New Brunswick	1	2	3	4	5	NF
University Researchers	1	2	3	4	5	NF
Canadian Wildlife Service	1	2	3	4	5	NF
Parks Canada	1	2	3	4	5	NF
Bird Studies Canada	1	2	3	4	5	NF
New Brunswick Tourism Association	1	2	3	4	5	NF

M. *To what extent* ***do you*** *agree or disagree with each of the following statements about* ***your attitude toward sand dunes.*** *(Circle* ***ONE*** *number for* ***EACH*** *statement).*

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
I am aware of the impacts that humans can have on sand dunes.	1	2	3	4	5
My personal actions can impact the ability of sand dunes to recover.	1	2	3	4	5
If I drive my ATV on sand dunes, it *doesn't* hurt the ecosystem's ability to survive.	1	2	3	4	5
I feel a strong personal obligation to protect sand dunes.	1	2	3	4	5
I feel an obligation to educate others about the importance of protecting sand dunes.	1	2	3	4	5
It is *not* my responsibility to protect sand dunes.	1	2	3	4	5

N. *To what extent do **you** agree or disagree with each of the following statements **about management**. (Circle **ONE** number for **EACH** statement).*

	Strongly Disagree	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
The government should do more to protect sand dunes.	1	2	3	4	5
Land managers are doing everything they can to save sand dunes.	1	2	3	4	5
I would be willing to work together with management agencies to help protect dunes and beaches.	1	2	3	4	5
I would be willing to participate in community discussions about ATV management.	1	2	3	4	5
I would support closing ATV trails leading to beaches.	1	2	3	4	5
I would support ATVs driving on the wet sand on beaches.	1	2	3	4	5
Laws protecting sand dunes are too strict.	1	2	3	4	5
I would be willing to limit my recreational use of sand dunes during certain seasons to help protect the dunes and the wildlife that live there.	1	2	3	4	5
I would limit my recreational use of beaches if there were more designated trails inland.	1	2	3	4	5
There should be limits on the number of ATVs allowed in certain areas.	1	2	3	4	5

O. *The last few questions will help us learn whether the sample of residents in this study is similar to residents in other communities across the province. Please **circle** your response.*

1. Are you: a) Female b) Male c) Other d) Prefer not to say

2. What is your age?
   a) 19-24 b) 25-29 c) 30-34 d) 35-39 e) 40-44 f) 45-49
   g) 50-54 h) 55-59 i) 60-64 j) 65-69 k) 70-74 l) 75+

3. How many ATV riders live in your household? _________

4. How many months per year do you live in this community? ____________

5. How many years have you lived in your community?
   a) Less than 1 year b) 1-5 years c) 6-10 years
   d) 11-15 years e) 16-20 years f) Over 20 years

Are there any other comments you wish to make?

Thank you again for your participation!

CONFIDENTIEL

Faites en sorte que votre opinion compte!

Que pensez-vous de l'utilisation des véhicules tout-terrain (VTT)?

Cher résident :

L'Université Memorial veut en connaître plus sur les opinions, les motivations, et les buts des résidents d'Escuminac, Pointe-Sapin, et l'île Miscou à propos de l'utilisation des VTT dans votre région. Vos réponses nous fourniront de précieux éclaircissements sur comment les représentations des néo-brunswicrois à propos des VTT et sur comment ils envisagent la gestion de cette activité dans leur région.

Vous avez été choisi au hasard pour partager vos opinions sur ce sujet. Ce sondage ne devrait prendre que 15 minutes à remplir. Nous demandons qu'une personne de **19 ans ou plus** participent à l'étude. **S'il y a plusieurs utilisateurs de VTT dans la maison, l'adulte qui fetera son ANNIVERSAIRE LE PROCHAIN devrait remplir le questionnaire.**

Quand vous aurez complété le sondage, s'il vous plaît scellez-le dans l'enveloppe fournie et suspendez-le dans le sac en plastique à la poignée de votre porte.
Un assistant de recherche va ramassera votre sondage ________________ d'entre ___ et ___.
**REMARQUER : Pour cette étude, un VTT est défini comme trois, quatre (quad), côte à côte (Side by Side) ou un six roues conçus pour une conduite tout-terrain. Les motoneiges et les motocross ne sont pas inclus comme VTT dans cette étude.*

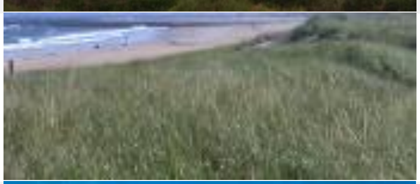
Veuillez répondre à toutes les questions de la manière la plus complète possible. Nous vous encourageons à émettre votre opinion, que vous soyez pour, contre ou que vous soyez neutre. Vos réponses seront groupées avec celles des autres. Toutes les réponses individuelles seront gardées **strictement confidentielles.**
Nous vous remercions pour votre aide en participant à cette étude portant sur l'utilisation récréative des VTT. Si vous avez des questions à propos de l'étude ou sur le questionnaire, n'hésitez pas à contacter Jessica Hogan au (506) 337-2124 ou par courriel au nbATVstudy@gmail.com. Votre participation à ce projet est grandement appréciée.
Sincèrement,

Jessica Hogan
Project Manager

Alistair Bath
Project Supervisor

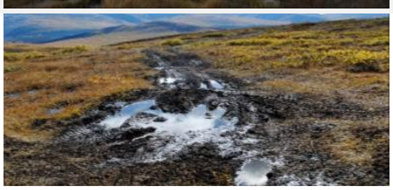
A. Ci-contre se trouve une photo d'une dune de sable côtière*. Les dunes de sable sont de petites crêtes ou amoncellements de sable (parfois couvert de végétation) qui se trouve à la limite d'une plage, au-dessus du niveau maximal normal des vagues.*

B. *Les premières questions vous demandent de* ***classer les niveaux d'impact (s'il y a lieu)*** *que vous voyez* ***sur chacune*** *de ces* ***photos de dunes de sable****. (****Veuillez encercler*** *le numéro qui correspond le mieux à votre réponse pour* ***chaque énoncé****) .*

Selon vous*, quelle est l'importance de l'impact humain (s'il y a lieu) sur les dunes suivantes ?*	**Aucun Impact**	**Faible Impact**	**Impact Modéré**	**Impact Élevé**	**Impact Extrême**	**Incertain**
	1	2	3	4	5	U
	1	2	3	4	5	U
	1	2	3	4	5	U
	1	2	3	4	5	U

C. Ci-contre se trouve une photo d'une* tourbière*. *Les tourbières sont des zones de végétation humide et spongieuse (appelé mousse de tourbe) qui ont été séparées en couches pendant plusieurs milliers d'années.*

D. *Les premières questions vous demandent de* ***classer les niveaux d'impact (s'il y a lieu)*** *que vous voyez* ***sur chacune*** *de ces* ***photos de tourbières.*** *(veuillez encercler le numéro qui correspond le mieux à votre réponse pour chaque énoncé) .*

Selon vous*, quelle est l'importance de l'impact humain (s'il y a lieu) sur les tourbières suivantes ?*	**Aucun Impact**	**Faible Impact**	**Impact Modéré**	**Impact Élevé**	**Impact Extrême**	**Incertain**
	1	2	3	4	5	U
	1	2	3	4	5	U
	1	2	3	4	5	U
	1	2	3	4	5	U

E. *Les questions suivantes portent sur* ***votre expérience avec l'VTT.*** *Veuillez encercler votre réponse :*

1. Avez-vous déjà utilisé un VTT soit comme conducteur ou passager ?
   a) Oui
   b) Non -> **Si non, veuillez passer à la section G.**
2. Si vous avez répondu oui à la question ci-dessus, comment avez-vous l'utilisez vas habitude ?
   a) Comme conducteur
   b) Comme passager
   c) Tous les deux
3. Possédez-vous un VTT? a) Oui b) Non
4. Si vous avez répondu oui, **combien** en possédez-vous? (Inscrivez un chiffre spécifique, ex., 2)
   a) VTT: _______ b) Côte à côte ________
5. Depuis combien d'années faites-vous du VTT? _________
6. Durant les 12 derniers mois, environ combien de jours avez-vous fait du VTT? _________
7. Pendant quels mois faites-vous habituellement du VTT? (Encerclez tout ce qui s'applique).

a) Janvier	b) Février	c) Mars	d) Avril	e) Mai	f) Juin
g) Juillet	h) Août	i) Septembre	j) Octobre	k) Novembre	l) Décembre

F. À quelle fréquence utilisez-vous votre VTT pour les utilisations suivantes ? *(Encerclez* ***UN*** *chiffre pour* ***CHAQUE*** *énoncé)*

J'utilise mon VTT…	Jamais	Rarement	Parfois	Plupart du temps	Tout le temps
…pour m'assister dans la coupe de bois.	1	2	3	4	5
…pour m'assister dans la chasse.	1	2	3	4	5
…pour m'aider à transporter mon équipement de pêche à la plage.	1	2	3	4	5
…pour m'aider à ramasser les casiers à homard de la plage.	1	2	3	4	5
…pour explorer les sentiers et les terres publiques.	1	2	3	4	5
…pour m'amuser et pour les sensations fortes.	1	2	3	4	5
…pour me transporter depuis le chalet.	1	2	3	4	5
…pour me rendre à la plage pour y marcher.	1	2	3	4	5
…pour rouler dans les dunes de sable.	1	2	3	4	5
…pour rouler sur les tourbières.	1	2	3	4	5
…pour rouler dans les pistes désignées pour le VTT.	1	2	3	4	5
…pour rouler sur les plages.	1	2	3	4	5
…sur les plages (sur le sable humide).	1	2	3	4	5

***G.** Les prochaines questions portent sur **votre opinion à propos de l'utilisation des VTT dans votre communauté.** Veuillez encercler le numéro qui correspond le mieux à votre réponse pour chaque énoncé.*

	Fortement en désaccord	**En désaccord**	**Indifférent**	**D'accord**	**Fortement d'accord**
L'utilisation des VTT est une partie importante de la culture de ma communauté.	1	2	3	4	5
Il est important de protéger l'environnement même si ça empêche l'utilisation de VTT dans certaines régions.	1	2	3	4	5
J'ai le droit de rouler où je veux sur les plages et les dunes de la région	1	2	3	4	5
L'utilisation récréative de l'environnement côtier est plus importante que la protection des dunes de sable.	1	2	3	4	5
Les besoins des gens seront toujours plus importants que tout droit qu'auraient les dunes de sable.	1	2	3	4	5
Les dunes de sable ne devraient pas être remises en état sauf s'il y a un avantage direct pour l'homme.	1	2	3	4	5
Nous devrions lutter pour avoir une société qui met des efforts pour la protection de l'environnement plutôt que sur une croissance économique.	1	2	3	4	5
Les dunes de sable devraient être protégées pour leur propre bien plutôt que pour simplement répondre à nos besoins.	1	2	3	4	5
Le droit d'exister des dunes de sable est plus important que les effets négatifs qu'aurait leur rétablissement sur les hommes.	1	2	3	4	5

H. *Les questions suivantes portent sur* ***vos connaissances sur les dunes de sable****.*

1. Avant de recevoir ce sondage, aviez-vous entendu parler des dunes de sable ?	Oui Non
2. Veuillez indiquer si vous croyez que **chacun** des énoncés suivants portant sur les dunes de sable est vrai ou faux. (Encerclez **UN** lettre pour **CHAQUE** *énoncé)*	

Sand dunes…	Vrai	Faux	Incertain
…sont près de ma communauté.	T	F	U
…changent constamment et se déplacent.	T	F	U
…protègent le littoral des dommages causés par les vagues lors de tempêtes.	T	F	U
…protègent l'habitat humide situé derrière elles.	T	F	U
…ont besoin de plantes pour aider au soutien du sable	T	F	U
…ont besoin d'eau pour aider au soutien du sable.	T	F	U
…ont besoin de vent pour aider au soutien du sable.	T	F	U
…offrent un habitat à plusieurs espèces d'oiseaux de rivage.	T	F	U

I. *Cette section porte sur ce que* ***vous jugez*** *être* ***inacceptable ou acceptable*** *pour les* ***actions suivantes****?*

À quel niveau croyez-vous que c'est inacceptable ou acceptable que des VTT…	Extrêmement Inacceptable	Modérément Inacceptable	Indifférent	Modérément acceptable	Extrêmement acceptable
…roulent sur des pistes désignées pour les VTT.	1	2	3	4	5
….roulent sur des pistes où personne n'est encore passé en VTT.	1	2	3	4	5
…roulent sur les dunes de sable.	1	2	3	4	5
…roulent sur les plages (sur le sable humide).	1	2	3	4	5
…roulent sur les tourbières.	1	2	3	4	5
…roulent sur les plantes des dunes.	1	2	3	4	5
…roulent sur toutes les plages.	1	2	3	4	5
….forment de profondes pistes dans le sable des dunes.	1	2	3	4	5
…soient interdits sur toutes les dunes de sable.	1	2	3	4	5
…soient interdits sur toutes les plages.	1	2	3	4	5

J. *Les dunes de sable font face à plusieurs problèmes.* ***Quelle importance croyez-vous que chacun de ces éléments ait comme impact sur les dunes de sable ?*** *(Encerclez* ***UN*** *chiffre pour* ***CHAQUE*** *énoncé)*

	Aucun Impact	**Faible Impact**	**Impact Modéré**	**Impact Élevé**	**Impact Extrême**	**Incertain**
a. Les VTT qui roulent sur la végétation.	1	2	3	4	5	U
b. Perte d'habitat causé par les développements humains. (Ex. construire une maison, un refuge ou un chalet)	1	2	3	4	5	U
c. Les VTT aplanissant les côtes de sable.	1	2	3	4	5	U
d. Feux de camp.	1	2	3	4	5	U
e. La sécheresse.	1	2	3	4	5	U
f. Les VTT qui forment de profondes pistes dans le sable.	1	2	3	4	5	U
g. Le tourisme.	1	2	3	4	5	U
h. Les tempêtes.	1	2	3	4	5	U
i. L'élargissement des pistes de VTT.	1	2	3	4	5	U
j. Le déversement des poubelles.	1	2	3	4	5	U
k. Râteler la plage.	1	2	3	4	5	U
l. Les animaux qui mangent l'herbe des dunes.	1	2	3	4	5	U

Parmi la liste des risques potentiels énumérés dans la section J (au-dessus), lequel serait le risque principal aux dunes de sable selon vous? (N'écrivez qu'UNE LETTRE) ____________

K. *Dans cette section, nous aimerions savoir comment* ***vous vous sentez*** *au sujet* ***des agents de conservation de Justice et Sécurité publique du Nouveau-Brunswick, de Conservation de la nature Canada et de la Fédération des VTTNB****.*

1. Les agents de conservation de Justice et Sécurité Publique du NB (Les agents de Conservation NB).

a) Ces questions portent sur votre opinion sur **les agents de conservation NB**.

Je fais confiance aux agents de conservation NB pour offrir:	**Fortement en désaccord**	**En désaccord**	**Indifférent**	**D'accord**	**Fortement d'accord**
De l'information véridique sur la gestion des enjeux liés aux oiseaux nichant sur la plage.	1	2	3	4	5
L'information la plus juste pour décider quelle action je devrais adopter concernant la gestion des VTT.	1	2	3	4	5
Des renseignements exacts et à jour concernant les enjeux liés aux VTT.	1	2	3	4	5

b) Concernant la gestion des VTT, je sens que **les agents de conservation NB**…

	Fortement en désaccord	**En désaccord**	**Indifférent**	**D'accord**	**Fortement d'accord**
…partagent des valeurs semblables aux miennes.	1	2	3	4	5
…partagent des opinions semblables aux miennes.	1	2	3	4	5
…prennent des décisions semblables à celles que je prendrais.	1	2	3	4	5
…partagent des objectifs semblables aux miens.	1	2	3	4	5

c) Concernant la gestion des VTT, j'ai confiance que **les agents de conservation**...

	Fortement en désaccord	**En désaccord**	**Indifférent**	**D'accord**	**Fortement d'accord**
…peuvent efficacement faire appliquer les lois.	1	2	3	4	5
…vont gérer les conflits de VTT de la bonne manière.	1	2	3	4	5
…vont écouter les inquiétudes des résidents à propos de la gestion des VTT.	1	2	3	4	5

d) Quelle note accorderiez-vous **aux agents de conservation NB** pour leur gestion des VTT?

	Parfait				**Échec**
Veuillez encercler *la lettre qui correspond le mieux à votre réponse.*	A	B	C	D	F

2. La Fédération des VTT du Nouveau-Brunswick (Fédération des VTTNB).

a) Ces questions portent sur **votre opinion** sur **La Fédération des VTTNB**

J'ai confiance en la Fédération VTT NB pour offrir:	**Fortement en désaccord**	**En désaccord**	**Indifférent**	**D'accord**	**Fortement d'accord**
De l'information véridique sur la gestion des enjeux liés aux oiseaux nichant sur la plage.	1	2	3	4	5
L'information la plus juste pour décider quelle action je devrais adopter concernant la gestion des VTT.	1	2	3	4	5
Des renseignements exacts et à jour concernant les enjeux liés aux VTT.	1	2	3	4	5

b) Concernant la gestion des VTT, **j'ai confiance que la Fédération VTTNB**…

	Fortement en désaccord	**En désaccord**	**Indifférent**	**D'accord**	**Fortement d'accord**
…partage des valeurs semblables aux miennes.	1	2	3	4	5
…partage des opinions semblables aux miennes.	1	2	3	4	5
…prenne des décisions semblables à celles que je prendrais.	1	2	3	4	5
…partage des objectifs semblables aux miens.	1	2	3	4	5

c) Concernant la gestion des VTT, j'ai confiance que **La Fédération des VTTNB** …

	Fortement en désaccord	**En désaccord**	**Indifférent**	**D'accord**	**Fortement d'accord**
…peut efficacement faire appliquer les lois.	1	2	3	4	5
…va gérer les conflits de VTT de la bonne manière.	1	2	3	4	5
…va écouter les inquiétudes des résidents à propos de la gestion des VTT.	1	2	3	4	5

d) Quelle note accorderiez-vous **La Fédération des VTTNB** pour leur gestion des VTT?

	Parfait				**Échec**
Veuillez encercler *la lettre qui correspond le mieux à votre réponse.*	A	B	C	D	F

3. La Conservation de la nature du Canada (CNC)*.*

a) Ces questions portent sur votre opinion sur **La Conservation de la Nature du Canada**.

J'ai confiance en CNC pour offrir :	**Fortement en désaccord**	**En désaccord**	**Indifférent**	**D'accord**	**Fortement d'accord**
De l'information véridique sur la gestion des enjeux liés aux oiseaux nichant sur la plage.	1	2	3	4	5
L'information la plus juste pour décider quelle action je devrais adopter concernant la gestion des VTT.	1	2	3	4	5
Des renseignements exacts et à jour concernant les enjeux liés aux VTT.	1	2	3	4	5

b) Concernant la gestion des VTT, je crois que **La Conservation de la Nature Canada**…

	Fortement en désaccord	**En désaccord**	**Indifférent**	**D'accord**	**Fortement d'accord**
…partage des valeurs semblables aux miennes.	1	2	3	4	5
…partage des opinions semblables aux miennes.	1	2	3	4	5
…prenne des décisions semblables à celles que je prendrais.	1	2	3	4	5
…partage des objectifs semblables aux miens.	1	2	3	4	5

c) Concernant la gestion des VTT, j'ai confiance que **La Conservation de la Nature Canada**…

	Fortement en désaccord	**En désaccord**	**Indifférent**	**D'accord**	**Fortement d'accord**
…peut efficacement faire appliquer les lois.	1	2	3	4	5
…va gérer les conflits de VTT de la bonne manière.	1	2	3	4	5
…va écouter les inquiétudes des résidents à propos de la gestion des VTT.	1	2	3	4	5

d) Quelle note accorderiez-vous à **La Conservation de la Nature Canada** pour leur gestion des VTT?

	Parfait				**Échec**
Veuillez encercler *la lettre qui correspond le mieux à votre réponse.*	A	B	C	D	F

L.** Parmi les groupes suivants qui pourraient vous offrir de **l'information à propos des VTT et de la gestion des VTT** dans votre communauté, à quel niveau **êtes-vous** d'accord ou en désaccord avec l'énon**cé « J'ai confiance en l'information provenant de ces agences ».

	Fortement en désaccord	En désaccord	Indifférent	D'accord	Fortement d'accord	Je ne connais pas
Les agents de conservation de Justice et Sécurité	1	2	3	4	5	CP
La Fédération des VTTNB	1	2	3	4	5	CP
La Conservation de la Nature Canada	1	2	3	4	5	CP
Nature Nouveau-Brunswick	1	2	3	4	5	CP
Chercheurs Universitaires	1	2	3	4	5	CP
Service Canadien de la Faune	1	2	3	4	5	CP
Parcs Canada	1	2	3	4	5	CP
Études d'oiseaux Canada	1	2	3	4	5	CP
Association du Tourisme NB	1	2	3	4	5	CP

***M.** Dans quelle mesure **êtes-vous** d'accord ou en désaccord avec chacun des énoncés suivants portant sur **votre attitude envers les dunes de sable.** (Encerclez **UN** chiffre pour **CHAQUE** énoncé)*

	Fortement en désaccord	En désaccord	Indifférent	D'accord	Fortement d'accord
Je suis conscient de l'impact que les hommes peuvent avoir sur les dunes de sable.	1	2	3	4	5
Mes actions personnelles peuvent avoir un impact sur la capacité des dunes de sable de se remettre en état.	1	2	3	4	5
Si je roule sur les dunes de sable avec mon VTT, ce ne pourrait pas nuire aux capacités de survie de l'écosystème.	1	2	3	4	5
Je ressens une forte obligation personnelle de protéger les dunes de sable.	1	2	3	4	5
Je ressens l'obligation d'éduquer les autres à propos de l'importance de protéger les dunes de sable.	1	2	3	4	5
Je *ne* suis *pas* responsable de la protection des dunes de sable.	1	2	3	4	5

***N.** Dans quelle mesure êtes-**vous** d'accord ou en désaccord avec chacun des énoncés suivants **portant sur la gestion.** (Encerclez **UN** chiffre pour **CHAQUE** énoncé)*

	Fortement en désaccord	**En désaccord**	**Indifférent**	**D'accord**	**Fortement d'accord**
Le gouvernement devrait agir davantage pour protéger les dunes de sable.	1	2	3	4	5
Les gestionnaires des terrains font de leur mieux pour sauvegarder les dunes de sable.	1	2	3	4	5
Je serais prêt à collaborer avec les agences de gestion pour aider à protéger les dunes et les plages.	1	2	3	4	5
Je serais prêt à participer à des discussions communautaires portant sur la gestion des VTT.	1	2	3	4	5
Je soutiendrais l'idée de fermer des pistes de VTT menant aux plages.	1	2	3	4	5
J'appuierais une décision permettant aux VTT de rouler sur le sable humide des plages.	1	2	3	4	5
Les lois protégeant les dunes de sable sont trop strictes.	1	2	3	4	5
Je serais prêt à limiter mon utilisation récréative des dunes de sable pendant certaines saisons afin de contribuer à la protection des dunes et à la faune qui y vit.	1	2	3	4	5
Je diminuerais mon utilisation récréative des plages s'il existait davantage de pistes désignées à l'intérieur des terres.	1	2	3	4	5
Le nombre de VTT devrait être limité dans certains endroits	1	2	3	4	5

O. *Les quelques questions suivantes devraient nous permettre de savoir si l'échantillon de résidents dans cette étude est similaire aux résidents dans d'autres communautés. Veuillez* ***encercler*** *votre réponse :*

1. Êtes-Vous : a) Femme b) Homme c) Autre d) Je préfère ne pas répondre.
2. Quel âge avez-vous ?

a) 19-24	b) 25-29	c) 30-34	d) 35-39	e) 40-44	f) 45-49
g) 50-54	h) 55-59	i) 60-64	j) 65-69	k) 70-74	l) 75+

3. Combien de conducteurs de VTT vivent dans votre maison ? _________
4. Combien de mois par année habitez-vous dans cette communauté ? ____________
5. Depuis combien d'années vivez-vous dans votre communauté ?

a) Moins de 1 ans	b) 1-5 ans	c) 6-10 ans
d) 11-15 ans	e) 16-20 ans	f) Plus de 20 ans

Aimeriez-vous laisser un commentaire ?

Nous vous remercions pour votre participation !